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BIO-PSYCHO-SOCIAL ASPECTS OF SEVERE MULTIPLE TRAUMA

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Til Egil
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Contents

Abstract

Subjects with severe multiple trauma present great challenges in rehabilitation, and investigations with a holistic bio-psycho-social point of view have been scarce. In the main part of this investigation all 146 patients with severe multiple trauma (ISS ≥16) admitted to a regional hospital in 1990, were target. Ten years survival probability for those discharged alive from the Department of Surgery (n: 91) was 82%. Mortality rates were significantly higher than those of the general population, particularly during the first year after discharge, during which the main cause of death was traumatic brain injury. Later, overuse of alcohol and drugs, were the main causes of death.

A principal aim was to analyse the relations between impairments/ functions, disabilities/ abilities and psychological and social well-being. In a three year follow-up investigation of 69 subjects (84% of those available), 80% had one or more residual impairments: 74% had physical and 32% cognitive impairment. Very few subjects (n=4) were ADL-dependent. Vocational disability was present in 19% and leisure disability in 76%. Vocational disability was associated with higher age, blue collar work and cognitive impairment. Leisure disability was most prevalent in those with severe physical impairments and residual pain. Cognitive performance was significantly related both to the severity of traumatic brain injury and to degree of psychological distress.

A consecutive series of subjects with severe multiple trauma without brain injury (n:26), were investigated at admission to the rehabilitation hospital, at discharge and at follow-up 1-3.5 year following trauma. Both retrospectively and prospectively, the subjects experienced significant decreases in satisfaction with life as a whole from before to after trauma. Furthermore, compared to before trauma, significantly fewer subjects reported to be satisfied (5-6) with life as a whole, and with the domains: Sexual life, ADL, contact with friends,

leisure, vocational situation and financial situation. Among the life satisfaction domains, the most important contributors for global life satisfaction after trauma, were satisfaction with leisure, family life and vocation. In multiple regression analyses, having a sufficient social network, and also a strong sense of coherence, could buffer the negative influence of disabilities on life satisfaction following trauma.

Though level of sense of coherence was closely related to simultaneously measured social well-being, the SOC was not stable over time, and the hypothesis about a strong sense of coherence as protective against future distress and reduced satisfaction after stressful life events could not be confirmed, at least not the first years after multiple trauma.

Original papers

This dissertation is based upon the following papers. In the text they will be referred to by their Roman numerals:

I. Anke AGW, Stanghelle JK, Finset A, Roaldsen KS, Pillgram-Larsen J, Fugl-Meyer AR: Long-term prevalence of impairments and disabilities after multiple trauma *J Trauma* 1997; 42: 54-61.

II. Finset A, Anke AW, Hofft E, Roaldsen KS, Pillgram-Larsen J, Stanghelle JK: Cognitive performance in multiple trauma patients 3 years after injury. *Psychosom Med* 1999; 61: 576-83.

III. Anke AGW, Fugl-Meyer AR: Life satisfaction several years after severe multiple trauma. *In press. Clinical Rehabilitation.*

IV. Snekkevik H, Anke AGW, Stanghelle JK, Fugl-Meyer AR: Is sense of coherence stable after multiple trauma? *In press. Clinical Rehabilitation.*

V. Anke AGW, Arnesen E: Ten years mortality following severe multiple trauma. *Submitted.*

List of abbreviations

AIS	= Abbreviated Injury Scale
ADL	= Activities of Daily Living
GCS	= Glasgow Coma Scale
GHQ	= General Health Questionnaire
HAD	= Hospital Anxiety and Depression Scale
ICF	= International Classification of Functioning, Disability and Health
ICIDH	= International Classification of Impairments, Disabilities and Handicap
ISS	= Injury Severity Score
SMR	= Standardised Mortality Ratio
SOC	= Sense of Coherence
WHO	= World Health Organisation

Introduction

Why this interest for subjects with severe multiple trauma?

When you know a thing, to hold that you know it; and when you do not know a thing, to allow that you do not know it; this is knowledge.

CONFUCIUS, Analects. Bk. ii, ch. 17. (Legge, tr.)

Patients or rather subjects with severe multiple trauma are treated and referred to as particularly challenging by intensive care personnel, and much organisational improvements have been achieved all over the world to try to diminish disability (1-4). In spite of this interest for organisational improvements of acute care, both pre- and in-hospital, multiple trauma appears neither well defined nor given special rehabilitative attention. For instance textbooks in rehabilitation medicine (5,6) hardly mentioned multiple trauma.

In my work with rehabilitation medicine at Sunnaas rehabilitation hospital, inspired by more experienced colleagues, these subjects represented great challenges. They appeared with a variety of impairments, often prognostic uncertainty and appearances of impairments not diagnosed in the acute phase; and – in contrast to treatment after spinal cord injuries - poorly organised co-operation between the department of surgery and the rehabilitation unit. Therefore, it became important for us to improve our knowledge and care of this group of subjects.

One really impressing experience in my work within rehabilitation medicine, was to perceive the great diversities of coping abilities of human beings, even after extreme life events. Firstly it appeared important to increase my knowledge by exploring this aspect further. The second important aspect was to explore some of the elements in rehabilitation

medicine pertaining to multiple trauma: the complex relations between personality trait, resources, impairments, disabilities, coping and satisfaction with life. But for those subjects, how can the rehabilitation process be operationalised? What is the outcome in rehabilitation medicine? Which models are useful?

There is a voluminous discussion on to which factors should be recorded for describing general outcome. According to Guldvog (7) outcome assessments should include clinical end points; physical, social and role functioning in everyday living; subjects perception of their general health and well-being; and satisfaction with life and treatment. A main clinical end point after trauma or disease is survival or death.

Others (8) have described the measures of outcome research as tools focusing on: 1) clinical signs and symptoms; 2) well-being or mental and emotional functioning; 3) physical, cognitive and social functioning; 4) satisfaction with care; 5) health-related quality of life (HRQL); and 6) costs and appropriate use of resources.

Many research methods are not suited for subjects living with disabilities, and accordingly it has been argued for "universal design" in research methods and instruments, to allow the results to reflect the experiences of all members of the society (9).

Disability outcomes research

There is growing enthusiasm for disability outcome research in general, but no general agreements of instruments, methods or use of clinical end points. This is, of course, an obstacle for evidence-based rehabilitative investigation. When doing research within the field of rehabilitation medicine, it seems necessary to use a conceptual framework or model, to try to explore the complex relationships between personality, resources, health, functioning, activities, environment and satisfaction with life. At least, one has to define carefully what dimension or dimensions that are investigated.

Fugl-Meyer et al (10) claim that adaptation after trauma or disease, and resulting level of satisfaction with life as a whole and with different domains of life, are the ultimate outcomes of rehabilitation medicine.

However, measures concerning life satisfaction or quality of life are often not mentioned or discussed. Andresen et al (8) have described 5 components *usually* found in the conceptual frameworks that present a dimensional approach to disability: 1) pathology or aetiology; 2) body functions, 3) personal activities; 4) interaction with the environment; and 5) community or societal participation. She pointed out that confusion can be created when distinctions among the various dimensions are not provided, or when the environmental factors are not included in the methodology and measures. Obviously the patient's subjective experiences are often not recorded, neither concerning subjective well-being, life satisfaction or satisfaction with treatment.

Recently van Dijk in his dissertation (11) investigated and defined the term "rehabilitation". He suggested that the concept of rehabilitation might be investigated as an intra-individual process of adaptation, where adaptation in this context is associated with equilibrium. Furthermore the term "rehabilitation" may be conceived as a *process within* an individual and as *assistance towards* that process.

There is under the auspices of the World Health Organisation an ongoing process to revise the International Classification of Impairments, Disabilities and Handicap (ICIDH) (12), which first appeared two decades ago. This has recently led to the concept of the International Classification of Functioning, Disability and Health (ICF) (13). I therefore choose to describe this model below, before the introduction of the Life Satisfaction Model, which is the basis of the major part of this dissertation.

ICIDH and ICF

The ICIDH, though controversial and quite extensively criticised, has been an important concept for rehabilitation medicine (14), as it described the *consequences* of chronic disease, disorders or impairments: "a manual of classification relating to the consequences of disease" (WHO 1980). In the ICIDH, WHO proposed that the medical model

Etiology → Pathology → Manifestation

be extended by

Disease/disorder → Impairment → Disability → Handicap

That would include the consequences of diseases common to chronic conditions, disorders, and impairments. As the ICIDH showed several general shortcomings (see for instance ref. 15), a new classification has been developed. This should include environmental factors, address dimensional overlaps, and propose associations between dimensions (Figure 1). The ICF claims to have moved away from a "consequence of disease" classification (1980 version) to a "components of health" classification, and has been suggested to be a promising conceptual framework for studying disabilities (16). Also stated by van Dijk (11), there is no mention of *consequences*, but of *functional states associated with health conditions*. This points to a more integrated and less biomedical idea of illness. The ICF emphasises to be a classification, and does not model the "process" of functioning and disability.

The model proposed includes both neutral and negative aspects of dimensions, and while Figure 1 presents the neutral terms (functioning, activities, participation), the coding scheme used in the ICF allows only for coding the negative aspects (impairments, activity limitation, participation restriction).

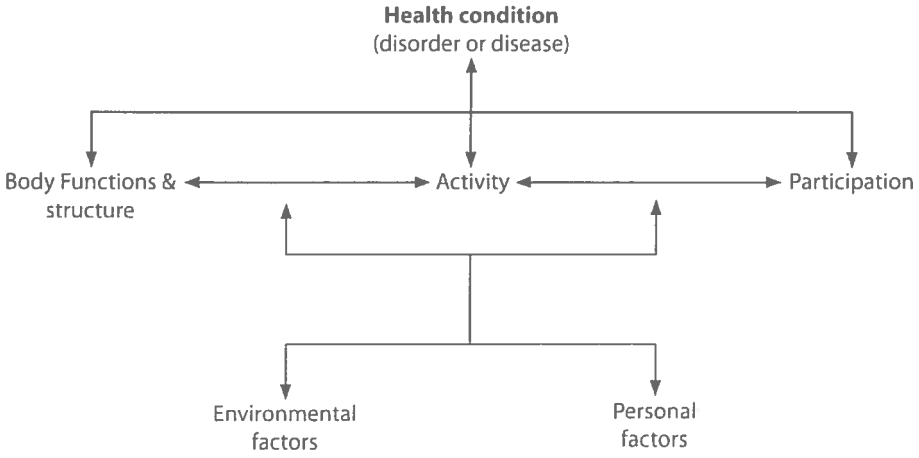

Figure 1. *The interactions between the components of ICF*

The components are defined as follows:

Body structures and functions/ impairments: Body functions are the physiological or psychological function of body systems. Significant deviations or loss in body structures and functions are described as impairments.

Activities are described as performance of person-level tasks or activities undertaken by the person. While activity limitations are classified to the extent that the individual has difficulty performing the activity, against a generally accepted population standard.

Participation is defined as "an individual's involvement in life situations in relation to health conditions, body functions and structures, activities and contextual factors." A key term in this definition is involvement. The ICF states that involvement means inclusion of the individual in life activities in the context of where they live. The restriction of participation or involvement in life activities/ society by external factors (social rules or environmental factors) is referred to as participation limitation/ restriction.

In the final version of ICF, the Activities and Participation component are, at least partly, integrated within one component.

The contextual factors are both environmental and personal. *Environmental factors* include the physical, social and attitudinal environments that influence individual functioning. *Personal factors* are described as "gender, age, other health conditions, fitness, lifestyle, habits, coping styles, social background, education, profession, past and current experiences (past life events and concurrent events), overall behaviours pattern and character style, individual psychological assets, and other characteristics, all or any of which may play a role in disability at any level." These are not classified.

The ICF-concept had been said to want to add a level of subjective satisfaction to the new version of the measure, by adding a second-level qualifier of subjective satisfaction to the participation dimension (16). In the final draft of ICF satisfaction with life, quality of life or social well-being, have still not been included in the classification system.

In this context I agree with van Dijk in some relevant critical considerations on the ICF (11, page 23):

1. The standard for identification of an individual's impairment, activity limitation and participation restriction is extrinsic.
2. The health condition of an individual is separated from personal factors belonging to the same individual.
3. The role of the environment remains unclear.
4. Subjective aspects are not addressed.

These considerations explain why the classification system, in my opinion, does not appear to be a unifying framework for patient care.

The Model of Life Satisfaction

The theoretical framework for this dissertation is a model with some elements from ICIDH (1980), omitting concept of handicap, and judging satisfaction with life as a whole, and satisfaction with different domains in life as the ultimate outcome measure in rehabilitation medicine. This model was first introduced by Fugl-Meyer et al in 1988 (10,15) and later modified. Figure 2 shows that:

"A conceptual model which suggests (left side of diagram) that for an individual, health implies function which provides ability to satisfy personal goals. Disease or injury (right side of diagram) may lead to loss of function at the organ level (WHO 1980) which in turn may lead to disability, i.e. inability to reach premorbid goals. Inadequate coping with the new life situation, i.e. the individual's inability to reorientate himself towards realisable and rewarding goals, will result in dissatisfaction."

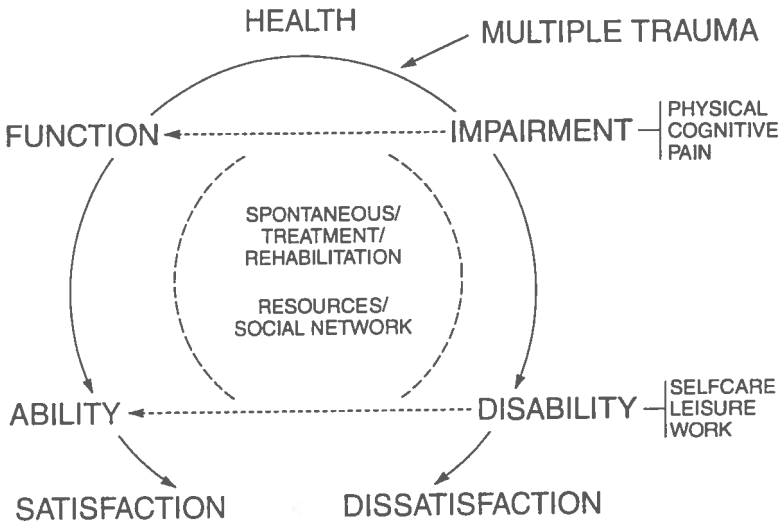

Figure 2. *The Model of Life Satisfaction*

For the individual, loss or restriction of premorbid abilities implies decreased capacity to manage some or all of the domains. This inability to reach premorbid goals creates a psychological and existential stress situation, an aspiration/ achievement-gap that calls for support and adequate coping strategies. In agreement with the later developed model of ICF, the Life-Satisfaction model used in the present dissertation uses both neutral and negative terms, i.e. function/ impairment, ability/ disability, satisfaction/ dissatisfaction. The concept of ability/ disability includes a variety of activity domains of life, and as so may be compared to the integrated activity/ participation component in the ICF.

Satisfaction with life as a whole can be defined as contentment, harmony or even happiness (10,17,18). Tatarkiewicz (18) claimed that satisfaction with life as a whole can be regarded as happiness, if justifiable and of reasonable duration. Also the concept of subjective well-being describes the person's own emotional and cognitive evaluations of their lives (19). An individual's judgement of life as a whole can be based on an affective aspect (hedonic level of affect) and a rational aspect, where the individual weights the degree to which he is satisfied in various aspects of life. This rational aspect describes the individual's level of contentment, and may best be explained through the degree to which an individual knows and believes that he can reach his goals (10,20,21). Michalos (22) found the perceived gap between what one «has» and what one «wants» to be the best predictor of happiness. In other words a satisfied subject is one who considers that she can achieve important goals within a variety of areas of activity: "To be happy a person must be able to act in ways that serve many goals, projects and aspirations simultaneously" (23). Satisfaction with particularly important goals would have particular impact on satisfaction with life as a whole.

This concept, the «bottom-up» model, proposes that overall life satisfaction result from satisfaction derived from specific domains of life. However, a satisfied life is not simply an accumulation of different satisfactions, and as demonstrated in earlier studies (10,24), a

person who is satisfied with life as a whole does not have to be satisfied with all domains in life. The opposite «top-down» point of view means that overall satisfaction with life should be seen as a trait: A happy individual has a disposition to experience himself as happy, and satisfaction with life as a whole is basis for satisfaction with different domains of life.

According to Fugl-Meyer et al (10,25), the goals, previous as well as possible new goals, will always be person-related. The level of satisfaction with life as a whole, for an individual, may be greater or less than the sum of domain-specific satisfactions seems to indicate – this is because the individual weighs his goals. Therefore, a main issue of rehabilitation is to support disabled subjects (i.e. those who cannot expect to reach their pre-impairment goals in their customary way) to reorientate themselves towards modified or new but realisable goals. The following definition of rehabilitation was introduced:

Rehabilitation is ensuring that subjects with impairment(s) which may lead to disabilities have their happiness secured or restored.

Furthermore, and also in agreement with elements later integrated in the theoretical framework of the ICF, but not in that classification system: We wanted to add elements of *sociodemographic factors, resources* and coping in relation to the Life Satisfaction model. According to Ben-Sira (26, page 726), resources are often classified according to their "source"; namely, who controls the resources: the individual himself (education, cultural characteristics, knowledge, money, etc), or his/her primary social network (social support) or secondary social environment (e.g. professional help) who place resources at the individual's disposal. Resources have the potential of enhancing successful coping, and self-controlled resources are frequently more effective than other-controlled resources (26). Individual resources and demographic factors, including the person's social network have been shown to influence the process of readjustment after trauma (27,28) and disease (29,30). Others (31)

have claimed that resources, defined as material, social or demographic characteristics that a person processes and may use to make progress toward his personal goals, show low predictive power for overall life satisfaction (Diener, Fujita 1995). One explanation for this is that people adapt to their level of resources.

There is a discussion about whether life events can permanently influence people's subjective well-being (17,19). Mankind is in a steady process of adaptation, and exposure to and coping with demands has been said to comprise the essence of human life (26,32). Thus, after most events there is a more or less fast adaptation and return to baseline, but nevertheless, some conditions affect people's evaluation of their lives lastingly. Coping with serious life events appears to be the central issue of rehabilitation medicine.

The sense of coherence

The sense of coherence was introduced by Antonovsky as a part of his salutogenic model. This model was constructed to answer the question: "What moves people toward the health end of the health ease/ dis-ease continuum?" (33). He had earlier constructed a concept labelled general resistance resources describing the total amount of resources available for a subject to reduce tension or cope with different life stressors, including resources like money, ego strength, cultural stability, social supports and other factors (29). "Why are this coping resources related to health? What do they have in common?" (33). Sense of coherence is thought to emerge out of the general resistance resources, and can be seen as a person's general orientation towards life, a way of viewing one's world (inner and outer) as structured rather than chaotic, and as posing problems which could be managed. More specifically Antonovsky (29,33) defined the sense of coherence as "a global orientation that expresses the extent to which a person has a pervasive, enduring, though dynamic feeling of confidence that

1) the stimuli deriving from one's internal and external environments in the course of living are structured, predictable and explicable, 2) resources are available to meet the demands posed by these stimuli, and 3) these demands are challenges, worthy of investment and engagement". These three components are labelled comprehensibility, manageability and meaningfulness. Thus, SOC should determine the perception and interpretation of external events, rather than the patterns of behaviour or specific coping strategies per se.

Antonovsky describes sense of coherence as a world view, global orientation or personality orientation (29, 34 p. 20) – a major coping resource for the preservation of health. Geyer (35), who discusses the fact that Antonovsky describes SOC as a disposition rather than a personality trait, claims that this distinction between trait and disposition "is misleading and it runs counter to the consensus of opinion in psychology" (35 p. 1773).

Usually, according to Antonovsky, the SOC-score for an individual should be a more or less constant value during the adult life, being established by the end of the second decade of life, and with only minor and temporary changes "in response to major changes in patterns of life experiences" (29 p. 125). However, in a prospective study of a group of medical students, Carmel et al (36) found increasing anxiety-scores and decreasing SOC-scores over time. Several authors (35,37,38) have asked for prospective investigations to clarify whether the SOC scale can be used as an outcome predictor with regard to psychosocial adaptation, in acute as well as in chronic health problems.

Sense of coherence may directly influence health in that it leads one to engage in behaviours which promotes health. Further, the strength of one's SOC is a powerful decisive throughout all stages of the stress process. A person with a strong SOC will tend to see stressors as neutral or even salutary in their consequences for her life. Thereby, in my opinion, a strong SOC could be viewed as an individual resource that facilitates the coping process.

Outcome after multiple trauma

Previous studies of long-term mortality after multiple trauma have been limited by fairly short follow-up periods (39,40,41), for example the two-year follow up investigation by van der Sluis et al (41). However, results so far have indicated a high survival probability after discharge from intensive care, and a need for outcome studies concerning function, activities and life satisfaction.

Differences in methodology and definitions often make it difficult to compare results concerning occurrence and level of impairments and disabilities after multiple trauma. Impairment, defined as loss or abnormality of physiologic or anatomic function, can be difficult to register, none the least for this heterogeneous population. In 1975 Bull (42) constructed a classification system of impairments after trauma, and reported that among those with severe injuries (ISS ≥16, cf. Methods), approximately 75% had at least "some residual disability".

Several authors have reported post-injury prevalences of disabilities, i.e. dependency in daily life activities (43), return to work (28), or a combination of dimensions, for example physical activity, mobility, self-care and vocational activity (41,44). Furthermore, changes of leisure activities have been reported for 45% of severely injured subjects (45).

There is a wealth of literature on psychological consequences of bodily trauma, also in the long-term perspective (See ref. 46). In Norway, Malt et al (47) claimed that the specific emotional responses to injury reflect the personal meaning of the trauma rather than injury severity per se. Even if psychological consequences of injury are important, and may effect also cognitive performances such as memory and attention (48), these aspects may often go unrecognised in multiple trauma subjects. Holbrook et al (49) found in their prospective study that postinjury depression was significantly associated with 6-month functional outcome.

Network resources, more specifically social support, have been shown to predict successful coping (32,33), and after major trauma MacKenzie et al (44) found that the number of confidants providing social support to the injured subject was positively correlated to return to work. Holbrook et al (49) measured social support after major trauma at discharge and 6-month follow-up, in terms of (1) the perceived number of social supports, and (2) satisfaction with social support. A negative change in satisfaction with social support was significantly associated with higher level of postinjury functional limitation.

What is understood by the term "quality of life", varies considerably in the literature, and is often linked to objective or health related phenomena, and not to subjective well-being or life satisfaction (50). Using the main search words "multiple trauma" and "life satisfaction", Medline yielded 0 articles. Using the search words "multiple trauma" and "quality of life", Medline yielded 38 articles published in 1984-2000, of these 22 in the English language and among these eight were judged to be of at least some relevance for the present investigation. Most of these 8 articles did not measure life satisfaction or subjective well-being, but quite objectively registered variables as mobility, dependency, medication, communication, and work status (41,51-53) or health related quality of life measured by the SF-36 (54). Holbrook (49) measured functional outcome using the Quality of Well-Being (QWB) scale, which includes a symptom scale and three scales of functioning: Mobility, physical activity, and social activity. The QWB- scale combines preference-weighted measures of "symptoms and functioning" to provide a numerical point-in-time expression of well-being, which ranges from 0 for death to 1.0 for "asymptomatic full functioning". One study (55) used a generic Perceived Quality of Life Measure, where accidentally traumatised subjects assessed their satisfaction with eleven aspects of life before and after trauma, rated on VAS-scales. After trauma, subjects reported significant decreases in relation to their overall health, happiness,

ability to think and to pursue leisure activities, their income and their employment. Also, their mean Perceived Quality of Life Score decreased with 13%. As recently discussed by Fugl-Meyer et al (21), the use of aggregated sum scores may obscure domains, within which a subject feels that he or she experiences an achievement/ aspirations gap.

Aims of the study

The overall aim of this investigation was to describe life after severe multiple trauma in terms of functions/ impairments, abilities/disabilities, sociodemographic and psychological coping resources and social well-being, and to to relate these aspects to each other.

Some specific aims in papers I-V were:

- To analyse mortality up to ten years after severe multiple trauma (V).
- To describe occurrence of impairments and disabilities (self-care, vocational and leisure disability) three years after trauma, and search for predictors of impairments and disabilities (I and II).
- To describe the levels and extent of changes in life satisfaction, and to relate life satisfaction to psychological well-being and sense of coherence. Finally, the stability of sense of coherence as a personality orientation was explored (III, IV).

Subjects

The subjects in parts I-III and V of this investigation were recruited from a regional surgical trauma unit during 1990, in Oslo, Norway. This year, Pillgram-Larsen and Solheim (56) prospectively investigated all multiple trauma patients, by analysing trauma scores and outcome during their acute stay. The total number of injured patients treated in 1990 was 2266, among whom 441 (19%) had multiple trauma. The definition of severe multiple trauma included an Injury Severity Score (ISS) of 16 or higher (cf. Methods-section) (57), and trauma to two or more body regions. As described by Pillgram-Larsen et al (56), 6.5% of all with injuries, were severely multitraumatised.

Figure 3 gives an overview of the subjects with severe multiple trauma and reasons for exclusion. The recorded in-hospital mortality was 28% and thus 105 subjects were discharged. A few of them were children younger than 12 years, and were excluded from follow up (I, II, III and V).

Paper V focuses on those subjects with severe multiple trauma who survived and were discharged from the trauma unit in 1990 (n=102). Nine subjects lived abroad and a further two could not be located. Hence, long-term mortality rate could be estimated for 91 of the discharged subjects.

In the follow-up investigation nearly three years (35 ± 4 months) after trauma, reasons for not being included were death (n:5), lost to follow up (n:3), and one subject had suffered a subsequent severe injury. Of the 82 remaining available subjects invited to participate, 69 (84%) volunteered to participate (I, III), 21 women (30%) and 48 men (70%). At the time of injury their mean age was 33 years, with a median age of 26 years (range 12-72 years). Twenty subjects (29%) had primary school education while the remaining subjects had higher education. Among the 58 subjects regularly working or studying at the time of injury, 14 were

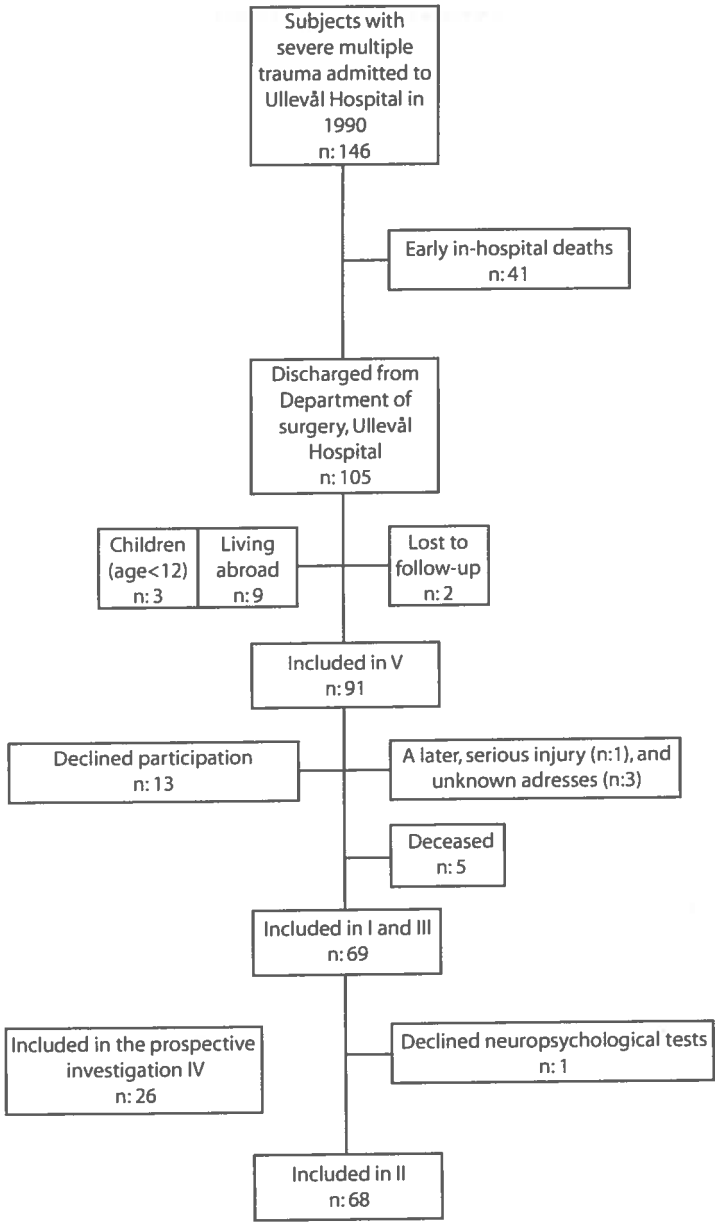

Figure 3. The subjects with severe multiple trauma and reasons for exclusions (I-V).

blue-collar and 44 were white-collar workers, the latter including 15 students. The mean ISS (cf. Methods) was 25 (range 17-50). The relative distribution of the most dominating injury (defined in the Methods-section) were: head (n=26, 37%), thorax/abdomen (n=22, 32%), extremities (n=11, 16%), face (n=6, 9%), spinal cord (n=4, 6%).

One of these subjects declined to participate in the neuropsychological tests, reducing the sample to 68 in the investigation of cognitive performance (II).

The subjects who were not included, did not differ significantly from the investigated subjects in terms of age, gender, injury type or injury severity.

The prospective investigation (IV) included subjects with severe multiple trauma consecutively admitted to Sunnaas Rehabilitation Hospital during the period from April-93 to January-96. Multiple trauma was defined as more than one injury. In accordance with clinical practice, also subjects with *multiple traumas within one body region*, particularly multiple extremity fractures, were included. Patients with evident neuropsychological deficits due to brain injury and with severe psychiatric problems were excluded. Two subjects declined to participate at the time of follow-up, giving 26 subjects, eight women and 18 men, to study prospectively. Their median age was 31 years (range 18-68 years), and median injury severity score was 25 (range 9-50). The dominating trauma for ten patients was complicated extremity fractures, nine had spinal cord injuries, and seven patients had pelvic fractures. Additional trauma were mainly rib fractures, lung contusions, pneumothorax/hematothorax and/or superficial wounds.

Methods

In I-III and V injury related variables were obtained from registrations at the surgical trauma unit in 1990 (56). The variables included age, gender, AIS/ ISS (type and severity of injury; cf. below), Glasgow Coma Scale and length of hospital stay.

In I-III all 69 included subjects were examined 35 ± 4 months after the trauma. Checklists concerning life satisfaction (LiSat-9) and leisure activities prior to and after trauma, were sent by mail to the subjects, filled out at home and brought by them to the hospital at the day of examination. On arrival at the hospital, the subjects filled out questionnaires on: Social network before and after trauma, the Sense of Coherence 13 items Questionnaire, the General Health Questionnaire 20 items and the Hospital Anxiety and Depression Scale. Thereafter, all subjects were physically examined by the author of this dissertation (AA), and neuropsychologically tested by an experienced neuropsychologist (AF). Information about educational level and vocational situation were obtained in an interview prior to the physical examination.

In IV the multiple trauma subjects admitted to Sunnaas Rehabilitation Hospital filled out questionnaires and checklists on three occasions: 1) within one week of admission, 2) shortly before discharge, and 3) at follow-up at a median of 24 months (range 12-41 months) after injury. The following questionnaires were filled out on all three occasions: The Sense of Coherence 13 items, one LiSat-9 item: the Overall Life Satisfaction, and the General Health Questionnaire 20 items. The Hospital Anxiety and Depression Scale was filled out at discharge and follow up.

In V the Norwegian population register was used to identify those subjects with multiple trauma who had died. Each individual was followed until death or until 30.06.2000. Norwegian life tables from 1995 (Statistics Norway 1996) were used to calculate expected number of deaths in an age and gender matched population over an equivalent follow-up time period. Mortality rates of the multiple trauma study population were compared to the general population by calculating Standardised Mortality Ratios (SMRs). SMR was defined as actual number of deaths in a study population divided by expected number of deaths. Expected survival over the entire follow-up time interval was calculated by multiplying the expected yearly survival probabilities over the follow-up time interval. Expected mortality was then calculated as 1.0 minus the cumulated expected survival rate. In which the subject's follow-up did not include the full year, adjustments were made to the yearly survival probabilities. An SMR of 1.0 indicates that the multiple trauma group has identical mortality to the general population, and greater than 1.0 indicates that the mortality rate is greater. Confidence intervals for SMRs ratios were computed according to Poisson distribution.

Causes of death were obtained from the National Registry of Causes of Death, Statistics Norway.

Measures

The Abbreviated Injury Scale (AIS) and the Injury Severity Score (ISS). Severe multiple trauma is usually defined as an Injury Severity Score of 16 and above, with injuries to two or more body regions (57). To register the AIS-score for specific body regions, the injury was categorised by body region (head or neck, face, thorax, abdominal or pelvic contents, extremities or pelvic girdle and external), and the severity was graded from 0 (no injury) to 5 (unsurvivable injury) (58). The ISS was calculated by adding the squares of the three highest scores from these most injured body regions.

Body region of most severe injury (I, II and V). The body region of most severe injury (highest AIS score) was defined: Scores due to skin injuries were excluded. For simplification, patients with injuries to the thorax and abdomen were combined into one group, and the highest score from either thorax or abdomen was used. With identical scores in two or more body regions it was decided through clinical reasoning, to let head take precedence over extremity, extremity over face, and face over thorax/ abdomen. In V, in accordance with the original scoring system, spinal cord injuries were included in thorax/abdominal injuries. In I, subjects with spinal cord injury were analysed as a separate group, although these subjects do not represent an AIS entity. This classification gave five body regions of most severe injury: Head, extremities, spinal cord, face and thorax/ abdomen. The AIS-score for specific body regions has been found to be a valid and reliable prognosticator for long-term outcome after multiple trauma (59), better than the total ISS (27,28).

Glasgow Coma Scale (II, V). The Glasgow Coma Scale (GCS), a measure of the best motor and verbal responses and degree of eye opening on admission, was applied to measure the state of consciousness as an indicator of the degree of brain injury suffered (60). According to conventional classification criteria, patients were categorised into one of three GCS categories, those with severe (GCS scores 3-8), moderate (scores 9-12), and mild or no (scores 13-15) affection of consciousness. In research on subjects with traumatic brain injury, and in clinical work, the GCS is a standard procedure for assessment of reduced level of consciousness and is a frequently used marker of injury severity. The scale has good sensitivity and reliability, with an intraclass correlation coefficient of 0.8 to 1.0 for trained users, and well-established construct validity (61).

Neuropsychological tests (I, II, III). Subjects were tested with a screening battery consisting of five well known and validated neuropsychological tests representing six different tasks: The Digit Span subtest of Wechsler's Adult Intelligence Scale (62), Knox Cubes imitation Test (63), PASAT (64), the Luria-Christensen 10 Words serial learning test which includes both Acquisition and Delayed Recall (65), and the Verbal Fluency task (66).

Functions/ Impairments (I and III). The ranking of cognitive and physical impairments was based upon the physician's and neuropsychologist's assessment following physical examination and neuropsychological testing.

Slight cognitive impairment related to the trauma was defined when subjects had sustained a head injury and slight cognitive deficits were verified on neuropsychological tests. More severe problems with cognitive performance on the tests, with deficits in a broad range of tests and at least one pronounced error, were classified as severe cognitive impairments.

Severe physical impairments were those due to spinal cord injuries, amputations, marked restriction of limb movement, loss of sight of one eye. Less severe restriction of limb movement, tinnitus, slight spasticity or disfigurement were classified as "slight". Insignificant impairments were scars or minor residual consequences of the trauma.

Furthermore, using the most severe physical or cognitive impairment score a *combined* impairment score was defined. For instance, a subject with slight cognitive impairment and severe physical impairment was classified as severely impaired.

The rating of pain intensity the week prior to assessment was dichotomised into: No or slight pain *vs.* moderate, severe, very severe and unbearable pain.

Abilities/ Disabilities (I and III). Prevalence of disabilities was recorded for personal (self-care) ADL with eight items from the Sunnaas ADL-index (67). Subjects were considered dependent if they reported dependency in at least one of the items.

Vocational disability was recorded when, as a consequence of the trauma, a previously vocationally or educationally active subject worked at a reduced level or not at all.

The checklist used for registration of non-work activities was a modification of that used by Bränholm and Fugl-Meyer (68). Leisure disability was defined if the subject had lost at least one non-work activity from before to after trauma.

Social Network (I and III). Each subject filled out a questionnaire containing six questions on social network (see Appendix A). The questions were answered both retrospectively (the situation before the injury) and currently (the actual situation). For simplification, the quantity and quality of the social network were dichotomised into sufficient *Vs* not sufficient. A subject considered having a minimum sufficient network *quantity* was one who did not live alone, or lived alone but had at least two dependable friends with whom he was in contact at least once a week (questions 1-4). A subject rated as having a minimum sufficient network *quality* was one who reported that he received more than little warmth and interest or did not often feel lonely (questions 5 and 6).

The Sense of Coherence (SOC) (III and IV)) was measured by Antonovskys 13-item instrument (29), with kind permission of the author. The scale is given in detail in Appendix B. The score of each item (1-7) is summed to a total, with possible range from 13-91. The higher the score, the stronger the sense of coherence. A high level of reliability and content-, face-and construct validity has been found (69).

Psychological distress (II, IV). Level of psychological distress was measured by the General Health Questionnaire 20 items (GHQ-20). The GHQ-20 is a widely used screening instrument for distress and psychopathology, also suitable for somatically ill subjects. Each item measures symptoms compared with what is normal for the patient, with four categories (more than usual, as usual, less than usual, far less than usual). A caseness, i.e. to be categorised as psychologically distressed, cutoff criterion of 24 (GHQ case ≥ 24), based on a 0-1-2-3 scoring procedure was applied (70,71). The instrument has been validated in different languages and cultures. It has been shown to be a valid and reliable instrument across cultures (72,73) and for accidentally injured adults (70).

The Hospital Anxiety and Depression Scale (HAD) (IV) (74). The scale is designed to measure anxiety and depression in somatically ill subjects in and outside the hospital. The fourteen-items of the HAD has been shown to differentiate between anxiety and depression (74,75). Each question has a four graded scale which rates the symptoms from 0-3 (0 and 1: no pathological symptoms, 3: clear pathology, and 2: symptoms measured in-between this ratings). Scores related to anxiety and depression are summed separately and a cut off point for pathological scores can be chosen between 8 and 11. In IV, the scores for clinically significant depression and/or anxiety were set at 11 or higher.

The life satisfaction checklist (LiSat-9) (III and IV). The checklist is given (in English translation) in Appendix C and contains one global item and eight domain specific items (10). In III, each item was checked along a 6-graded ordinal scale ranging from 1 (very dissatisfied) to 6 (very satisfied). In IV, only the overall life satisfaction item: Satisfaction with life as a whole, was analysed. In several of the analyses the scale was dichotomised into 1-4 *vs.* 5-6 with the intention to separate those who were satisfied (5-6) from those who were not

satisfied (1-4). This instrument has recently been validated in a nationally representative Scandinavian (Swedish) sample using an extended version, LiSat-11 (21). The internal consistency (factor analyses) is virtually identical whether using the full scale or the dichotomy used here (21,76). An acceptable test-retest reliability (77) as well as sensitivity have been demonstrated (77,78).

Statistics

Throughout this dissertation the chosen level of statistical significance was $p \leq 0.05$.

For comparisons of groups of data, simple cross-tabulations were performed (χ^2 test or Fisher's exact test, when appropriate). Associations were analysed with Spearmans correlation coefficient (ρ), while the Mann-Whitney nonparametric two sample test was used to analyse differences in medians. The internal consistency of the SOC-scale was analysed using Chronbachs alpha. To analyse for the stability over time of the SOC, intraclass correlation coefficient (ICC) was computed. When comparing a dichotomised variable at two different points of time, the two-sided sign test was used. To decide whether a mean change within a patient group was statistically significant, a two sided paired Wilcoxon test was used. The Wilcoxon signed rank test for matched pairs was used to analyse differences in in life satisfaction before and after trauma.

Pearson's product moment correlation was applied to correlate neuropsychological scores with GCS and GHQ scores. Differences between subgroups were analysed with simple factorial ANOVA models.

Multiple linear regression techniques were used when the intention was to decide whether a variable was independently associated with a defined outcome variable (the dependent variable). Analyses of mortality by calculating Standardised Mortality Ratios were done as explained in the Methods-section.

Analyses were performed with the SAS™, the NCSS™ and the SPSS™ systems.

Main results

Ten years mortality following severe multiple trauma (V)

The early in-hospital lethality for the 146 subjects with severe multiple trauma was 28% (56). Long-term survival rate could be estimated for 91 of the subjects who were discharged from acute care, and the survival probability from discharge to ten years following trauma was 82%. Standardised Mortality Ratios (SMRs) demonstrated a statistically significant higher mortality than in the age and gender matched general population, both during the first year after discharge (SMR 27.2), and one to ten years postinjury (SMR 3.1). The mortality rate compared to the general population was particularly high in the younger age group (<45 years), and after the first year, higher death rate was only found in the younger. More severe Injury Severity Scores, Glasgow Coma Scale scores and severe brain injuries were significantly correlated to death the first year after discharge. Later, among the dominating injury types, only those subjects with severe chest or abdominal injuries had higher mortality rate than the general population. Psychosocial problems manifested by overuse of alcohol, drugs or narcotics, were main causes of death among those who died later than one year after discharge.

In summary, mortality rates compared to the general population were increased after discharge, with a particular high SMR in the younger age group. Causes of death were only related to organic consequences of the trauma the first year following discharge.

Impairments and disabilities after multiple trauma (I)

At follow-up three years after injury 80% had one or more residual impairments. While the majority (74%) had physical impairments, about one third (32%) of the subjects had cognitive impairments. In 30 subjects (44% of the sample), the impairments were categorised as severe.

Significantly fewer subjects with a dominating thorax/abdominal injury had physical ($p < 0.05$) or combined ($p < 0.001$) impairments at follow-up than subjects with other trauma-types. Pain prevailed in 20 subjects (29%). In agreement with the surgeons' prediction on long-term outcome at the time of discharge, none lived in a vegetative state. However, only one third of those predicted to have no late sequela were without late impairments. The ISS was positively and significantly correlated with degrees of impairments, but the associations appear prognostically rather weak.

Very few of the subjects (n=4, 6%) were disabled in terms of personal ADL-dependency. Lost or reduced working capacity was prevalent in 19% of those subjects previously vocationally active. Vocational disability was significantly associated with higher age, cognitive impairment and blue-collar work. Further, vocational disability was significantly correlated with decline in both quality and quantity of the subjects' social network. Strikingly, no less than 76% of the subjects had lost at least one non-work (leisure) activity with a median of six losses. The losses were most prevalent for physically demanding activities, and were significantly associated with physical impairment and pain.

In summary, three years after multiple trauma there was a high prevalence of impairments (80%) and leisure disability (76%), while vocational disability prevailed in 19%, and personal ADL-disability in 6%.

Cognitive performance three years after multiple trauma (II)

Glasgow Coma Scale (GCS)-score at admission to surgery was chosen as indicator of a head injury component. Thirty-four of the 68 subjects had a GCS-score of 15 on admission to the hospital, indicating no reduction in consciousness, while the rest had GCS scores between 3-14. Of the 67 subjects who completed the General Health Questionnaire (GHQ), the mean

GHQ score at follow-up was 22.1 and 18 (26.9%) met the case criterion. Psychological distress was not found to be related to brain injury severity as measured by the GCS (r= 0.01).

The neuropsychological tests showed that cognitive performance in these multiple trauma subjects related both to the severity of the traumatic brain injury and to the degree of psychological distress. In all but one of the six neuropsychological tasks (the exception being the Knox Cubes test of nonverbal attention span), cognitive performance was significantly correlated to the severity of traumatic brain injury. In both attention span tasks (Digit Span and Knox Cubes test), subjects designated as cases by the GHQ had significantly lower scores than noncase subjects. In the multiple linear regression analyses GHQ score alone contributed significantly to scores on the Knox Cubes test (non-verbal attention), while both GHQ score and GCS score contributed to the scores on the Digit Span test (verbal attention).

In summary, cognitive disturbances in multiple trauma subjects were related both to the severity of the traumatic brain injury and to the degree of psychological distress. The strength of the association between brain injury as indicated by GCS scores and cognitive performance differed between different neuropsychological tests.

Life satisfaction after severe multiple trauma (III)

Three years after trauma, a total of 60 subjects (87%) experienced a decrease in at least one of the nine life satisfaction items from before to after trauma (6-graded scale). Compared to before trauma, significantly fewer subjects now reported to be satisfied (5-6) with life as a whole (75% *vs.* 41%) as well as with the domains: Sexual life (65% *vs.* 48%), ADL (100% *vs.* 81%), contacts with friends (81% *vs.* 64%), leisure (71% *vs.* 39%), vocational situation (69% *vs.* 31%) and financial situation (48% *vs.* 25%). Only satisfactions with family life and partner relationship did not change significantly. To determine the weighted impact of the domain specific satisfaction-items on satisfaction with life as a whole, a multiple linear regression

analyses was performed. Among the life satisfaction domains, the most important contributors for global life satisfaction after trauma were satisfaction with leisure, family life and vocation.

Sense of coherence was significantly stronger in those subjects who were satisfied than in those who were not satisfied with life as a whole, and in six of the eight domains.

In the final regression analyses, cognitive impairment contributed significantly in explaining satisfaction with partner relations and family life, while vocational and leisure disability were important determinants of satisfaction with life as a whole. Sociodemographic factors (age, gender, educational level and blue/ white collar work) were of little importance, while a strong sense of coherence and having a sufficient social network quality had significant impact on satisfaction with life as a whole and some of the domain specific satisfactions.

In summary, over a wide array, life satisfaction was reduced after multiple trauma. Both personal resources (a strong sense of coherence) and having a qualitatively sufficient social network, appeared to buffer the negative influence of disabilities on life satisfaction after trauma.

The stability of sense of coherence, aspects of psychological well-being and life satisfaction in a prospective investigation of subjects with multiple trauma (IV)

Among the 26 consecutively admitted subjects with severe multiple trauma not involving brain injury, the 13-items sense of coherence scale was not stable over time. The median SOC-scores at admission to rehabilitation (63), at discharge (68) and at follow up (65), were fairly stable, though Wilcoxon analyses showed a significant decline from discharge to follow up. An acceptable degree of internal consistence was found each time SOC was measured (Chronbachs alpha varied from 0.86 to 0.89). SOC-scores at admission *vs.* follow up, i.e. over a period of about two years, were not significantly associated. Moreover, the intraclass correlation coefficient (ICC) analysed over all three occasions was 0.74, which indicates poor

to moderate over-time reliability (79). When used at admission to or discharge from intensive rehabilitation, sense of coherence could not adequately prognosticate future satisfaction with life as a whole and level of psychological well-being. On the other hand when measured simultaneously, the SOC-13-scores were closely associated with overall life satisfaction at all times of measurement. Furthermore, a weak sense of coherence was significantly correlated with psychological distress, anxiety and occurrence of depression.

Satisfaction with life as a whole was considerably reduced after multiple trauma. While 22/26 reported that they had been satisfied or very satisfied with life as whole prior to the trauma, this was the case for 15/26 at discharge, and only 8/26 at follow up. At discharge and at follow up those with case-scores on GHQ were 10/26 at both occasions, while fewer subjects were anxious (3/26, 5/26) or depressed (3/25, 4/25).

In summary, SOC was not stable over time after severe multiple trauma. SOC measured at admission to rehabilitation, could neither predict future satisfaction with life as a whole or future psychological well being. Measured simultaneously, overall life satisfaction and occurrence of anxiety were significantly associated with SOC.

Discussion

One final topic of this dissertation on bio-psycho-social aspects after severe multiple trauma, was long-term mortality. The main outcome measure, however, has been social well-being or satisfaction with life. The basis of social well-being is sufficient, dynamic coping resources. Emerging from these resources, according to Antonovsky (29,33), is the personality orientation sense of coherence, which is said to facilitate the coping process.

In this context the following factors will be discussed:

- Mortality
- Impairments
- Prevalence of disabilities and levels of life satisfaction
- Social well-being in relation to disabilities
- Resources as background factors for abilities/ disabilities and life satisfaction

Some limitations. Generally, for all investigations included in this dissertation, the small number of subjects limits generalisations of the results. In addition, a second possible weakness is a considerable heterogeneity regarding dominating injuries and types of impairments. On the other hand, the distribution of age (mean age 33 years), gender (70% men) and Injury Severity Score (ISS) (mean score 25) among the 69 severely multitraumatised subjects investigated three years after injury, are similar to other long-term investigations of trauma populations (43,44,52). Regarding the retrospective follow-up, recalled life satisfaction prior to trauma can not exclude the occurrence of some idealisation of the time before trauma. However, we believe this is less important than the actual *experience* of the person reporting her/ his situation. In the prospective investigation on the stability of sense of coherence, the major limitations are the small and selected sample, in addition to the variations between one and 3.5 years follow-up time.

On mortality

We have not been able to compare ten years survival probability after multiple trauma with other studies. In van der Sluis et als (41) two years follow-up investigation of 537 discharged severely multitraumatised subjects, 2.2% were dead, a clearly lower figure than in our study (7% after two years). A possible explanation for this difference is a considerable shorter length of stay at the department of surgery in Norway, with early discharge to local hospitals. Although older age earlier has been shown to relate significantly to long-term mortality after trauma (41,80,81), it seemed to be a reasonable finding that the mortality rate was higher than in the general population in the younger age group. Further, in agreement with others who have found that traumatic brain injury, as part of multiple trauma, correlated with higher mortality (82-84), severe traumatic brain injury was the major cause of death the first year after discharge. However, the fact that overuse of drugs or alcohol was a leading cause of death among those who died later, has not been reported earlier. Furthermore, the finding that chest and abdominal injuries, with suspected least impairments (39,59) was statistically more prevalent in these subjects, could be a coincidence which also should be investigated further.

In the following discussion, the Life Satisfaction Model will be referred to (Figure 2). Initial discussion will be on impairments, thereafter abilities/ disabilities and then social well-being in terms of life satisfaction, in relation to individual and network resources.

On impairments

The finding that 80% had one or more impairments is in reasonable accordance with Bull (42). On the other hand, differences in methodology and definitions makes it difficult to compare the prevalence of cognitive impairments, physical impairments and pain with other

investigations. It appears particularly intriguing that only 1/3 of patients predicted by surgeons as having no future impairment, actually had none at follow up.

There exists several trauma-scoring systems used to evaluate trauma care (57,85-87). In agreement with others (42,44,52), the Injury Severity Score (ISS) was significantly correlated with later degrees of impairments, but the correlation was not high enough to make ISS a recommendable clinical predictor. In this context, Fern et al (54) emphasises the need for injury scoring systems that predict the outcome for patients better than ISS, particularly for patients with multiple extremity injuries (88,89).

In consensus with MacKenzie et al (44), a classification system based on the highest AIS-score, was clinically meaningful in relation to type and degree of impairments after three years. In addition to high prevalences of impairments after dominating head (90%) and spinal cord injuries (100%), there was a remarkably high prevalence of impairments after extremity injuries (90%). Moreover, the present results confirm that subjects with dominating injuries to chest or abdomen have reduced risk of late impairments compared to other trauma types (39,59).

While neuropsychological testing diagnosed cognitive impairments in about 1/3 of these Norwegian multitraumatised subjects, van der Sluis et al (45) found that 84% of severely injured patients reported psychological complaints such as fatigue, slowness and memory impairments 6 years after trauma. The finding that reduced attentional capacity may be related to psychological distress has been reported in patient groups without cerebral injury (90-93), and similar results are found in depressed subjects (94-97). This is in consensus with our finding that cognitive performance in neuropscychological tests were related both to the severity of the traumatic brain injury and to the degree of psychological distress. However, that Knox Cubes test of nonverbal attention is more sensitive to the type of attentional deficits

suffered by subjects with psychological distress, than to cognitive impairment after traumatic brain injury, has not been previously reported by others.

Accidental injuries may cause long-term psychosocial problems (98). The subjects recruited solely from Sunnaas rehabilitation hospital had higher prevalence of distress (GHQ-case-score) (43%) than among those discharged from the department of surgery, and also higher than found in mildly injured trauma population (99), and in the general population (46). A possible explanation might be the severity of impairments in those subjects that were transferred to a rehabilitation unit.

As traumatic brain injury has been shown to influence disability in multiple trauma subjects (51,84), the finding that occurrence and degree of cognitive impairment was significantly related to vocational activity, was not unexpected. Further, but less investigated in the past, in regression analyses cognitive impairment was significantly correlated to the emotionally life satisfaction domains, i.e. satisfaction with partner relation and family life. In contrast, but in congruence with findings after spinal cord injury (100,101), there were no significant associations between degree of physical impairment and life satisfaction. However, the fact that degree of physical impairment was significantly correlated to leisure disability, should be taken into account in the daily rehabilitative work.

On prevalence of disabilities and levels of life satisfaction

The present findings of only a few of the multiple trauma subjects being dependent in personal ADL is congruent with Kivioja et al (43). The finding that more than 80% could return to work and education, is also in agreement with other reports (27,43,45,52,102). While van der Sluis et al found changes of leisure activities in 45% of 55 severely injured respondents 6 years after trauma (45), ¾ of the subjects in our investigation lost leisure

activities, particularly physical demanding activities. Also subjects with multiple sclerosis have been found to loose physically demanding leisure activities (103).

In reasonable accordance with Thiagarajan (55), the present investigation not only demonstrated a pronounced decrease in satisfaction with life as a whole after severe multiple trauma, but also decreases in satisfaction with most of the domains, except the two emotionally weighted domains (satisfaction with family life and partner relations). Moreover, the proportion of subjects satisfied/ very satisfied with life as a whole, decreased further from discharge to follow-up, at least one year after injury.

The findings of decreases in satisfaction with life as a whole and many domains are supported by previous findings of low levels of satisfaction in subjects with disabilities due to neurological disorders (14,24,104). In fact, the perceived losses in life satisfaction were on par with those found in spinal cord injured subjects (104). The levels of life satisfaction reported for the time before injury is comparable with the 75% satisfied subjects found among a nationally representative Swedish sample of 18-74 year old people at good health (Fugl-Meyer KS, personal communication). The somewhat higher prevalence of satisfied subjects prior to trauma found in the prospective investigation (85%), may be due to the small and selected sample. It may, though, quite likely be a Polly-Anna effect (i.e. that a certain proportion of the patients idealises their pre-trauma life). Further, comparing this study with the Swedish representative sample, some degree of idealisation of the time before trauma concerning satisfaction with vocational situation, leisure and contact with friends seems to occur. However, in my opinion this is less important than the actual experience of the person reporting his/ her situation. Furthermore, three years after trauma the subjects were significantly less satisfied with life as a whole, as well as all domains except contacts with friends and sexual life, than were the healthy persons among the representative Swedish population (Fugl-Meyer: see over).

Social well-being in relation to disabilities

Generally there are few studies on how abilities/disabilities relate to domain specific satisfaction. However, the demonstration that self-care disability was significantly correlated to satisfaction with life as a whole and most life satisfaction domains, is in accordance with the findings of Viitanen (24). The fact that these associations disappeared in the regression analyses, might be due to the small number of dependent subjects (n=4).

The finding that vocational disability influences satisfaction with vocational situation, as well as satisfaction with life as a whole, has also been reported by others (77).

Previous studies have reported changes in leisure activities after severe injury (45,55), and low satisfaction with leisure in subjects with spinal cord injury (104). These results agree with our findings that leisure disability influence leisure satisfaction, and further, the importance of leisure satisfaction for satisfaction with life as a whole.

On resources as background factors for abilities/ disabilities and life satisfaction

The influence of sociodemographic factors on return to work after multiple trauma, has been investigated by others (28,43,44). Our findings confirm previous results that older age (43) and blue collar work (44), are significantly associated with vocational disability after multiple trauma. Also level of education, pretrauma-income and social support network have been positively related to return to work (44).

The general assumption that a good social network could lead to better outcome after severe multiple trauma by facilitating coping was to some degree supported. However, the fact that the investigations were cross-sectional, makes the positive significant associations between sufficient quality of social network, and outcome in terms of vocational activity and life satisfaction, bi-directional. On the other hand, the persistent positive association in regression analyses between social network quality, but not quantity, and satisfaction with life

as a whole, could indicate a protective effect of the social network resource against decreases in satisfaction with life, at least satisfaction with life as a whole.

In agreement with Diener and Fujita (31), who claimed that resources show low predictive value for overall life satisfaction, individual resources, with the exception of sense of coherence, were found to be of little importance for life satisfaction. The findings that level of sense of coherence was closely associated with simultaneously measured satisfaction with life as a whole and several life satisfaction domains, are reported by others (105,106). Hence, the sense of coherence may influence experienced life satisfaction, or perceived life satisfaction may influence SOC. The appreciable over-time variations in SOC-values shown in this study, which agree with Carmel et al (107), make the SOC scale inconvenient as a predictive factor for individual patients. The best explanation for the variations in SOC-scores may be what Antonovsky (69) suggested as a possible cause of variation: "major changes in patterns of life experiences".

Several investigations have shown consistently high negative correlations between sense of coherence and trait- and state-anxiety (36,108), and in some studies, with depression (109,110). These results are substantiated by the present findings. The significant association between SOC at discharge and later anxiety can, moreover, be a reflection of the highly significant relationship between SOC and anxiety registered simultaneously rather than a predictive ability of the sense of coherence scale.

The hypothesis that a strong sense of coherence is protective against distress and reduced satisfaction after stressful life events was not confirmed, at least not in the first years after severe multiple trauma.

In Conclusion

From a general clinical point of view, it seems like AIS-scores, but not ISS, to some extent can predict impairments and disabilities. Furthermore, occurrences of disabilities and to a lesser degree impairments, are important for long-term adaptation to life. The process is influenced by a person's resources including the individuals personality orientation, which can facilitate the coping process. To some degree the quality of the social network is positively related to overall life satisfaction. Since psychological well-being also seems to be of significance, a model that takes into account all these factors should be the most appropriate model to use in the future.

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Appendix A

Social network

We want to know something about your social network and whether there have been any changes since the injury:

Your situation today:

1. How many people live in your household?
☐ Live alone
☐ Two people
☐ Three or more

2. If you do not live alone, with whom do you live? Tick more than one box if applicable.
☐ Spouse
☐ Cohabitant
☐ Friend(s)
☐ Children
☐ Parents/ Inlaws

3. Approximately how many close friends do you have - people you feel comfortable with and can confide in? (You can count relatives if you wish.) (Tick box or write number if applicable.)
☐ None
☐ One
☐ More. Number.....

4. How often do you meet friends and relatives with whom you do not live, e.g. visits at each other's home, go out together, talk on the phone?
☐ At least once a week
☐ Less than once a week, but at least once a month
☐ Less than once a month

5. Do any of the people close to you give you attention and take interest in what you do?
☐ Shows no or little warmth and interest
☐ Yes, shows some warmth and interest
☐ Yes, shows a lot of warmth and interest

6. Do you ever feel lonely?
☐ Never/ seldom
☐ Sometimes
☐ Often

Your situation before the injury:

7. How many people lived in your household?
☐ Lived alone
☐ Two people
☐ Three or more

8. If you did not live alone, with whom did you live? Tick more than one box if applicable.
☐ Spouse
☐Cohabitant
☐ Friend(s)
☐ Children
☐ Parents/ Inlaws

9. Approximately how many close friends did you have - people you felt comfortable with and could confide in? (You can count relatives if you wish.) (Tick box or write number if applicable).
☐ None
☐ One
☐ More. Number.....

10. How often did you meet friends and relatives with whom you did not live, e.g. visits at each other's home, go out together, talk on the phone?
☐ At least once a week
☐ Less than once a week, but at least once a month
☐ Less than once a month

11. Did any of the people close to you give you attencion and took interest in what you did?
☐ Showed no or little warmth and interest
☐ Yes, showed some warmth and interest
☐ Yes, showed a lot of warmth and interest

12. Did you ever feel lonely?
☐ Never/ seldom
☐ Sometimes
☐ Often

Appendix B

The Abbrevinted Sense of Coherence Checklist (SOC-13)

The subjects were informed that this checklist had questions concerning different aspects of life, each question graded from 1 to 7, where 1 and 7 were the two opposite answers. They were told to read the questions thoroughly and mark the number which best suited (matched) their own experiences.

1. Doing the things you do every day is:
1 2 3 4 5 6 7
a source of deep pleasure and satisfaction — a source of pain and boredom

2. Do you have very mixed-up feelings and ideas?
1 2 3 4 5 6 7
very seldom or never — very often

3. Does it happen that you have feelings inside you would rather not feel?
1 2 3 4 5 6 7
very seldom or never — very often

4. Many people -even those with a strong character- sometimes feel like sad sacks (loosers) in certain situations. How often have you felt this way in the past?
1 2 3 4 5 6 7
very seldom or never — very often

5. When something happened, have you generally found that
1 2 3 4 5 6 7
you overestimated or underestimated its importance — you saw things in the right proportion

6. How often do you have the feeling that there's little meaning in the things you do in your daily life?
1 2 3 4 5 6 7
very often — very seldom or never

7. How often do you have feelings that you're not sure you can keep under control?
1 2 3 4 5 6 7
very often — very seldom or never

8. Do you have the feeling that you don't really care about what goes on around you?
1 2 3 4 5 6 7
very seldom or never — very often

9. Has it happened in the past that you were surprised by the behaviour of people whom you ought to know?
1 2 3 4 5 6 7
never happened — always happened

10. Has it happened that people whom you counted on disappointed you?
1 2 3 4 5 6 7
never happened — always happened

11. Until now, your life has had:
1 2 3 4 5 6 7
no clear goal or purpose at all — very clear goals and purpose

12. Do you have the feeling that you're being treated unfairly?
1 2 3 4 5 6 7
very often — very seldom or never

13. Do you have the feeling that you are in an unfamiliar situation and don't know what to do?
1 2 3 4 5 6 7
very often — very seldom or never

Appendix C

Life satisfaction checklist

How satisfactory are these different aspects of your life? Indicate the number which best suits your situation *

1 = Very dissatisfying	4 = Rather satisfying
2 = Dissatisfying	5 = Satisfying
3 = Rather dissatisfying	6 = Very satisfying

Life as a whole is	1	2	3	4	5	6
My vocational situation is	1	2	3	4	5	6
My financial situation is	1	2	3	4	5	6
My leisure situation is	1	2	3	4	5	6
My contact with friends and acquaintances are	1	2	3	4	5	6
My sexual life is	1	2	3	4	5	6
My ability to manage my self-care (dressing, hygiene, transfers, etcetera) is	1	2	3	4	5	6
My family life is	1	2	3	4	5	6
My partner relationship is	1	2	3	4	5	6

---

* For characterising pre-trauma life satisfaction, the phrasing was:
How satisfactory was these different aspects of your life prior to your injury? Indicate the number which best suited your situation
Life as a whole **was .....**
My vocational situation **was**.....

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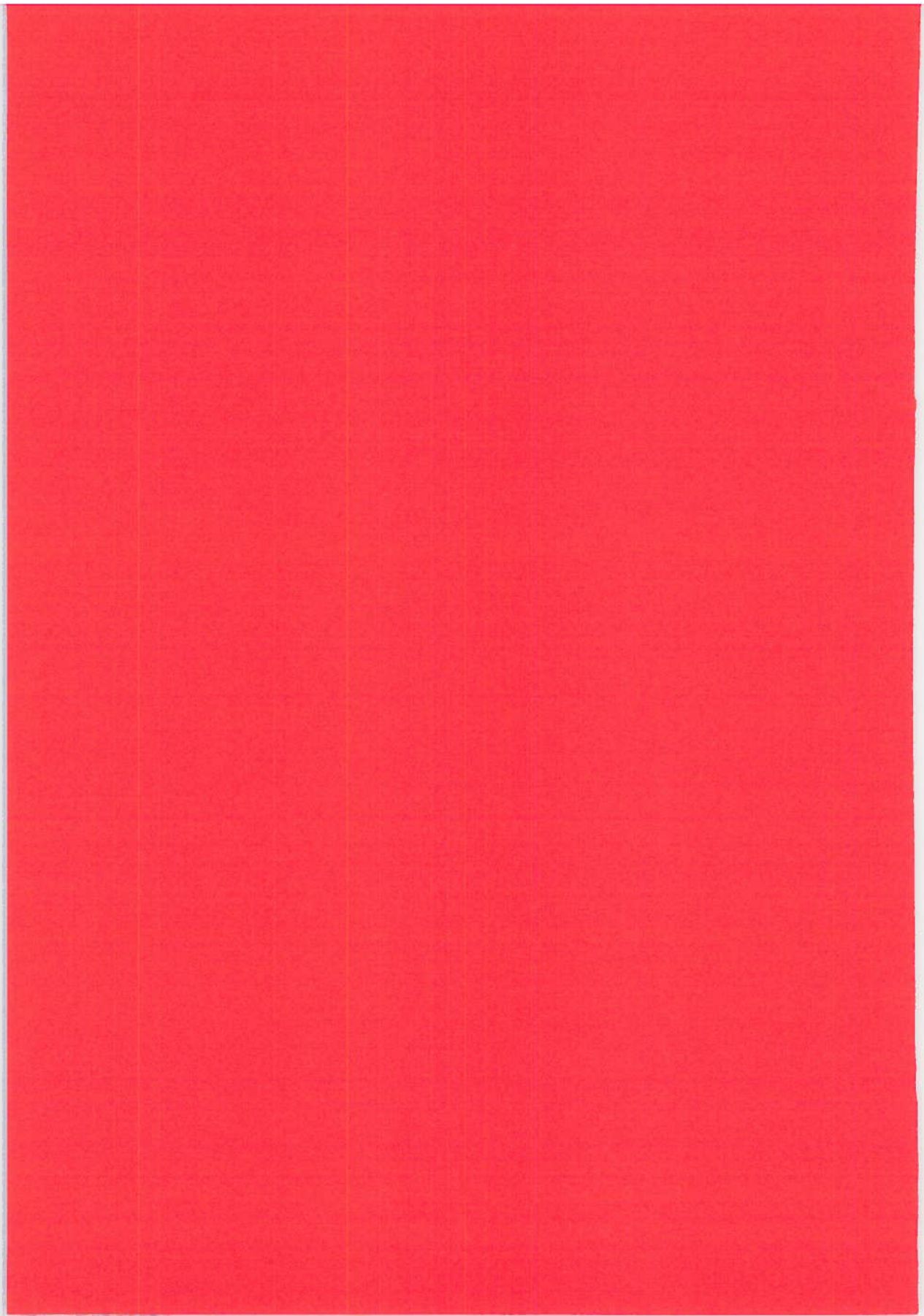
Paper I



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Long-Term Prevalence of Impairments and Disabilities after Multiple Trauma

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The prevalence of impairments and disabilities in activities of daily living (ADL), nonwork activities, and work were registered in a consecutive series (n=69) of subjects with severe injuries. At follow-up 3 years after trauma, residual impairments prevailed in 80%. Only a few (6%) were ADL-dependent. Seventy-six percent had lost at least one nonwork activity, while vocational disability caused by the trauma occurred in 19%. Cognitive impairment was significantly associated with vocational disability, while physical impairment and pain were significantly associated with nonwork disability. Other parameters that influenced vocational disability negatively were age and blue-collar employment status. Although overall changes in social network quantity and quality were small, significantly more subjects with cognitive impairment or vocational disability experienced a decline in the quality and quantity of their social network after trauma. Furthermore, 25% of the subjects reported an increase in feelings of loneliness after trauma. We recommend the design of individualized, multidisciplinary rehabilitation plans before discharge from departments of surgery.

Key Words: **Multiple trauma, Impairment, Disability, Rehabilitation, Leisure, Work.**

This investigation was designed to analyze the prevalence of impairments and disabilities after severe multiple trauma. To a great extent, fatal cases have been statistically predicted from the Injury Severity Score (ISS),[1] and, when brain injuries are involved, from the Glasgow Coma Scale.[2] Less knowledge is available about predictors for impairments and disabilities. Some subquestions were: To what extent is injury-type and severity predictive of late impairments and disabilities? To what extent does the trauma cause changes in the quantity and quality of social network? To what extent do demographic variables and impairments influence the ability to manage personal activities of daily living (ADL), nonwork activities, and work?

The theoretical framework of this investigation was based on a conceptual model for the relationships between health, disease/injury, and life satisfaction previously described (Fugl-Meyer et al.[3] and Fig. 1): An injury may lead to impairment (loss of function at the organ level, i.e., loss or abnormality of physiologic or anatomic function), which in turn may lead to disability.[4] For the individual, loss or restriction of premorbid abilities implies decreased capacity to manage self-care, nonwork activities, and work activities. This inability to reach premorbid goals is a psychological and existential stress situation, which calls for support and adequate coping strategies where reorientation towards modified or new goals is an important part of the process. The individual resources and demographic factors, including the person's social network will influence the process,[5–10] as well as the quality of the treatment.

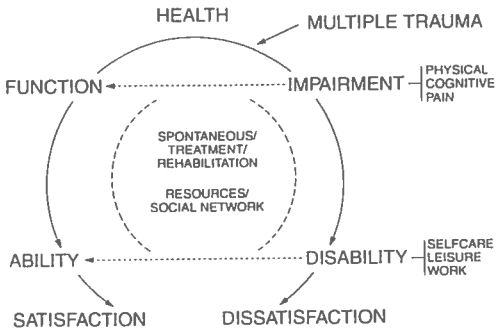

FIG 1. **The association between injury, impairment/function, and disability/ability. Spontaneous restoration, treatment, and rehabilitation will improve functions and abilities, while individual resources and environmental support are important parts of the process. By resources, we mean innate or achieved traits or properties[6] (in this investigation: age, sex, education, type of work), as well as social network.**

SUBJECTS AND PROCEDURES

The target population included all patients with severe multiple trauma, aged ≥ 12 years, admitted within 24 hours of the injury to the Department of Surgery at Ullevål Hospital in Oslo during 1990. The sample was limited to those patients with an ISS[1] of 16 and above and with injuries to two or more body regions. Study subjects were grouped according to the following ranges of ISS: 16–24, 25–33, 34–38, 41–48, 50–66, or 75.[11] The subjects were examined in 1993, 35 ± 4 months after the injuries.

Inclusion of Patients

Of the 146 patients admitted during the specified time period, 105 were discharged alive. After exclusion (see Fig. 2), 82

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FIG 2. An overview of the subjects with severe multiple injuries treated at Ullevål Hospital in 1990. The reasons for exclusions from the investigation are given (n denotes number of subjects).

subjects remained and were invited to participate in the investigation. Of these, 13 declined to participate, leaving 69 subjects. There were no significant differences concerning age, sex, injury-type, and injury severity between the 69 who actually entered the study and the 13 who declined to do so. This was also true for the 82 invited versus the 23 a priori excluded subjects.

Defining Body Region of Most Severe Injury

The highest Abbreviated Injury Scale (AIS) score[12] for specific body regions has been demonstrated to be a better prognosticator for long-term outcome than the total ISS.[7,8] Therefore, and in accordance with MacKenzie et al.,[9] we made a classification based on the highest AIS score that was thought to be meaningful relative to disability. Scores due to external region (skin) injury were excluded. For simplification, patients with injuries to the thorax and abdomen were combined into one group, and the highest AIS score from either thorax or abdomen was used. With identical AIS scores in two or more body regions, it was chosen, by clinical reasoning, to let head take precedence over extremity, extremity over face, and face over thorax/abdomen. Moreover, patients with spinal cord injuries were analyzed as a separate group, although these patients do not represent an AIS entity. This classification, therefore, gave five body regions of most severe injury: head, extremities, spinal cord, face, and thorax/abdomen.

Demographic Variables

The demographic variables registered included sex, age, education, type of work, and social network. These background variables constituted the investigated individual resources (Fig. 1).

Social Network

Each subject filled in a checklist on social network (see Appendix A). The six questions were answered both retrospectively (the situation before the injury) and currently (the actual situation). For simplification, the quantity and quality of the social network were dichotomized into sufficient versus not sufficient. A subject considered having a minimum sufficient network *quantity* was one who did not live alone (question 1 and 2), or lived alone but had at least two dependable friends (question 3) with whom he was in contact at least once a week (question 4). A subject rated as having a minimum sufficient network *quality* was one who reported that he received more than a little warmth and interest (question 5) or who did not often feel lonely (question 6).

Functions/Impairments and Abilities/Disabilities

Occurrence of impairments and disabilities were recorded as presented in Table 1.

Statistics

For comparisons of groups of data, simple cross-tabulations were performed (χ^2 test or Fisher's exact test when appropriate). Correlations were analyzed with Spearman's ρ. The Mann-Whitney nonparametric two-sample test was used to analyze differences in medians, while the Sign test was used to analyze changes in activity preferences. Values of p of ≤ 0.05 were considered statistically significant. Generally, associations and differences are only mentioned if this criterion was fulfilled.

RESULTS

Among the 69 subjects, 21 were women (30%) and 48 were men (70%). At the time of injury, their mean age was 33 ± 16 years, with a median age of 26 years (range, 12–72 years). Twenty subjects (29%) had primary school education (7–9 years), while the remainder had higher education. Among the subjects regularly working or studying at the time of the injury, 14 were blue-collar and 44 were white-collar workers, the latter including 15 students. The mean ISS was 25 (range, 17–50). Figure 3 gives an overview of the body regions of most severe injury and distribution of additional injuries.

Functions/Impairments

Table 2 summarizes the prevalence of cognitive and physical impairments 3 years after injury, and shows that only 14 (20%) had no or insignificant residual impairment. While the majority (74%) had physical impairments, about one third (32%) of the subjects had cognitive impairments. Alcohol abuse, however, was judged to be the reason for cognitive impairments in four patients. Therefore, 18 subjects (26%) were rated as having cognitive impairment definitely as a result of the trauma. In 30 subjects (44% of the sample), the impairment was categorized as severe, generally physical (41%). Isolated cognitive impairment prevailed only for a few subjects (n=4), and if so, was slight.

An overview of prevalent impairments related to body

TABLE 1. Prevalence of impairments and disabilities in 69 subjects with multiple trauma

	n (%)	Procedures
Cognitive impairment[a]		Ranking was based upon the physician and neuropsychologist opinions after physical examination and neuropsychological testing. Severe physical impairments were those due to spinal cord injuries, amputations, marked restriction of limb movement, loss of sight of one eye. Less severe restriction of limb movement, tinnitus, slight spastisity or disfigurement were classified as "slight." Insignificant impairments were scars or other minor residual effects. Furthermore, using the most severe physical or cognitive impairment score a combined impairment score was defined. For instance, a patient with slight cognitive impairment and severe physical impairment was classified as severely impaired.
No/insignificant	47 (68)	
Slight	16 (23)	
Severe	6 (9)	
Physical impairment		
No/insignificant	18 (26)	
Slight	23 (33)	
Severe	28 (41)	
Combined impairment		
No/insignificant	14 (20)	
Slight	24 (35)	
Severe	31 (45)	
Pain		The ratings of pain intensity the last week were dichotomized into two categories: No or slight pain vs. moderate, severe, very severe, and unbearable pain.
No/slight	49 (71)	
Moderate to unbearable	20 (29)	
Personal (self-care) ADL		Eight items from the Sunnaas ADL index[13] was used (see Appendix B). Subjects were considered dependent if they reported dependency in at least one of the items.
Dependent	4 (6)	
Nondependent	65 (94)	
Nonwork activities (n = 67)		The checklist used is a modification of that used by Bränholm and Fugl-Meyer.[14] Leisure disability was defined if the subjects had lost at least one nonwork activity.
Leisure disability	51 (76)	
No leisure disability	16 (24)	
Vocational situation (n = 58)		When as a consequence of the multiple trauma a previously vocationally or educationally active subject worked at a reduced level compared with that before the trauma, he was classified as vocationally disabled.
Vocational disability	11 (19)	
No vocational disability	47 (81)	

[a] Four of the subjects had cognitive impairment of other reasons than the trauma (i.e., alcohol abuse).

region of most severe injury is given in Figure 4. Four persons with cognitive impairments of other reasons than the trauma (i.e., of alcohol abuse) were excluded from Figure 4*A*. As shown in Figure 4*A*, cognitive impairments almost exclusively occurred when head injury was the dominating injury, the exception being one subject with a severe extremity injury but also with a concomitant slighter head injury leading to cognitive impairment. All four subjects with spinal cord injury were classified as severely physically impaired, and 80 to 90% of subjects with principal head injuries, extremity injuries, and face injuries (Fig. 4*B*) had slight or severe impairments. Significantly fewer subjects with a dominating thorax/abdominal injury had physical ($p = 0.019$) or combined ($p = 0.001$) impairments at follow-up (Fig. 4*C*).

Using the subcategories of Pillgram-Larsen et al.[11] of the ISS score (see above) to analyze for the predictive effect of ISS on long-term functions/impairments, several significant associations were found. Thus, injury score was significantly and positively associated with physical impairment score ($\rho = 0.342$, $p < 0.01$). This was also the case for the cognitive impairment score ($\rho = 0.258$, $p < 0.05$), and therefore also for the combined impairment score ($\rho = 0.398$, $p < 0.01$). However, these correlations appear prognostically rather insufficient.

At discharge from the department of surgery, the surgeons had predicted long-term outcome in the following four categories: no sequela, sequela, disabled, and vegetative (Table 3). In agreement with the findings at follow-up, none was predicted to live in a vegetative state. A significant correlation resulted between the surgeons' early assessment and the prevailing (at follow-up) level of impairment ($\rho = 0.472$, $p < 0.001$). However, only one third of those predicted as having no late sequela were without late impairments.

Among the 17 subjects with brain concussion (AIS 1–2), only one had a cognitive impairment at follow-up, while for five of the nine with a moderate head trauma (AIS 3), a slight cognitive impairment prevailed. None of these had severe cognitive deficits. In contrast, the majority (n=12) of the 16 subjects with severe head injury (AIS 4–5) were cognitively impaired, half of these severely. The three AIS categories were closely correlated with level of cognitive function/impairment (Spearman's $\rho = 0.682$, $p < 0.001$).

Among the 39 subjects with extremity AIS score, 23 had impairments caused by these injuries. The majority of those with sequela had AIS scores of 1–3 (n=21).

Pain prevailed in 20 subjects (29%), and 18 of these had slight (n=6) or severe (n=12) physical impairments, while three subjects also suffered from cognitive impairments.

Social Network

The vast majority of subjects were gauged to have had sufficient quantity (94%) and quality (91%) of their social networks before the multiple trauma. The corresponding proportions at the time of follow-up were 91% and 84%, respectively. Evidently, these changes were nonsignificant. However, within the small group (six) of severely cognitively impaired subjects, half were noted as having gone from sufficient to insufficient network quality and quantity. Such associations were not found for physical impairment or pain.

Among the six pairs of questions categorizing the sufficiency of the social network, only the pair of questions rating loneliness showed a significant difference—an increase in

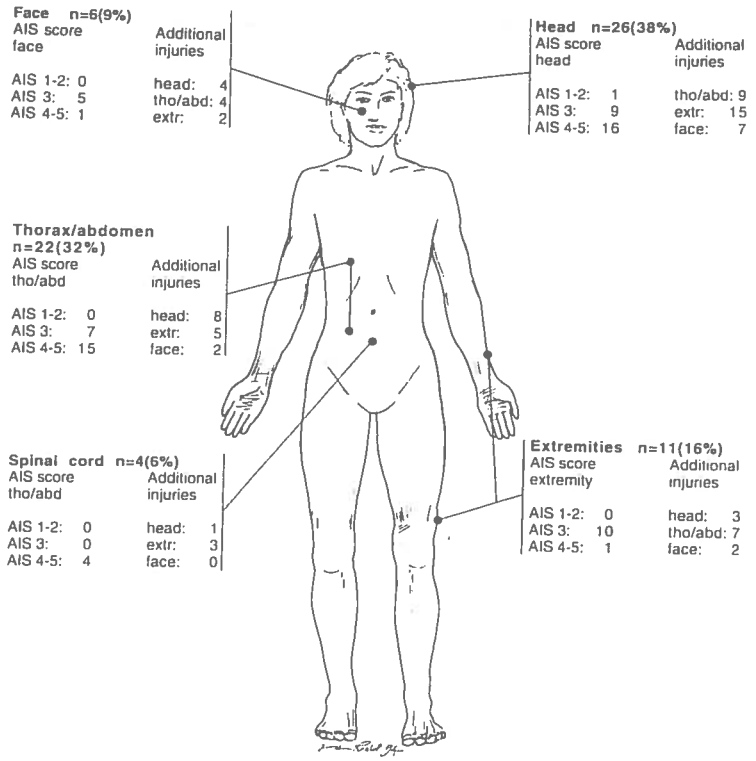

FIG 3. **Body region of most severe injury and distribution of additional injuries according to the Abbreviated Injury Scale[11] in 69 subjects with multiple injuries.**

loneliness—from before to after injury. Seven percent reported they often, and 23% sometimes, felt lonely before trauma. The corresponding proportions at follow-up were 14% and 43%, respectively ($p = 0.010$, Sign test).

Abilities/Disabilities

Very few (n=4) of the subjects were disabled in terms of ADL-dependency. Among these four subjects, two had severe impairment because of brain injury, one needed help because of alcohol abuse, and one because of psychological distress/chronic pain syndrome. Therefore, disability in personal ADL caused by impairment was a rare phenomenon and further statistical computations did not appear meaningful.

Among the 67 patients who filled in the checklist on *nonwork activities*, 51 subjects (76%) had ceased to practice at least one activity; the median number of lost activities among these subjects was 6 (range, 1–24). Most prominently, loss of leisure activities (Table 4) occurred for outdoor activities, particularly physically demanding activities like jogging, skiing, and cycling. For social/cultural activities, significant losses mainly occurred for activities implying leaving the home. Concerning indoor activities, losses appeared most commonly when the activity demanded dexterity, while only a few subjects had lost their capacity to perform home maintenance, the exceptions being home repairs (dexterity) and gardening (physical demand).

It is, therefore, not surprising that significantly more subjects among those who were severely physically impaired (26/28, 93%) than among those who had no or insignificant or slight physical impairments (25/39, 64%) had lost one or more of their pretrauma nonwork activities (Table 5). Also the occurrence of pain was significantly correlated to loss of nonwork activities. Seventeen out of the 18 subjects with pain belonged to this group.

No other significant correlations occurred for the variables listed in Table 5. Few subjects among those with lost activities (n=17, 33%) had managed to find *new* leisure activities at follow-up.

TABLE 2. **Distribution of physical and cognitive impairments in 69 subjects with multiple injuries, 3 years after injury**

	Cognitive Impairments		
	None	Slight	Severe
Physical Impairments			
No/insignificant	14	4	0
Slight	15	6	2
Severe	18	6	4

Work

Fifty-eight subjects were regularly employed or studying at the time of the injury. At follow-up, 11 of these subjects (19%) were vocationally disabled as a consequence of the

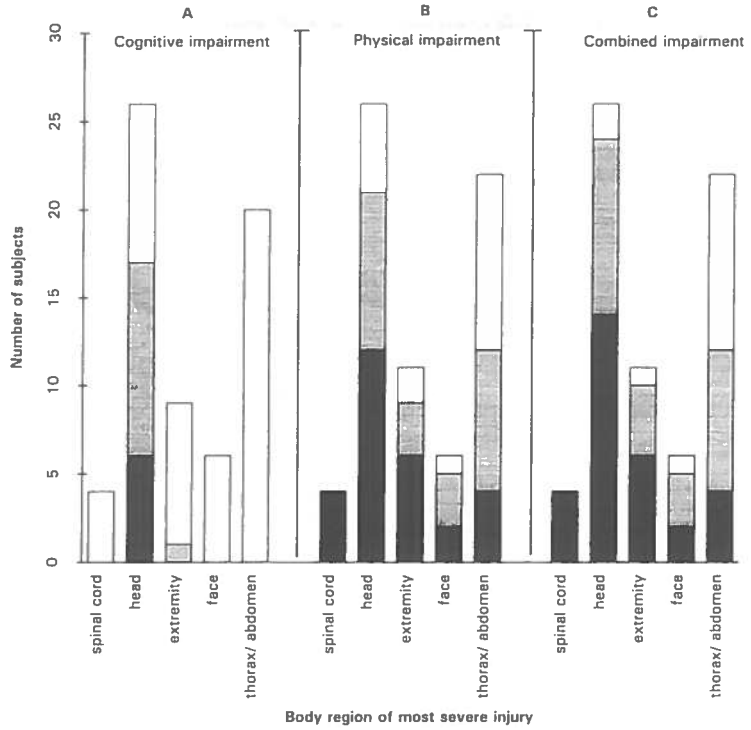

FIG 4. The number of subjects having cognitive (*A*), physical (*B*), and a combination of cognitive and physical impairments (*C*) are given by region of most severe injury in 69 subjects with multiple injuries 3 years after trauma. Only those patients with cognitive impairment caused by trauma are included in (*A*). Levels of impairment are: ■ severe impairment, □ slight impairment, and □ no/insignificant impairment.

trauma (as defined above). Additionally, two subjects had obtained old-age pension. Comparing the 11 subjects with injury-related work disability with the 45 subjects with no posttrauma vocational disability, three demographic factors were significantly associated with vocational disability (Table 5). These were: higher age (median, 32 vs. 22 years), blue-collar work (55% vs.18%), and decreased quality/quantity of social network. All vocationally disabled subjects were gauged to have a sufficient social network before injury, while after injury 27% had an insufficient network quantity and 36% an insufficient network quality. In contrast, neither sex nor educational level was significantly associated.

Using the trichotomized scales for physical and cognitive impairments, cognitive functions/impairments were significantly associated with decreased versus maintained working capacity. This was due to the relatively greater proportion of severely cognitively impaired subjects in the former group (3 out of 11) than in the latter group (1 out of 45). No such associations occurred for physical impairment or pain. However, higher ISS (median, 29 vs. 22) predisposed for vocational disability. Finally, as shown in Table 5, there was a significantly higher number of lost *nonwork* activities among the vocationally disabled subjects than among those with no reduction of working capacity compared with before injury (median lost number of activities being 8 and 2, respectively).

TABLE 3. **Level of impairments in 69 subjects with multiple injuries at follow-up 3 years after trauma, by predicted outcome in the acute stage**

	Level of Impairment		
	No/insignificant	Slight	Severe
Predicted outcome			
No sequela (n = 39)	13	15	11
Sequela (n = 20)	1	9	10
Disabled (n = 10)	0	0	10

Physical and cognitive impairments are combined into one impairment score. (Numbers of subjects in each category.)

DISCUSSION

The principal findings in this investigation of a consecutive series of subjects with multiple injuries were that 80% had one or more residual impairments 3 years (35 ± 4 months) after trauma. Only a small minority were ADL-dependent, while lost or reduced working capacity was prevalent in 19% of those subjects previously vocationally active. Strikingly, 76% had lost at least one nonwork activity with a median of six losses. The losses were most prevalent for physically demanding activities.

In long-term studies of outcome after multiple trauma, various types of disability scales to measure outcome have been applied. The results of these scales have been related to

TABLE 4. Nonwork activities for 67 subjects with multiple injuries

	Active before Trauma n (%)	Lost the Activity n (%)	p Values (Sign test)
Home/family activities			
Home repairs	47 (70)	12 (26)	$p < 0.01$
Child rearing	25 (37)	2 (8)	NS
Cooking	51 (76)	4 (8)	NS
Baking	36 (54)	6 (17)	NS
Cleaning	45 (67)	9 (20)	NS
Mending/laundry	43 (64)	3 (7)	NS
Shopping	55 (82)	3 (5)	NS
Gardening	41 (61)	16 (39)	$p < 0.01$
Indoor activities			
Painting	12 (18)	7 (58)	$p = 0.01$
Embroidery	6 (9)	0	NS
Knitting	15 (22)	6 (40)	NS
Wood work	25 (37)	13 (52)	$p = 0.01$
Car maintenance	26 (39)	12 (46)	$p < 0.01$
Sewing	11 (16)	3 (27)	NS
Outdoor activities			
Jogging	40 (60)	24 (60)	$p < 0.01$
Swimming	48 (72)	12 (25)	$p < 0.05$
Cycling	47 (70)	16 (34)	$p < 0.01$
Skiing	42 (63)	23 (55)	$p < 0.01$
Gymnastics	36 (54)	13 (36)	$p = 0.01$
Football/icehockey	23 (34)	15 (65)	$p < 0.01$
Tennis/badminton	24 (36)	14 (58)	$p < 0.01$
Cottage activities	50 (75)	5 (10)	NS
Hunting	11 (16)	5 (7)	NS
Fishing	34 (51)	9 (26)	$p < 0.05$
Walking	55 (82)	11 (20)	$p = 0.01$
Other activity	13 (19)	10 (77)	$p < 0.05$
Social/cultural activities			
Meeting friends	66 (99)	7 (11)	$p < 0.05$
Watching television	64 (96)	0	NS
Cinema	53 (79)	10 (19)	$p < 0.01$
Politics	8 (12)	0	NS
Religious meetings	5 (7)	1 (14)	NS
Dancing	42 (63)	18 (43)	$p < 0.01$
Singing/music	21 (31)	2 (10)	NS
Social clubs	19 (28)	6 (32)	NS
Photography	25 (37)	5 (20)	NS
Traveling	56 (84)	12 (21)	$p < 0.01$
Social activities	54 (81)	11 (20)	$p < 0.01$
Newspapers	62 (93)	3 (5)	NS
Reading nonfiction	45 (67)	3 (7)	NS
Reading fiction	43 (64)	5 (12)	NS
Reading work literature	43 (64)	5 (12)	NS

Subjects who practiced the activity before trauma (number and percent of the respondents) and subjects who lost the activity (number and percent of previously active subjects). $p > 0.05$ is given as NS (nonsignificant). The grouping into four main categories follows that suggested by Bränholm and Fugl-Meyer.[14]

TABLE 5. Items related to disability after multiple trauma

	Leisure Disability (n = 51)	Vocational Disability (n = 11)
Demographic/resources		
Age	NS	$p < 0.01$
Blue/white-collar work	NS	$p < 0.05$
Decrease of network quantity	NS	$p < 0.05$
Decrease of network quality	NS	$p < 0.01$
Injury		
Injury Severity Score	NS	$p < 0.05$
Impairments		
Cognitive impairment	NS	$p < 0.05$
Physical impairment	$p < 0.01$	NS
Pain	$p = 0.05$	NS
Disabilities		
Numbers of lost leisure activities		$p < 0.05$

Decrease of network quantity and quality, means sufficient social network before trauma and insufficient social network 3 years after trauma. p values ≤ 0.05 are given, while p values > 0.05 are denoted NS (nonsignificant).

the scores of the Abbreviated Injury Scale (AIS) or its derivative, the Injury Severity Score (ISS) (for references see Smit et al.[15]). Very few have studied impairment as an outcome. Differences in methodology and definitions makes it generally difficult to compare the results of the present with the previously published investigations on multiple trauma. However, the overall prevalence of impairments in this study concur with Bull's results.[16] Bull used a classification system which resembles that used in this study, and found that 75% of the patients with ISS 15–75 had some sort of impairment at follow-up.[16] In agreement with others,[9,16,17] the present study shows a significant correlation between ISS and degrees of impairments. The correlation was, however, according to our opinion, not sufficiently high to introduce the ISS as an adequate predictor of future impairment.

MacKenzie et al.[7–9] used a scoring system based on the AIS of the most severe injury sustained, involving the five body regions of head, spine, extremities, thorax/abdomen, and others. In this 1-year follow-up investigation of 479 trauma patients, MacKenzie et al. demonstrated that AIS was a better predictor of self-reported disability than ISS, with moderate and severe trauma to the brain and spine being most important, followed closely by injuries to the extremities. In our investigation, which included only severely multiply injured subjects with a generally higher risk for impairments, but a lower number of participants, we analyzed *impairments* (not disabilities) in relation to five somewhat different body regions of most severe injury (head, spinal cord, thorax/abdomen, extremity, face). The results confirm that this classification was meaningful in relation to head injuries (all except one with cognitive impairments belonged to this group), spinal cord injuries (all were classified as severely physically impaired), and dominating injuries to the thorax/abdomen (which were shown to have the smallest risk for impairments, 54%) ($p = 0.019$). Furthermore, the AIS scores of head injuries were closely correlated to levels of cognitive impairment. As MacKenzie and coworkers[9,18] have previously reported, there was a remarkably high prevalence of impairments after extremity injuries (59% in our study), even with low AIS scores (1–3).

Accordingly, the prevalence of impairments was high and the ISS was an inadequate predictor of impairment; while the body region of most severe injury appeared more meaningful relative to type and degree of impairment.

Whereas the retrospective recording of social network after multiple trauma may be regarded as *objectively* dubiously valid,the *subjective* experience, i.e., what the subjects really experienced, was stated. About 25% experienced a decline in the quality of their social network after trauma, expressed by

an increase in feelings of loneliness. This increased feeling of loneliness was not accompanied, in most subjects, by a decrease in the number and frequency of contact with other people. A tentative explanation might be that the severe trauma and its consequences resulted in a feeling of being alienated. Notably, although the overall changes of social network were small, the subjects with severe cognitive impairments often became socially isolated, with an insufficiency in both quantity and quality of their social network.

Another interesting aspect of the present study was to discuss the influence of injury, impairments, and individual resources on disabilities. A possible weakness in this investigation was the wide range of age (12–72 years) in relation to the sample size. The only direct correlation demonstrated between injury and disability was between the ISS and vocational disability. This finding probably can partly be explained by the relatively higher ISS's among subjects with severe head injuries leading to cognitive impairments.

The low proportion of long-term dependents in personal ADL (6%) is reasonably similar to that reported by Kivioja et al.[19] 5 to 20 years after severe multiple injuries. Our four subjects were dependent because of cognitive impairments, pain, and psychological reasons, and the small number made a statistical search for predictors meaningless. The very high proportion of leisure disability (76%), particularly for physically demanding activities, has not been reported earlier. The investigation further elucidated how difficult it is to find *new* nonwork activities. As one young man with incomplete paraplegia and chronic pain problems, who, before his injury, was particularly interested in ice hockey, expressed it, "You can't expect me to take up chess!" He had a combination of physical impairment and pain, both risk factors for losing nonwork activities, which seem to be as (or more) important for life satisfaction as are ADL and work, at least in Scandinavia.[3]

In agreement with other reports,[7,17,19,20] this study shows a high rate of return to work or education (81%). Two variables were potent predictors of vocational disability: severe cognitive impairment, and, in agreement with MacKenzie et al.,[9] blue-collar work. MacKenzie also found that return to work after 1 year was related to level of education and social support network (defined by the presence of one or more confidants). Whereas cognitive impairment has been shown to predict level of disability in traumatic brain injury patients,[21] we have not located any publications on relative impact of cognitive impairment on disability in patients with multiple trauma. Higher age as a predictor of failure to return to work is in agreement with Kivioja et al.[19] Greater difficulties with vocational rehabilitation in patients with more severe physical impairments might be expected; this was, however, not the case. On the other hand, the vocationally disabled group was characterized by other dramatic life changes, since they lost more leisure activities than did the vocationally active subjects. Furthermore, approximately one third of these subjects, all with sufficient social network quantity and quality before trauma, were gauged to have insufficient social network after trauma. In her investigation of post-stroke hemiplegics, Sjögren[10] reported a pattern of unemployment, reduced number of leisure activities, depression, and discontentment, and called this a general picture of social and emotional deprivation. These types of situations appear to resemble the condition of many subjects with severe multiple injuries. Finding solutions for such deprivations, by supporting reorientation toward new goals and thereby reinforcing the coping process, is the field of challenge for rehabilitation medicine.

The high prevalence of impairments after severe multiple trauma, and the obvious difficulties in early prediction, call for the need of individualized, continuous, and well-designed rehabilitation plans. These plans should be designed before discharge from the department of surgery. The rehabilitation plan should not only address physical medical intervention, but should also concentrate on nonwork and work activities, with particular emphasis on those patients at imminent risk of losing their work and social network. Thus, a multidisciplinary approach is needed to optimize the coping process after severe multiple trauma.

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APPENDIX A

Social Network

We want to know something about your social network and whether there has been any changes since the injury:

Your situation *today:*

1. How many people live in your household?
   - ☐ Live alone
   - ☐ Two people
   - ☐ Three or more
2. If you do not live alone, with whom do you live? Tick more than one box if applicable.
   - ☐ Spouse
   - ☐ Cohabitant
   - ☐ Friend(s)
   - ☐ Children
   - ☐ Parents/Inlaws
3. Approximately how many close friends do you have—people you feel comfortable with and can confide in? (You can count relatives if you wish.) (Tick box or write number if applicable.)
   - ☐ None
   - ☐ One
   - ☐ More. Number —
4. How often do you meet friends and relatives with whom you do not live, e.g., visits at each other's home, go out together, talk on the phone?
   - ☐ At least once a week
   - ☐ Less than once a week, but at least once a month
   - ☐ Less than once a month
5. Do any of the people close to you give you attention and take interest in what you do?
   - ☐ Shows no or little warmth and interest
   - ☐ Yes, shows some warmth and interest
   - ☐ Yes, shows a lot of warmth and interest
6. Do you ever feel lonely?
   - ☐ Never/seldom
   - ☐ Sometimes
   - ☐ Often

Your situation *before the injury:*

7. How many people lived in your household?
   - ☐ Lived alone
   - ☐ Two people
   - ☐ Three or more
8. If you did not live alone, with whom did you live? Tick more than one box if applicable.
   - ☐ Spouse
   - ☐ Cohabitant
   - ☐ Friend(s)
   - ☐ Children
   - ☐ Parents/Inlaws
9. Approximately how many close friends did you have—people you felt comfortable with and could confide in? (You can count relatives if you wish.) (Tick box or write number if applicable.)
   - ☐ None
   - ☐ One
   - ☐ More, Number —
10. How often did you meet friends and relatives with whom you did not live, e.g., visits at each other's home, go out together, talk on the phone?
    - ☐ At least once a week
    - ☐ Less than once a week, but at least once a month
    - ☐ Less than once a month
11. Did any of the people close to you give you attention and took interest in what you did?
    - ☐ Showed no or little warmth and interest
    - ☐ Yes, showed some warmth and interest
    - ☐ Yes, showed a lot of warmth and interest
12. Did you ever feel lonely?
    - ☐ Never/seldom
    - ☐ Sometimes
    - ☐ Often

APPENDIX B

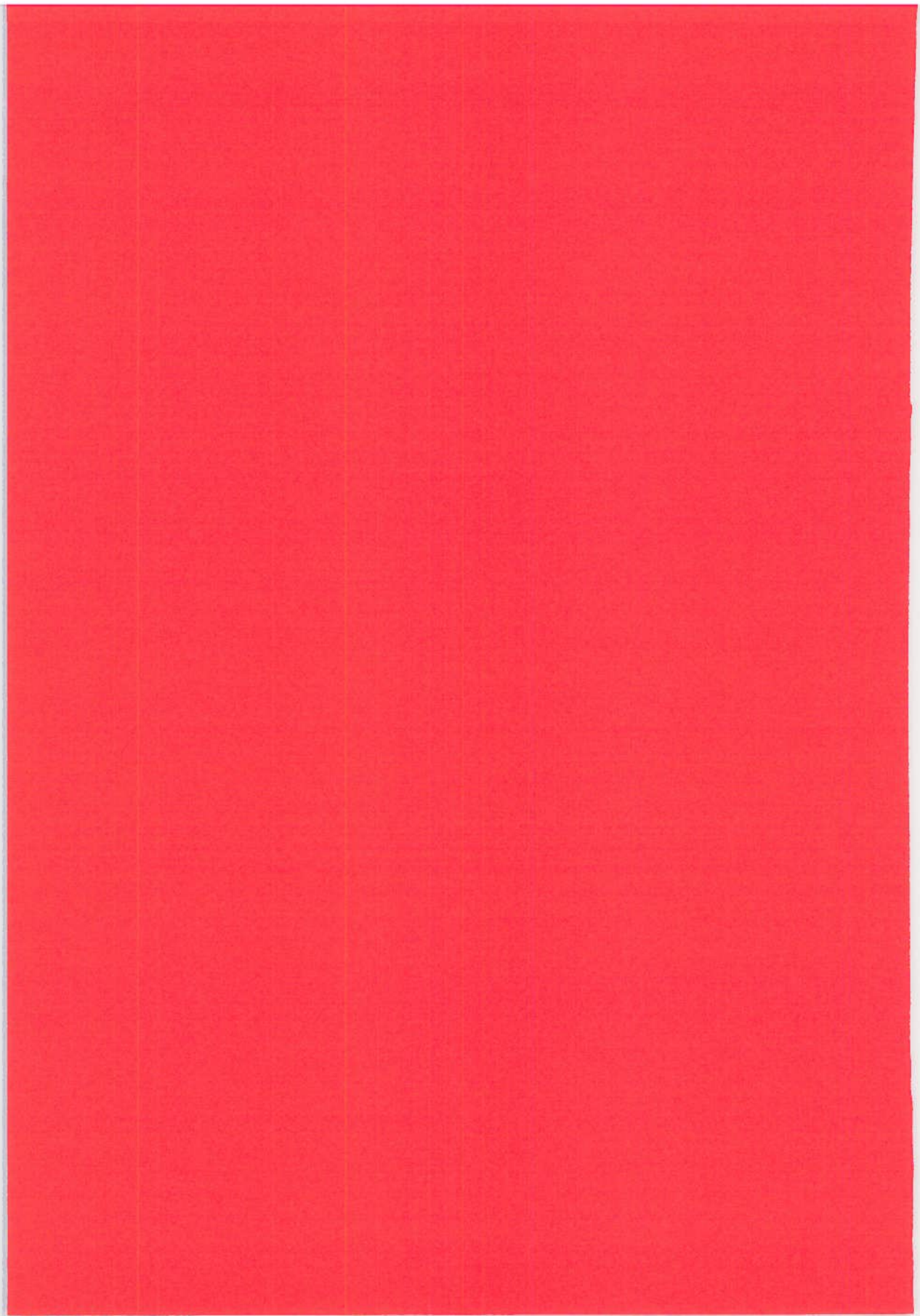
Personal Activities of Daily Living

1. Eating
2. Continence
3. Indoor mobility
4. Toilet management
5. Transfer
6. Dressing/undressing
7. Grooming
8. Cooking

INDEPENDENT
3 = fully independent (without aids)
2 = can manage alone and does with aids

DEPENDENT
1 = need some personal help or motivation, alternatively can manage alone, but does not
0 = can not manage

Paper II



Cognitive Performance in Multiple Trauma Patients 3 Years After Injury

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Objectives: Patients with sequelae from multiple trauma commonly display cognitive disturbances, specifically in the areas of attention and memory. This study was designed to assess cognitive functioning 3 years after severe multiple trauma and to investigate how cognitive performance is related to head injury severity and psychological distress respectively. **Methods:** Sixty-eight multiple trauma patients were tested with a screening battery consisting of six neuropsychological tasks 3 years after injury. A measure of psychological distress (20-item General Health Questionnaire, or GHQ-20) was also administered. **Results:** Patients who neither showed signs of reduced consciousness on admission to the hospital nor reported significant psychological distress at follow-up tended to have normal test performance. In five of the six tasks, cognitive impairment was related to the severity of the traumatic brain injury as measured by the Glasgow Coma Scale (GCS). In both attention span tasks, patients designated as cases by the GHQ had significantly lower scores than noncase patients. These bivariate relationships were upheld in multiple regression analyses, in which age, sex, and GCS and GHQ scores were entered as independent variables. When patients with severe head injuries were excluded from the analyses, GCS scores still contributed to the variance in tests of verbal attention span and delayed recall, but performance on attentional tasks was more strongly related to psychological distress than to GCS scores. **Conclusions:** Cognitive deficits in multiple trauma patients were related both to the severity of the traumatic brain injury and to the degree of psychological distress. The strength of the association between brain injury as indicated by GCS scores and cognitive performance differed between different tasks. Neuropsychological testing may assist in differentiating primary organic from secondary psychogenic impairments. **Key words:** multiple trauma, neuropsychological tests, cognitive impairment, psychological distress, brain injuries.

AIS = Abbreviated Injury Scale; ANOVA = analysis of variance; GCS = Glasgow Coma Scale; GHQ = General Health Questionnaire; GHQ-20 = 20-item General Health Questionnaire; MT = multiple trauma; PA-SAT = Paced Auditory Serial Addition Task; TBI = traumatic brain injury.

INTRODUCTION

Multiple traumas (MTs) are severe accidental injuries involving more than one body organ system. The head, neck, and face as well as the extremities are particularly vulnerable to injury, but damage to the thoracic and abdominal regions is also common (1). MT patients often suffer long-term or even permanent sequelae. In the present study, long-term sequelae in cognitive functioning in a sample of MT patients admitted to a regional trauma center were investigated. In a previous article (2), we reported residual impairments in terms of reductions in work or nonwork activities in 80% of these patients at 3 years after injury.

Psychological and psychiatric problems are often seen subsequent to MT (3–6). Depressive disorders are the most frequent psychiatric complication (3). Posttraumatic stress symptoms, including intrusive distressing recollections, avoidance behavior, and hyperarousal, are also reported (6, 7). Although the degree of psychological distress is associated with the severity of the impact of injury, the specific emotional responses to injury are reported to reflect the personal meaning of the trauma rather than injury severity per se (8).

Even if psychological sequelae of injury are important to patients, these aspects will often go unrecognized by health personnel, especially during the acute phase (9). Moreover, a number of patients develop their distress response over time, without showing specific adjustment reactions during the first few days or weeks after injury. Consequently, there is a risk that psychiatric disorders will remain untreated.

Changes in cognitive performance among MT patients have been investigated less frequently. Cognitive impairment has been reported mostly in MT sample populations dominated by patients with rather severe brain injury; in the literature, it has often been referred to as "organic brain syndrome" without further qualification (3, 10). Lehmann et al. (11) recently reported deficits in information-processing speed, concentration, recent memory, and learning performance in a study of 58 MT patients examined an average of 5.8

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years after injury. However, most of these patients had suffered severe head injury, with a mean duration of coma of 15.4 days. In a more broadly defined MT population, however, there is distinct variability in terms of brain damage, ranging from no cerebral affliction, as can occur with mild head injury, to severe brain injury.

Even if a head injury or cerebral concussion is present, cognitive impairment may be related to different causes. Whereas cognitive changes due to cerebral damage after severe TBI are well documented (12), there are different interpretations in the research literature concerning mild head injury (13). A number of studies conducted in the 1970s and early 1980s reported frequent cognitive problems, such as attentional impairments, after mild head injuries, at least during the first few months after injury, and some investigators tended to attribute these impairments to direct cerebral injury (14, 15). More recent investigations have shown that if and when these impairments occur, they are most often transitory. Levin et al. (16), in their carefully designed multicenter study, concluded that "a single, uncomplicated minor head injury produces no permanent, disabling neurobehavioral impairment in the great majority of patients free of preexisting neuropsychiatric disorder and substance abuse."

In a minority of patients with mild head injury, however, cognitive impairments persist for a long time after injury. The pathogenesis of these long-term impairments is controversial. Whereas some authors claim that persisting cognitive impairment, even in patients who suffered a slight trauma, is due to direct and primary cerebral injury (17), most researchers today will probably attribute permanently reduced cognitive functioning in patients with mild head injury but no specific risk factors as secondary to psychosomatic or emotional factors (18, 19) or cognitive factors, such as patient expectation (20). Ongoing litigation may possibly play a role in some cases (13). An interaction between cerebral affection caused by the injury and subsequent adjustment problems has also been suggested (21).

A study of long-term sequelae in cognitive performance of MT patients should be done for at least two reasons. First, it is of clinical interest to look into the nature and spectrum of cognitive impairments after MT. Second, because of the variability within the MT population, both in the severity of brain injury and in the emotional responses of patients as time passes, an MT patient sample is suitable for studying the relative influence of the primary organic (in terms of direct cerebral damage) vs. secondary emotional factors in problems of cognitive functioning. The purposes of the present study thus were to assess cognitive test performance 3 years after MT and to explore how it varies as a consequence of the severity of head injury and degree of psychological distress.

METHODS

Subjects

Of 143 patients consecutively admitted to the trauma unit at Ullevål General Hospital, Oslo, Norway, 102 patients, aged 12 years and older, survived and were discharged. At follow-up 3 years after injury, 5 patients were dead, 14 patients were living abroad or could not be located, and 1 patient had suffered a subsequent severe injury. Of the 82 remaining patients invited to participate in the present study, 14 declined, bringing the sample population to 68. The 29 patients who were alive at follow-up but were not included in the sample did not differ from study subjects in terms of age, sex, injury type, or injury severity. Table 1 presents information on sex, age, and the nature of injuries.

Measures

Type and severity of injury. The location and severity of injuries were scored according to the AIS (22) to classify patients in categories of injury and to assess the presence of head injury. The AIS is a numerical, nonlinear trauma rating system in which the severity of injury in seven body regions is rated according to a six-point scale ranging from 0 (no injury) to 5 (critical injury) (23). A number of studies examining the relationship between injury severity and functional outcome have applied the AIS and its derivative to assess the combined effects of multiple injuries (Injury Severity Score) as a measure for injury severity. In these studies, AIS was shown to be a valid and reliable prognosticator for long-term outcome after MT (24). In our study, the AIS score was determined at discharge from the trauma unit.

The GCS, a measure of the best motor and verbal responses and degree of eye opening on admission, was applied to measure the state of consciousness as an indicator of the degree of brain injury suffered (25). According to conventional classification criteria, patients were categorized into one of three GCS categories, those with severe (GCS score of 3–8 points), moderate (score of 9–12), and mild or no (score of 13–15) affection of consciousness. In research on TBI, the GCS is a standard procedure for assessment of reduced level of consciousness and is a frequently used marker of injury severity. The scale has good sensitivity and reliability, with an intraclass correlation coefficient of 0.8 to 1.0 for trained users, and well-established cross-sectional construct validity (26).

Psychological distress. Psychological distress was measured by the GHQ-20. The GHQ is a widely used screening instrument that makes use of a wide range of indicators of psychological distress and psychological disorders in the anxiety/depression spectrum. Each item is scored along a four-point scale ranging from 0 (no distress) to 3 (severe distress) in relation to the particular aspect of distress measured (anxiety, depressed mood, difficulties in coping, etc.). The instrument has been validated in different languages and cultures and has been shown to be a valid and reliable instrument across cultures (27, 28).

GHQ-20 has been validated in a series of accidentally injured adults (29). A caseness cutoff criterion of 24 (GHQ case > 24), based on a 0–1-2–3 scoring procedure, was applied according to the criteria developed in that study.

Neuropsychological tests. Patients were tested with a screening battery consisting of five neuropsychological tests representing six

TABLE 1. Number of Patients, GCS Scores at Admission, and GHQ Scores 3 Years After Injury According to Sex, Age, and Type of Most Severe Injury[a] F- and p-values refer to ANOVA tests of between group differences.

Category	Patients		GCS		GHQ	
	n	%	Mean	SD	Mean	SD
Sex						
Male	47	69	12.0	3.0	22.8	10.5
Female	21	31	13.5	2.4	20.6	10.6
			df = (1,66)		*df* = (1,65)	
			F = 2.67		*F* = .60	
			NS		NS	
Age						
12–20 years	19	28	11.1	4.6	17.8	5.1
21–30 years	21	31	13.4	2.3	22.7	11.0
31–50 years	16	24	12.8	3.2	24.0	12.1
51–72 years	12	18	12.5	4.0	25.5	12.9
			df = (3,64)		*df* = (3,63)	
			F = 1.16		*F* = 1.73	
			NS		NS	
Type of most severe injury						
Head injury	27	40	9.8	4.2	21.9	9.4
Extremities	15	22	14.5	.7	21.3	12.7
Thorax or abdomen	17	25	14.1	1.7	24.6	11.3
Other	9	14	14.0	1.7	19.4	6.5
			df = (3,64)		*df* = (3,63)	
			F = 12.91		*F* = .52	
			p < .0001		NS	
Total sample	68		12.5	3.6	22.1	10.4

[a] ANOVA of between-group differences.

different tasks. The Digit Span subtest of Wechsler's Adult Intelligence Scale (30) and the Knox Cubes Imitation Test (31) are frequently used as measures of verbal and nonverbal attention span, respectively.

In the PASAT (32), subjects hear a stream of single digits. Their task is to continuously add the last digit spoken to the one immediately preceding it (32). The speed of presentation can be varied. In the present study, patients were tested using two speeds. A number of patients failed to complete the test at the faster speed. Thus, only data from the test using the slower speed (one digit every 4 seconds) are presented here.

In the Luria-Christensen 10 Words serial learning test, patients are asked to learn 10 common nouns by the end of up to 10 repeated presentations (33). The test includes two tasks, Acquisition and Delayed Recall. The effectiveness of Acquisition is presented in terms of number of words learned. The score of Delayed Recall represents the number of words recalled at the end of the test session.

The Verbal Fluency task, which is particularly sensitive to left prefrontal damage, is a task in which the patient is asked to state as many words he or she can remember, beginning with the letters F, A, and S (in that order) (34). Norms are based on comparisons with responses from noninjured subjects. In the screening battery applied in the present study, patients presented as many words as they could remember during 1 minute using two different first letters (F and A).

Statistical Procedures

Neuropsychological test scores were correlated with GCS and GHQ scores, applying Pearson's product-moment correlation (Table 3). Differences between subcategories of patients were analyzed by means of simple factorial ANOVA models (Tables 1, 2, and 4). To compare patients in the three GCS categories, post hoc computations of least significant between-group differences, with Bonferroni corrections, were applied. Finally, a series of multiple linear regression analyses were performed, with neuropsychological test scores as dependent variables (Table 5). All independent variables were entered in one block.

RESULTS

Type and Severity of Injury

Types of injuries, in terms of body area with the highest AIS scores, are given in Table 1. Twenty-seven patients (40%) had head injury as the most severe injury. Another 16 patients had AIS scores indicating some degree of concussion or head injury, bringing the total number of head injury patients (including patients with concussions only) to 43 (63%).

The mean GCS score at admission was 12.5 (Table 1). Patients in the 12- to 20-years-old age group tended to have somewhat lower GCS scores than older patients. Ten of the 11 severe head injuries (GCS score of 3–8) were suffered by men. Because of this, there is a trend, although not a statistically significant one, for men to have lower GCS scores than women. Obviously, patients with head injury as the most severe

injury had much lower GCS scores than patients in other categories.

Thirty-four patients had a GCS score of 15, indicating no reduction in consciousness on admission to the hospital. This does not, however, rule out a possible concussion. In fact, 16 of these 34 patients had AIS scores indicating a minor concussion component in their injury. However, a minor concussion without any effect on consciousness hardly produces a brain injury at all, and GCS score was chosen as the best indicator of a head injury component.

Psychological Distress

The mean GHQ score in the sample at follow-up 3 years after injury was 22.1 (Table 1). There was a trend, although not a statistically significant one, of increased GHQ score with increasing age. No significant GHQ score differences between the sexes were found.

Distress was not related to head injury severity; in fact, there was a zero correlation between GHQ scores and TBI severity as measured by the GCS ($r = 0.01$). As indicated in Table 1, the GHQ score tended to be slightly higher among patients with injuries to the thorax or abdomen than in other injury categories.

Of the 67 patients who completed the GHQ, 18 (26.9%) met the case criterion (GHQ score > 24). Almost half (47.1%) of the patients with injuries to the thorax or abdomen were GHQ cases, compared with only 19.2% of head injury patients, but the difference did not reach statistical significance.

Neuropsychological Test Data

The means and standard deviations of each of the six tasks are presented in Table 2. For the sake of comparison, test scores of the subsample of 25 patients who had both a GCS score of 15 (indicating no affection of consciousness level) and a GHQ score below the case criterion are presented in Table 2. There are statistically significant differences between the two groups on four of the six tasks.

Patients more than 50 years old had significantly lower scores than at least one other age group on the Knox Cubes Imitation Test, PASAT, and Delayed Recall task.

Female patients had significantly higher scores on the Verbal Fluency and Acquisition tasks. When GCS scores were included as covariates, differences in scores failed to reach statistical significance.

Test Results and TBI Severity

Pearson's product-moment correlations were computed between all six neuropsychological tasks and GCS total scores. Each individual task, except the Knox Cubes test, was positively correlated with GCS scores (Table 3).

Test scores on all six tasks for patients in the three GCS categories (those with severe (GCS scores of 3–8 points), moderate (GCS score of 9–12), and mild or no (GCS score of 13–15) affection of consciousness) were compared in a pairwise manner, applying post hoc least significant differences analyses with Bonferroni corrections, for a total of 18 (6 × 3) comparisons. Patients with severe disturbance of consciousness had significantly lower scores than those with mild or no affection of consciousness on five of the six tasks: Digit Span ($df = (2,64)$, $p = .001$), PASAT ($df = (2,55)$, $p = .028$), Verbal Fluency ($df = (2,65)$, $p = .001$), Words Learned ($df = (2,56)$, $p = .006$), and Words Recalled ($df = (2,65)$, $p = .038$). Patients in the moderate category had significantly lower scores than patients in the mild or no affection of consciousness group on one test only, Digit Span ($df = (2,64)$, $p = .032$). Moreover, on the Verbal Fluency task, patients with severe distur-

TABLE 2. Results of Neuropsychological Tasks

Task	Patients With GHQ Score <24 and GCS Score = 15[a]			All Other Patients			Total Sample			*df*	*F*[b]	*p*[b]
	Mean	SD	*n*	Mean	SD	*n*	Mean	SD	*n*			
Digit Span	11.6	2.2	24	9.6	1.5	42	10.4	2.0	66	1,64	18.1	<.001
Knox Cubes	13.8	2.2	25	12.8	1.9	41	13.2	2.1	66	1,64	3.7	NS
PASAT[c]	53.0	7.1	23	46.5	8.1	35	48.5	8.5	58	1,56	13.3	<.01
Verbal Fluency	14.0	5.0	25	11.4	4.4	42	12.2	4.9	67	1,65	4.7	<.05
Words Learned	10.0	0.0	25	9.3	1.3	42	9.5	1.2	67	1,65	6.5	<.05
Words Recalled	8.4	1.5	25	7.7	2.3	42	7.9	2.1	67	1,65	1.9	NS

[a] GHQ score <24 indicates noncase status; GCS = 15 indicates no disturbance of consciousness.
[b] ANOVA between-group differences.
[c] One digit every 4 seconds.

TABLE 3. Coefficients of Correlation Between GCS and GHQ Sum Scores and Each of the Six Neuropsychological Tasks

Task	GCS		GHQ	
	Sum Score	p	Sum Score	p
Digit Span	0.45	<.001	−0.35	<.01
Knox Cubes	0.08	NS	−0.39	<.01
PASAT[a]	0.36	<.01	−0.22	NS
Verbal Fluency	0.40	<.01	−0.13	NS
Words Learned	0.41	<.001	−0.09	NS
Words Recalled	0.38	<.01	−0.05	NS

[a] One digit every 4 seconds.

bance of consciousness had significantly lower scores than patients with a moderate disturbance (df = (2,65), p = .010).

Test Results and Level of Psychological Distress: GHQ Scores

Each of the neuropsychological tasks was correlated with total GHQ scores. Both the attention span tasks (Digit Span and Knox Cubes test) were positively correlated with GHQ scores (Table 3).

Moreover, test scores for all six tasks were broken down against whether patients were rated as GHQ cases on follow-up. Again, on both attention span tasks (Digit Span and Knox Cubes test), patients designated as GHQ cases had significantly lower scores than noncase patients (Table 4). Moreover, although there were no differences on the Acquisition task in terms of the number of words learned, GHQ case patients needed a significantly higher number of presentations than required by GHQ noncase patients to reach the criterion (10 words).

Relative Effect of TBI Severity and Level of Distress on Test Scores

Multiple linear regression analyses were performed with sex, age, GCS score, and GHQ sum scores as independent variables and the test score as the dependent variable for each individual task (Table 5).

Both the GCS and GHQ scores contributed significantly to the variance in the Digit Span task (GCS: β = 0.42, $p < .001$; GHQ: $\beta = -0.36$, $p < .01$). GHQ score alone contributed significantly to scores on the Knox Cubes test ($\beta = -0.37$; $p < .01$). Moreover, GCS scores significantly predicted performance of the PASAT (β = .38, $p < .01$), the Verbal Fluency task (β = 0.31, $p < .02$), and the Acquisition (β =.31, $p < .01$) and Delayed Recall (β = 0.33, $p < .01$) tasks of the 10 Words test. Neither age nor sex had significant independent contributions to any of the test scores.

To test the specific influence of a moderate to mild injury on test scores, a parallel series of regression analyses were performed, excluding the 11 patients with a GCS score of 3 to 8, which indicates severe brain injury. GCS scores still represented a significant contribution in two separate tests (Digit Span: β = 0.28, $p < .05$; Delayed Recall: β = 0.29, $p < .05$) and nearly reached significance in one other (Acquisition: β = 0.25, p = .051).

DISCUSSION

The present study showed that performance on a number of tests of cognitive functioning in a sample of MT patients 3 years after injury is differentially related to both the severity of head injury and the degree of psychological distress at follow-up.

The fact that neuropsychological test performance is related to the degree of head injury severity is certainly no news. But the results of the study go beyond that rather obvious observation. The main findings are

TABLE 4. Test Scores on Each Neuropsychological Task According to GHQ Categories

	GHQ Case (n = 18)		GHQ Noncase (n = 49)		df	F[a]	p[a]
	Mean	SD	Mean	SD			
Digit Span	9.4	1.3	10.7	2.1	1,64	6.1	<.05
Knox Cubes	11.9	2.9	13.7	1.9	1,64	11.8	<.01
PASAT[b]	45.6	8.6	49.4	8.4	1,56	2.1	NS
Verbal Fluency	11.5	4.7	12.7	4.8	1,65	0.83	NS
Words Learned	9.5	0.6	9.6	1.2	1,65	0.14	NS
Words Recalled	8.1	1.7	8.0	2.1	1,65	0.02	NS

[a] ANOVA of between-group differences.
[b] One digit every 4 seconds.

TABLE 5. Multiple Linear Regression Analyses With Neuropsychological Test Scores as Dependent Variables and All Independent Variables Entered into One Block

Independent variable	Dependent Variables											
	Digit Span		Knox Cubes		PASAT		Verbal Fluency		Words Learned		Words Recalled	
	β	p	β	p	β	p	β	p	β	p	β	p
All patients												
Sex	0.05	.63	0.20	.08	0.09	.22	−0.15	0.13	−0.18	.13	−0.12	.34
Age	−0.02	.86	−0.22	.06	0.01	.97	0.13	0.30	−0.14	.27	−0.18	.14
GCS	0.42	.001	0.05	.65	0.38	.004	0.31	0.011	0.32	.010	−0.33	.007
GHQ	−0.36	.002	−0.37	.002	−0.26	.05	−0.14	0.23	−0.04	.71	−0.00	.98
	r^2 = 0.29		r^2 = 0.25		r^2 = 0.19		r^2 = 0.18		r^2 = 0.17		r^2 = 0.15	
Patients with GCS scores of 9–15												
Sex	0.05	.67	0.16	.20	0.00	.99	−0.18	.18	−0.19	.15	−0.14	.28
Age	−0.04	.75	−0.25	.050	0.08	.61	0.18	.18	−0.17	.20	−0.25	.062
GCS	0.28	.031	0.13	.28	0.20	.16	0.02	.89	0.25	.051	0.29	.027
GHQ	−0.34	.010	−0.32	.013	−0.29	.053	−0.13	.35	−0.18	.17	−0.09	.50
	r^2 = 0.21		r^2 = 0.24		r^2 = 0.12		r^2 = 0.08		r^2 = 0.19		r^2 = 0.18	

that the strength and nature of the association between the brain injury indicator (GCS score) and cognitive performance differ between different tasks and, perhaps more interestingly, that performance on some tasks is more strongly related to psychological distress at the time of testing than to brain injury severity.

Patients Without Signs of Brain Injury or Distress

When the 25 patients who neither had signs of reduced consciousness on admission to the hospital nor qualified as GHQ cases were considered separately, their mean test scores were well in accordance with mean values in the published norms for each test (Table 2). Thus, we may infer that the MT patients in our study who neither suffered TBI nor experienced significant psychological distress displayed normal cognitive functioning 3 years after injury.

Brain Injury and Test Performance

As expected, the severity of head injury as indicated by the GCS score was significantly related to cognitive test performance on most tasks, and these bivariate relationships were upheld in multiple regression analyses, in which age, sex, and GHQ scores were entered as independent variables together with GCS scores.

There was one interesting exception to this rule. Nonverbal attention span, as measured by the Knox Cubes Imitation Test, did not differentiate between patients with and without brain injury. We interpret this to be the result of a floor effect in this particular task when it comes to direct sequelae of brain injury. Performance on the Knox Cubes test is reported to be significantly impaired in patients with severe, focal brain lesions (31), but few patients in our sample had a level of brain damage severe enough to produce reduced Knox Cubes scores as a result of primary cerebral injury.

Obviously, patients with severe head injuries tended to have the most significantly lowered test performance compared with other categories. However, in keeping with other studies, many patients also in the mild to moderate TBI categories displayed clinically significantly reduced cognitive functioning in the areas of verbal attention span, speed of processing (35), and memory (36), even in the absence of psychological distress.

Psychological Distress and Test Performance

More than one-fourth of patients met the caseness criterion on the GHQ-20, indicating a higher level of distress than is present in the normal population (6, 29). On the basis of results of earlier studies of MT patients, we may assume that this increased level of distress is related to the injuries suffered by the subjects in this study (3–6).

On average, patients with psychological distress, operationalized as GHQ cases, had consistent problems in terms of attention span, both verbal and nonverbal, and learning efficiency. These findings are in accordance with those published in the literature, indicating specific problems of depressed patients in the areas of attention (37, 38) and effort-demanding tasks (39, 40). It is especially interesting that GHQ cases tended to exhibit impaired performance in the task of nonverbal attention, the Knox Cubes test. This task appears to be specifically sensitive to the type of at-

tentional deficits suffered by patients with a high degree of psychological distress.

There was a zero correlation between distress (GHQ scores) and GSC scores. Patient response to injury in terms of distress is thus quite independent of head injury severity. Even a seemingly mild or moderate injury may have devastating personal affects and produce high scores on tests of psychological distress for the individual patient (8).

Cognitive Dysfunction in MT Patients—Organic or Psychogenic?

The study confirmed that different psychological tests are sensitive to different aspects of cognitive sequelae subsequent to traumatic injury. For instance, the Verbal Fluency task is sensitive to a rather severe head injury but not to mild TBI or psychological distress. However, we also found that verbal attention span and memory tasks may be moderately affected in patients with mild to moderate injury, even when psychological distress is controlled for. The latter findings indicate that one should be careful not to rule out that a cognitive impairment may be related to brain injury, even when the head injury itself is mild to moderate.

On the other hand, a pattern of reduced attentional capacity, perhaps especially in terms of nonverbal processing and slow and inefficient performance on effort-demanding tasks, may be related to psychological distress regardless of whether a head injury is present. Similar findings are reported in other patient populations characterized by psychological distress, fatigue, and/or pain but without cerebral injury, such as patients with chronic fatigue syndrome (41, 42), fibromyalgia (43), and common whiplash (44). It is certainly important not to interpret all cognitive impairment as related to brain injury, even in patients who have suffered head trauma.

Conclusion

In conclusion, we found that a substantial number of patients in our sample of MT patients, particularly those who had neither suffered a significant head injury nor reported psychological distress, did not display signs of cognitive impairment 3 years after injury. However, several patients had test results indicative of cognitive impairments that were significantly related to their GCS and GHQ scores. Although the patterns of test performance of patients with moderate head injuries and those with psychological distress shared similar features, different neuropsychological tests seemed to be sensitive to different aspects of cognitive functioning. In interpreting findings on cognitive impairment, due attention should thus be given to the sensitivity of different tests to diverse areas of cognitive functioning that may reflect primary cerebral mechanisms of TBI, secondary psychological reactions to the injury, or both.

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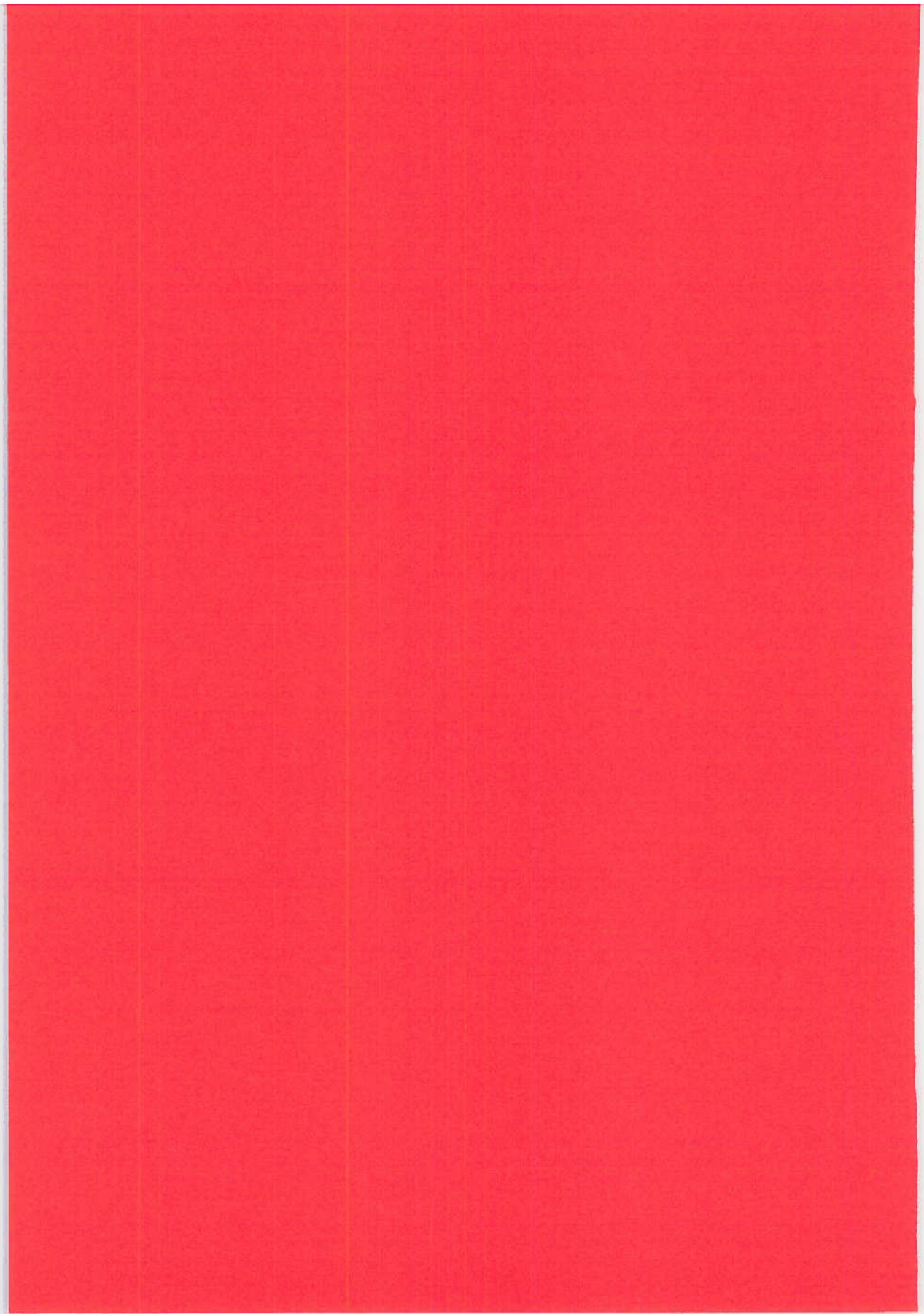
Paper III



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Life satisfaction several years after severe multiple trauma – a retrospective investigation

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Objectives: To describe the prevalence of self-reported changes in life satisfaction after multiple trauma, to analyse associations between satisfaction with life as a whole and with domains in life, and to identify important contributors for satisfaction with life.
Design: Retrospective follow-up study.
Setting: Rehabilitation hospital three years after multiple trauma.
Subjects: Sixty-nine subjects with severe multiple trauma [ISS ≥ 16].
Main outcome measures: Clinical examinations to reveal prevalences of impairments and disabilities. Questionnaires about satisfaction with life as a whole and eight domains of life, both for the time before trauma, and for the actual situation; sense of coherence (SOC-13); social network.
Results: A total of 87% experienced a decrease in at least one of the nine life satisfaction items from before to after trauma (six-graded scale). After trauma significantly fewer subjects reported to be satisfied[5–6] with life as a whole, as well as the domains sexual life, ADL, contact with friends, leisure, vocational and financial situation. Satisfaction with family life and partner relationship showed a significant decrease. The most important domains after trauma were satisfaction with leisure, family life and vocation. Vocational and leisure disability after trauma were important determinants for satisfaction with life as a whole. A strong sense of coherence and good social networks had significant impact on satisfaction with life as a whole and some of the domain-specific satisfactions.
Conclusions: Both personal resources (a strong sense of coherence) and the presence of a qualitatively sufficient social network can buffer the negative influence of disabilities on life satisfaction after trauma.

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Introduction

We previously reported the prevalence of impairments and disabilities in a consecutive series of subjects with multiple injuries, as well as the impact of impairments and sociodemographic factors on their self-care, nonwork activities and work.[1] This investigation of the same sample was designed to describe the changes in life satisfaction experienced by these multiple trauma victims, both satisfaction with life as a whole and satisfaction with specific domains of life. In addition, analyses regarding the relations between the different domains of life satisfaction and satisfaction with life as a whole were done. Further, associations between impairments and disabilities and aspects of life satisfaction were explored. Lastly, it was hypothesized that a strong individual sense of coherence[2] and a good social network could facilitate coping and thereby influence satisfaction with life after multiple trauma.

Most trauma outcome studies measure objective or health-related phenomena,[3–5] while this investigation attaches importance to an individual's assessment of their life satisfaction. Satisfaction with life as a whole can be defined as contentment, harmony or even happiness.[6–8] An individual's judgement of life as a whole can be based on an affective aspect (hedonic level of affect) and a rational aspect, where the individual weights the degree to which they are satisfied in various aspects of life. This rational aspect describes the individual's level of contentment, and may best be explained through the degree to which an individual knows and believes that they can reach their goals.[6,9] In other words a satisfied subject is one who considers that they can achieve important goals within a variety of areas of activity.[10] This conception, the 'bottom-up' model, proposes that overall life satisfaction results from satisfaction derived from specific domains of life. The contradictory 'top-down' point of view means that overall satisfaction with life should be seen as a trait: A happy individual has a disposition to experience themselves as happy, and satisfaction with life as a whole is basis for satisfaction with different domains of life.

There is a discussion whether life events can permanently influence a person's subjective well-being.[7,11] After most events there is a rapid adaptation and return to baseline, but nevertheless, some conditions have a lasting effect on a person's evaluation of their lives. Sense of coherence (SOC) can be regarded as a personality orientation that facilitates the coping process,[12,13] i.e., a mechanism underlying a person's management of stress. The concept of SOC was introduced to explain why resources such as education, wealth and social network promote health. It has been described as 'a global orientation that expresses the extent to which one has a pervasive, enduring, though dynamic feeling of confidence that 1) the stimuli deriving from one's internal and external environments in the course of living are structured, predictable and explicable; 2) the resources are available to one to meet the demands posed by these stimuli; and 3) these demands are challenges, worthy of investment and engagement' (ref. 2, p. 19). Antonovsky elaborated what he called the salutogenic model designed to explain successful coping with stressors: 'the ability (in confronting a stressor life situation) to choose what seems to be the most appropriate strategy from among the variety of potential resources available' (ref. 2, p. 140).

A high level of satisfaction with life can be regarded as a result of successful coping with stressor situations. Theoretically, good coping resources and strategies could protect subjects with impairments and disabilities after multiple trauma from a decrease in satisfaction with life by supporting, if necessary, reorientation towards new goals (Figure 1).[6,9]

Method

Subjects and procedure

The target sample was 146 patients with severe multiple trauma, consecutively admitted to the Department of Surgery, Ullevål Hospital, Oslo, Norway, during 1990. Only those patients with an Injury Severity Score (ISS) of 16 and above were included.[14] ISS was defined as the sum of the squares of the highest Abbreviated Injury Scale (AIS) score in each of the three most severely injured body regions, with a possible range in ISS from 16 to 75.[15]

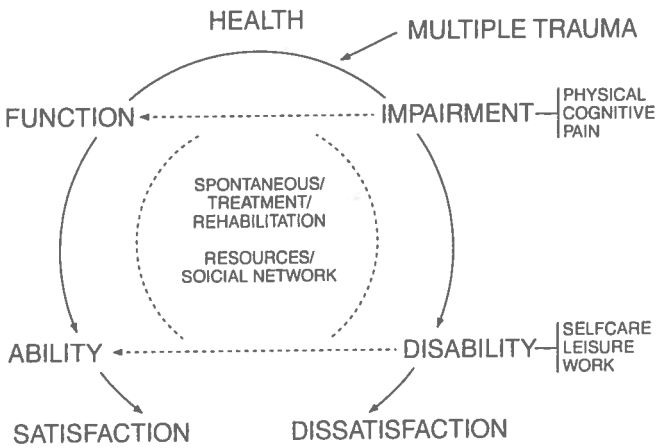

Figure 1 The association between injury, impairment/function and disability/ability. Spontaneous restoration, treatment and rehabilitation will improve function and abilities, while individual resources and environmental support are important parts of the process. By resources, we mean innate or achieved traits or properties, as well as social network.

The target sample has been described in detail elsewhere.[1] In brief, 105 patients were discharged alive from acute care. Among the 82 subjects within reach three years (35 ± 4 months) after trauma, 69 (84%) volunteered to participate in the investigation. Their median age was 26 years (range 12–72) at the time of injury and the majority (n = 48, 70%) were men. The mean ISS was 25 (range 17–50). Twenty subjects (29%) had primary school education (7–9 years) only. Among the subjects regularly working or studying at the time of injury, 14 were blue-collar and 44 were white-collar workers. The distribution of the most common injuries were: head (n = 26, 38%), thorax/abdomen (n = 22, 32%), extremities (n = 11, 16%), face (n = 6, 9%), spinal cord (n = 4, 6%). There were no significant differences concerning age, sex, injury type and injury severity between the 69 who participated and the 13 who declined to do so. The participants' prevalence and magnitudes of impairments and disabilities were registered (see ref. 1) three years (35 ± 4 months) after the injuries.

The ranking of cognitive and physical impairments was based upon physician's and neuropsychologist's assessment following physical examination and neuropsychological testing, and is explained in detail elsewhere.[1]

The rating of pain intensity the week prior to assessment was dichotomized into no or slight pain versus moderate, severe, very severe and unbearable pain.

Prevalence of disabilities was recorded for personal (self-care) ADL with eight items from the Sunnaas ADL Index.[16] Subjects were considered dependent if they reported dependency in at least one of the items.[1] Vocational disability was recorded when, as a consequence of the trauma, a previously vocationally or educationally active subject worked at a reduced level or not at all. The checklist used for registration of nonwork activities was a modification of that used by Bränholm and Fugl-Meyer.[17] Leisure disability was defined if the subject had lost at least one nonwork activity.

All participants gave their informed consent to participate, and the regional medical research ethics committee of eastern Norway approved the investigation. The subjects filled in the mailed life satisfaction and leisure activities checklists at

home. The checklists on social network and sense of coherence were filled in at the rehabilitation hospital prior to the clinical examinations, which were part of the investigation.

Measures

The life satisfaction checklist (LiSat 9) used by us is given (in English translation) in Appendix 1 and was filled in by all the subjects. The participants were asked to complete the checklist both for their current situation (three years post injury), and for their situation as it was prior to the trauma. Because of the small sample, in several of the analyses we chose to dichotomize the scale into 1–4 (not satisfied) versus 5–6 (satisfied).[6,18] The statistical validity of this dichotomy has recently been shown.[19]

Sense of coherence (SOC) was measured using Antonovsky's abbreviated instrument (SOC-13).[2] The original SOC scale is a 29-item, 7-point semantic differential questionnaire. High levels of reliability and content, face and construct validity have been found.[13] The abbreviated 13-item scale (with range 13–91) is closely correlated with the 29-item scale and was completed by 67 of the 69 subjects.

Social network quantity and quality were registered using a checklist containing six questions (see Appendix 2 and ref. 1). The questions were answered both retrospectively (the situation before the injury) and currently (the actual situation). For simplification, the quantity and quality of the social network were dichotomized into sufficient versus not sufficient. A subject considered having a minimum sufficient network quantity was someone who did not live alone, or lived alone but had at least two dependable friends with whom they were in contact at least once a week (questions 1–4). A subject rated as having a minimum sufficient network quality was someone who reported that they received more than little warmth and interest or did not often feel lonely (questions 5 and 6). In the present investigation only social network at follow up was analysed.

Statistics

For comparison of groups of data, simple cross-tabulations were performed (χ^2 test or Fisher's exact test when appropriate). The Wilcoxon signed rank test for matched pairs was used to analyse differences in life satisfaction (6-graded scale) before and after trauma. Correlations were analysed with Spearman's ρ, while the Mann–Whitney nonparametric two-sample test was used to analyse differences in medians. Values of $p \leq 0.05$ were considered statistically significant. Generally, associations and differences are only mentioned if this criterion was fulfilled. When the intention was to decide whether a variable was independently associated with life satisfaction after trauma, multiple linear regression techniques were used. Level of impairments and occurrences of disabilities were entered as classified in Table 1. Only variables that were significantly correlated to life satisfaction in univariate analyses were included as independent variables in multiple regression analyses.

Results

Table 1 presents the proportions of subjects with impairments, disabilities, sufficient quantity/quality of the social network, as well as the individuals' SOC scores at follow up three years following multiple trauma.

Changes in life satisfaction

Using the dichotomy satisfied (grades 5–6) versus not satisfied (grades 1–4), the subjects' levels of life satisfaction as reported prior to and after the trauma are given in Table 2 as proportions of subjects who were at least satisfied. Moreover, analyses of the full 6-graded scale gave 60 subjects (87%) who reported a lower level of life satisfaction in at least one of the life satisfaction items at the follow up after trauma than they felt they had before. The reported levels of satisfaction with life as a whole before and after the multiple trauma are given in Table 3. While 37 (54%) had a decrease in satisfaction with life as a whole, the situation was unchanged for 27 subjects (39%), and a small proportion ($n = 5$, 7%) had an increase ($p < 0.001$). Much the same directions and magnitude of changes were true for satisfaction with vocational situation, leisure, sexual life and financial situation; while somewhat smaller though significant changes occurred for satisfaction with contact with friends (decrease $n = 20$,

30%; unchanged $n = 38$, 55%; increase $n = 10$, 14%) and ADL (decrease $n = 26$, 39%; unchanged $n = 47$, 68%; increase $n = 1$, 1%). The only items for which no changes were reported were family life and partner relationship.

Table 1 Proportions of subjects with impairments, disabilities, insufficient quality/quantity of the social network and mean/median SOC scores, among 69 multitraumatized subjects three years after trauma

	N (%)
Cognitive impairment[ab]	
Slight/severe	16 (23%)/6 (9%)
Physical impairment	
Slight/severe	23 (33%)/28 (41%)
Pain	
Moderate to unbearable	20 (29%)
Personal (self-care) ADL	
Self-care dependent	4 (6%)
Vocational situation ($n = 58$)	
Vocational disability	11 (19%)
Non-work activities ($n = 67$)	
Leisure disability	51 (76%)
Social network quantity	
Insufficient quantity	6 (9%)
Social network quality	
Insufficient quality	11 (16%)
Sense of coherence (SOC) score ($n = 67$)	
Mean ± SD	60 ± 13
Median (range)	63 (29–81)

[a]For physical and cognitive impairments two grades of deceased function (slight/severe) are given.
[b]Four of the subjects had cognitive impairment due to other reasons than the trauma (i.e., alcohol abuse).

Relationship between satisfaction with life as a whole and the domains

To determine the weighted impact of the domain-specific items of satisfaction on satisfaction with life as a whole before and after trauma, respectively, a multiple linear regression analysis was performed. Because only 42 subjects among the 69 responders could answer the question about satisfaction with partner relations, this item, which is closely correlated to satisfaction with family life ($\rho = 0.86$), was disregarded. As

Table 3 Distribution of paired classifications for the reported patterns of change in scores (1–6) for satisfaction with life as a whole, between before trauma and at follow-up three years after trauma. The main diagonal (equal score before and after) is oriented from the lower-left to the upper-right corner

		Before trauma						
LiSaT score		6	5	4	3	2	1	
After trauma	1	3		1			1	5
	2	2	1		2	1		6
	3	3	2	1				6
	4	4	12	6		2		24
	5	6	16	2				24
	6	3		1				4
Total		21	31	11	2	3	1	69

Table 2 Proportions (%) of the 69 subjects with multiple trauma who were satisfied or very satisfied (grades 5–6) with life as a whole and with the eight domains of life, before trauma and three years after trauma

	Satisfied before trauma *n* (%)	Satisfied at follow up *n* (%)	*p*-value
Life as a whole	52/69 (75%)	28/69 (41%)	<0.001
Sexual life	39/60 (65%)	29/60 (48%)	<0.05
Partner relationship	30/47 (64%)	25/43 (58%)	NS
Family life	48/65 (74%)	42/64 (66%)	NS
ADL	69/69 (100%)	56/69 (81%)	<0.001
Contacts with friends and acquaintances	56/69 (81%)	44/69 (64%)	<0.05
Leisure	49/69 (71%)	27/69 (39%)	<0.001
Vocational situation	46/67 (69%)	20/65 (31%)	<0.001
Financial situation	33/69 (48%)	17/69 (25%)	<0.01

Number of satisfied subjects is shown together with the total number of subjects who answered the actual item. Levels of statistical differences are also given (χ^2 test).

shown in Table 4, satisfaction with family life and with vocational situation were significant explanatory variables both before and after trauma. The two other domains in the models, satisfaction with contacts with friends and with leisure, are closely correlated, and were significant explanatory factors either before or after trauma. Notably, satisfaction with leisure was the single most important variable in the regression after trauma, and the computations revealed that satisfaction with leisure alone gave an adjusted R squared of 0.59.

Life satisfaction and SOC

As shown in Table 5 there were significant differences in sense of coherence score between those who were satisfied versus those who were not satisfied after multiple trauma, both for satisfaction with life as a whole as well as six of the eight domains.

Life satisfaction related to impairments, disabilities, SOC and social network

Univariate analyses between all nine life satisfaction items (6-grade scale) and demographic factors, level of impairments, occurrence of disabilities, social network and sense of coherence were performed. Except for lower level of satisfaction with sexual life ($p = 0.05$) and contacts with friends/acquaintances ($p = 0.01$) with increasing age (Kruskal–Wallis test), neither gender nor age were significantly associated with any of the life satisfaction items. Furthermore, neither quantity of social network nor physical impairment were significantly related to levels of life satisfaction. In contrast, level of cognitive

Table 4 Automatic stepwise regression model to predict satisfaction with life as a whole before and after multiple trauma respectively

	Before trauma ($n = 64$)		After trauma ($n = 61$)	
Satisfaction with	S-beta	p-value	S-est	p-value
Vocational situation	0.41	0.001	0.20	0.05
Contacts with friends	0.36	0.001	–	NS
Family life	0.21	0.05	0.33	0.001
Leisure	–	NS	0.52	0.001
R-squared	0.85		0.78	

Numbers of subjects are given in the table. The independent variables entered were domain-specific satisfaction with all domains, except satisfaction with partner relationships (6-grade scales). Only variables with statistically significant estimates of standardized beta coefficients are shown.

Table 5 Median SOC score (range) by life satisfaction items dichotomized into satisfied (grades 5–6) and not satisfied (grades 1–4) after trauma. The right column indicates whether differences in SOC score emerged. Items are arranged according to the factor analytic pattern found by Fugl-Meyer *et al.*[b]

	Satisfied (5–6)	Not satisfied (1–4)	p-value (Mann–Whitney)
Life as a whole ($n = 67$)	70.5 (57–81)	53 (29–73)	0.001
Sexual life ($n = 58$)	67 (42–81)	62 (29–78)	0.01
Partner relationship ($n = 42$)	67 (46–81)	46 (29–68)	0.001
Family life ($n = 62$)	65.5 (40–81)	48 (29–76)	0.001
ADL ($n = 67$)	64 (29–81)	57.5 (40–78)	0.45
Contacts with friends and acquaintances ($n = 67$)	65.5 (33–81)	54 (29–78)	0.01
Leisure ($n = 67$)	68 (37–81)	54 (29–75)	0.001
Vocational situation ($n = 64$)	68 (46–81)	59.5 (29–80)	0.01
Financial situation ($n = 67$)	68 (38–80)	63 (29–81)	0.16

impairment and pain were significantly correlated to being/not being satisfied, both with life as a whole and with several of the domains. Not surprisingly, there were many statistically significant relations between perceived dissatisfaction (grades 1–4) and occurrence of disabilities in ADL, work and leisure. Lastly, both the quality of the subject's social network and SOC score were significantly related to all items of current life satisfaction, except satisfaction with financial situation and ADL.

In order to deduct minimum sets of the included variables that were significantly associated with each of the life satisfaction items, a series of stepwise multiple regression analyses were performed (entering as independent variables only those that were significantly associated with the life-satisfaction items in the univariate analyses). Satisfaction with the financial situation was not included as it was significantly correlated only with educational level. As shown in Table 6 the explained variances (adjusted R^2) were relatively low, between 0.30 and 0.42, for most life satisfaction items, except for satisfaction with life as a whole (adjusted $R^2 = 0.60$), satisfaction with partner relationships (adjusted $R^2 = 0.61$) and satisfaction with leisure (adjusted $R^2 = 0.55$). With this small sample, including dropouts, the results of the regression analyses seemed meaningful only when at least 50% of the variance was explained.

For satisfaction with life as a whole, both personal and network resources had significant positive impacts. Further, these two environmental resources had additive effects in contrast to the negative impact of vocational disability and leisure disability. As seen when the disabilities are entered in the regression in addition to the impairments, level of cognitive impairment is no longer significantly associated with global life satisfaction (or most other life satisfaction domains), as it was in the univariate analyses. However, cognitive impairment still contributes significantly in explaining satisfaction with partner relationships, together with sense of coherence score.

Among the sociodemographic factors, educational level was in univariate analyses significantly associated with both global life satisfaction and satisfaction with several domains, while blue/white-collar work was significantly correlated with satisfaction with family life, partner relations and contacts with friends. In the final regression model, blue-collar work was the only explanatory sociodemographic variable.

Discussion

The main findings in this investigation of life satisfaction reported by Norwegian subjects several years after multiple trauma are a pronounced experienced decrease in satisfaction with life as a whole, as well as in satisfaction with sexual life, ADL, contacts with friends, leisure, vocational and financial situations. Among the domains, the most important contributors for satisfaction with life as a whole after trauma, were satisfaction with leisure, family life and vocation. Furthermore a strong sense of coherence and a sufficient social network quality had a significant impact on satisfaction with life as a whole. Disabilities caused by the trauma contribute more than resulting cognitive and physical impairments for life satisfaction three years after trauma.

As indicated by others,[9,18] a retrospective investigation of life satisfaction cannot exclude the occurrence of some idealization of life prior to trauma. Further, comparing this study with a Swedish reference group with more than 2000 subjects,[19] some degree of idealization of the time before trauma concerning satisfaction with vocational situation, leisure and contact with friends seems to occur. A prospective investigation will, whenever possible, be preferable, and the retro-

Clinical messages

- There is a marked decrease in satisfaction with life as a whole and domains of life after severe multiple trauma.
- A strong sense of coherence and having a qualitatively sufficient social network might buffer the negative influence of disabilities on life satisfaction.
- The findings indicate a need for better organized comprehensive rehabilitation services, with careful consideration of social and personal factors.

Table 6 Regression analyses of satisfaction with life as a whole and the domains in 69 subjects after multiple trauma

Independent variable	Standardized beta coefficients							
	Life as a whole (n = 55)	Sexual life (n = 50)	Partner relations (n = 34)	Family life (n = 51)	ADL (n = 65)	Contact with friends/ acqaintances (n = 67)	Leisure (n = 65)	Vocational situation (n = 55)
Age	•	ns	•	•	•	ns	•	•
Educational level	ns	•	•	ns	•	•	ns	•
Blue/white-collar work	•	•	−0.33[b]	−0.31[b]	•	ns	•	•
Impairments								
Cognitive	ns	ns	−0.27[a]	−0.26[a]	•	ns	ns	•
Pain	ns	•	•	•	−0.36[c]	•	−0.19[a]	•
Disabilities								
ADL	ns	ns	ns	ns	−0.45[c]	ns	−0.42[c]	ns
Work	−0.23[a]	−0.56[c]	ns	ns	•	ns	•	−0.66[c]
Leisure	−0.26[b]	ns	•	ns	ns	•	−0.18[a]	•
Social network quality	+0.28[b]	ns	ns	ns	•	+0.53[c]	ns	ns
Sense of coherence	+0.43[c]	ns	+0.60[c]	+0.47[c]	•	+0.21[a]	+0.37[c]	ns
Adjusted R-squared	0.60	0.30	0.61	0.38	0.30	0.41	0.55	0.42

Life satisfaction (6-grade scales) is modelled as a function of sociodemographic factors, impairments, disabilities, social network quality and sense of coherence. Only variables that were significantly correlated to life satisfaction in univariate analyses were included. Estimates of standardized beta coefficients are displayed when statistically significant. Numbers of observations are given for the final model.
•Not applicable (i.e., nonsignificant in univariate analyses).
ns, nonsignificant.
[a]$p \leq 0.05$.
[b]$p \leq 0.01$.
[c]$p \leq 0.001$.

spective measure of perceived satisfaction with life prior to trauma is a clear weakness of this study. In our opinion, this is less important than the actual experience of the person reporting their situation. Furthermore, three years after trauma, the multiple trauma subjects were significantly less satisfied than was a reference population[19] with life as a whole, as well as all domains except contact with friends and sexual life.

A second possibly important weakness of the study is the small sample size. In addition, there is a considerable heterogeneity regarding common injuries and types of impairments, thus precluding valid generalizations. On the other hand, both ISS scores, distribution of injury types and resulting prevalence of impairments/disabilities are quite similar to those found in other countries.[1,20]

The findings of decreased satisfaction with life as a whole, and all domains except satisfaction with family life and partner relations, are supported by previous findings of levels of satisfaction in patients with disabilities due to spinal cord injury, stroke and multiple sclerosis.[18,21,22] Subjects with these neurological disorders though reported lower levels of satisfaction with ADL and sexual life. This is probably caused mainly by more severe functional deficit.[23] Despite less severe impairments, the multiple trauma subjects experienced losses in satisfaction with life with values generally on a par with those found after spinal cord injury.

The finding at follow-up that only 31% were satisfied with their vocational situation, and only 25% with their financial situation, may reflect an insufficient health, rehabilitation and social security system for multiple trauma patients. In this context it is worth mentioning that successful vocational rehabilitation leads to increased satisfaction with the vocational situation as well as life as a whole,[24] supporting the view that achievements of important goals can have positive impact on satisfaction with life as a whole (the bottom-up model).

Fugl-Meyer *et al.*[3] have reported three areas of domain-specific goals to explain satisfaction with life as a whole: emotion-related (partner relations, family life, sexual life), sociability-related (contact with friends, leisure situation) and provider-related (vocational and financial situation). In the present study, one domain from each of these three areas was found to be the most important explanatory variable for global life satisfaction, both before and after trauma (Table 4).

In agreement with studies on spinal cord-injured subjects,[25,26] our analyses did not demonstrate significant associations between level of physical impairment and any of the life satisfaction items. Though no significant association between cognitive impairment and quality of life was found after subarachnoid haemorrhage,[27] in the present investigation lower level of cognitive function was univariately related to low satisfaction with life as a whole and several life satisfaction domains. Also in regression analyses cognitive impairment had an independent influence on satisfaction with partner relations and family life.

Social and personal resources have been reported to be more closely associated with subjective well-being than are material resources.[28] After multiple trauma there was an independent 'buffering effect' on life satisfaction of a sufficient quality of social network and a strong sense of coherence. Other sociodemographic factors appeared to be of marginal importance for life satisfaction, with one exception: blue-collar workers, in accordance with the finbings of Bränholm *et al.*,[29] were found to be less satisfied with partner relations after trauma than white-collar workers.

The finding of a close correlation between simultaneously rated sense of coherence and satisfaction with life as a whole and most domains is in accordance with other cross-sectional studies.[12,13,30] Evidently this indicates that actual SOC is a covariant of different aspects of life satisfaction. Sagy *et al.*[12] found a direct pathway between SOC and global life satisfaction that contributed more to life satisfaction in older people than did health. However, SOC may not be stable over time or across traumatic experiences. Prospective studies on the predictive value of SOC for life satisfaction will therefore be a logical consequence of the present investigation.

Coping with serious life events appears to be the central issue of rehabilitation medicine. Although rehabilitation services have improved in Norway during the last decade, we believe that subjects suffering multiple trauma today will

share experiences with the study group. Finally, the low levels of long-term satisfaction with life as a whole, as well as with satisfaction with several domains found here, indicate a need for better organized comprehensive rehabilitation services after acute care, with careful considerations of social and personal factors to support coping and reintegration.

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Appendix 1 – Life satisfaction checklist

How satisfactory are these different aspects of your life? Indicate the number that best suits your situation.[a]

1 = Very dissatisfying
2 = Dissatisfying
3 = Rather dissatisfying
4 = Rather satisfying
5 = Satisfying
6 = Very satisfying

Life as a whole is	1	2	3	4	5	6
My vocational situation is	1	2	3	4	5	6
My financial situation is	1	2	3	4	5	6
My leisure situation is	1	2	3	4	5	6
My contact with friends and acquaintances are	1	2	3	4	5	6
My sexual life is	1	2	3	4	5	6
My ability to manage my self-care (dressing, hygiene, transfers, etcetera) is	1	2	3	4	5	6
My family life is	1	2	3	4	5	6
My partner relationship is	1	2	3	4	5	6

[a]For characterizing pretrauma life satisfaction, the phrasing was:
'How satisfactory were these different aspects of your life prior to your injury? Indicate the number that best suited your situation.'
Life as a whole *was* . . .
My vocational situation *was* . . .

Appendix 2 – Social network

We want to know something about your social network and whether there has been any changes since the injury:

Your situation *today*:

1. How many people live in your household?
☐ Live alone
☐ Two people
☐ Three or more

2. If you do not live alone, with whom do you live? Tick more than one box if applicable.
☐ Spouse
☐ Cohabitant
☐ Friend(s)
☐ Children
☐ Parents/Inlaws

Your situation *before the injury*:

7. How many people lived in your household?
☐ Lived alone
☐ Two people
☐ Three or more

8. If you did not live alone, with whom did you live? Tick more than one box if applicable.
☐ Spouse
☐ Cohabitant
☐ Friend(s)
☐ Children
☐ Parents/Inlaws

3. Approximately how many close friends do you have – people you feel comfortable with and can confide in? (You can count relatives if you wish.) (Tick box or write number if applicable.)
- ☐ None
- ☐ One
- ☐ More. Number.....

4. How often do you meet friends and relatives with whom you do not live, e.g., visits at each other's home, go out together, talk on the phone?
- ☐ At least once a week
- ☐ Less than once a week, but at least once a month
- ☐ Less than once a month

5. Do any of the people close to you give you attention and take interest in what you do?
- ☐ Shows no or little warmth and interest
- ☐ Yes, shows some warmth and interest
- ☐ Yes, shows a lot of warmth and interest

6. Do you ever feel lonely?
- ☐ Never/seldom
- ☐ Sometimes
- ☐ Often

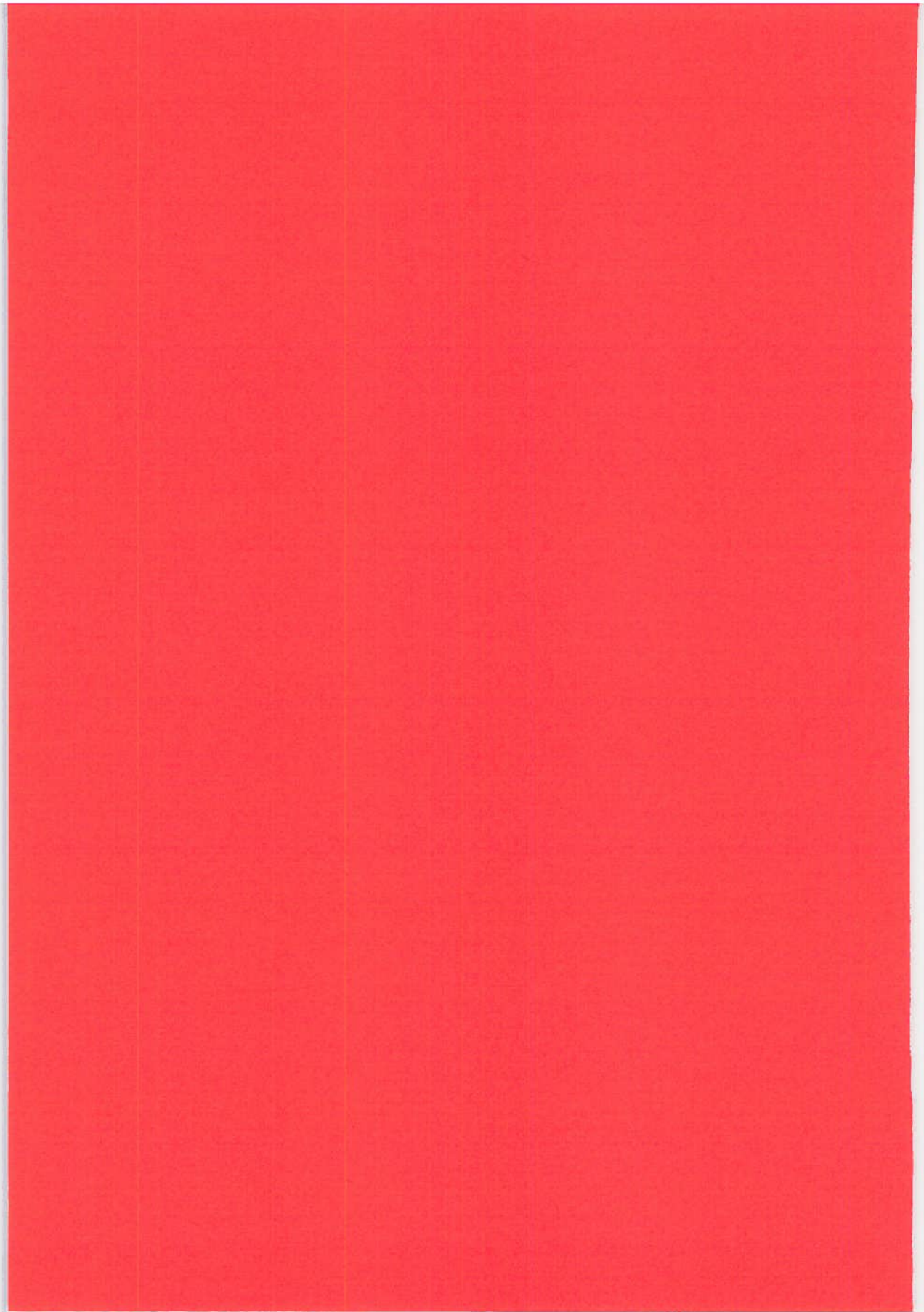
9. Approximately how many close friends did you have – people you felt comfortable with and could confide in? (You can count relatives if you wish.) (Tick box or write number if applicable).
- ☐ None
- ☐ One
- ☐ More. Number.....

10. How often did you meet friends and relatives with whom you did not live, e.g., visits at each other's home, go out together, talk on the phone?
- ☐ At least once a week
- ☐ Less than once a week, but at least once a month
- ☐ Less than once a month

11. Did any of the people close to you give you attention and took interest in what you did?
- ☐ Showed no or little warmth and interest
- ☐ Yes, showed some warmth and interest
- ☐ Yes, showed a lot of warmth and interest

12. Did you ever feel lonely?
- ☐ Never/seldom
- ☐ Sometimes
- ☐ Often

Paper IV



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Is sense of coherence stable after multiple trauma?

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Objectives: To explore whether sense of coherence (SOC) is stable over time after multiple trauma. The associations between SOC and satisfaction with life as a whole, as well as aspects of psychological well-being, were explored. Finally, an overriding aim was to assess whether SOC has long-term prognostic value for global life satisfaction or psychological well-being.
Design: Prospective study.
Setting: Sunnaas Rehabilitation Hospital.
Subjects: Twenty-six subjects with severe multiple trauma, without neuropsychological deficits.
Main outcome measures: Questionnaires that were answered at admission, at discharge and at follow up 1–3 years after trauma were: Sense of Coherence Scale 13 items (SOC-13), satisfaction with life as a whole, General Health Questionnaire 20 items (GHQ-20), Hospital Anxiety and Depression Scale (HAD).
Results: While median SOC scores were fairly stable, individual scores were not stable over time, and for some subjects showed large variations. SOC score had neither long-term prognostic value for satisfaction with life as a whole nor for psychological well-being, at least not in the first years after severe multiple trauma. However, SOC was closely associated with overall life satisfaction when measured simultaneously. Furthermore, a weak SOC correlated with scores on psychological distress, anxiety and depression. SOC scores were also significantly related to being or not being in a state of anxiety, but not to being or not being depressed. Global life satisfaction was considerably reduced from before trauma (reported at admission) to the time of follow up.
Conclusion: SOC was not stable over time after severe multiple trauma. SOC measured at admission could neither predict future satisfaction with life as a whole nor future psychological well-being. Measured simultaneously, overall life satisfaction and occurrence of anxiety were significantly associated with SOC.

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Introduction

Sense of coherence (SOC) was introduced by Antonovsky as a part of his salutogenic model. He constructed a concept labelled 'general resistance resources' describing the total amount of resources available for a subject to reduce tension or cope with different life stressors, including resources like money, ego strength, cultural stability, social supports and other factors.[1] Sense of coherence is thought to emerge out of the general resistance resources, and can be seen as a person's general orientation towards life. More specifically Antonovsky[1] defined the sense of coherence as 'a global orientation that expresses the extent to which a person has a pervasive, enduring, though dynamic feeling of confidence that 1) the stimuli deriving from one's internal and external environments in the course of living are structured, predictable and explicable, 2) resources are available to meet the demands posed by these stimuli, and 3) these demands are challenges, worthy of investment and engagement.' These three components are labelled comprehensibility, manageability and meaningfulness. Thus, SOC should determine the perception and interpretation of external events, rather than the patterns of behaviour or specific coping strategies *per se*.

Usually, according to Antonovsky, the SOC score for an individual should be a more or less constant value during the adult life, being established by the end of the second decade of life, and with only minor and temporary changes 'in response to major changes in patterns of life experiences' (ref. 1, p. 125). However, we have located only few prospective studies.[2,3]

Antonovsky regarded sense of coherence as a personality orientation that facilitates the coping process, while satisfaction with life as a whole can be seen as an indication of the degree to which the coping (or rehabilitation) process has succeeded.[4] In a previous retrospective investigation of subjects with multiple trauma,[5] we have reported that SOC measured by the method described by Antonovsky[1] was closely related to satisfaction with life as a whole as well as to a series of domain-specific life satisfaction items. As coping with serious life events appears to be the central issue in rehabilitation medicine, it was important for us to analyse SOC further, in terms of the instrument's stability over time after multiple trauma, whether it is associated with levels of simultaneously reported overall life satisfaction, and with psychological distress.

A further aim was to determine whether SOC measured at admission and at discharge had long-term prognostic value for psychological well-being and for satisfaction with life as a whole.

The regional medical research ethics committee approved the investigation.

Subjects and methods

Subjects

The investigation included patients with severe multiple trauma, consecutively admitted to Sunnaas Rehabilitation Hospital for primary rehabilitation during the period from April 1993 to January 1996. Severe multiple trauma was defined both as trauma to more than one body region,[6] and, in accordance with clinical practice, as multiple trauma within one body region. At least one body region was severely injured, most commonly multiple extremity injuries, with expected permanent impairment. Further criteria for inclusion were voluntary participation, age 18–68 years at the time of injury, and that the patients had the physical and mental ability to answer the questionnaires themselves. Patients with neuropsychological deficit due to brain injury were excluded.

Twenty-eight consecutively admitted patients fulfilled the criteria and signed a letter of informed consent. Additionally six patients with multiple trauma, but with severe psychiatric problems, were admitted to the hospital in the same period, but were excluded from the study. Two men were only willing to fill in the questionnaires at admission, however, thus follow up was possible for 26 patients (8 women and 18 men). Their median age was 31 years (range 18–68 years). The injury severity score (ISS) was calculated[6]: The injuries were categorized by body region (head or neck, face, thorax, abdominal or pelvic contents, extremities or pelvic girdle and external), and the severity was graded from 0 (no injury) to 5 (unsurvivable injury). The ISS was calculated by adding the squares of the

three highest scores from these most injured body regions. The median injury severity score was 25 (range 9–50). The dominating trauma was complicated extremity fractures in 10 patients, spinal cord injury in nine patients and pelvic fractures in seven patients. Additional traumas were mainly rib fractures, lung contusions, pneumothorax/haematothorax and/or wounds. The subjects' total median time as inpatients was 161 days (range 73–290), and the median length of stay at the rehabilitation hospital was 118 days (range 20–235).

All patients underwent an individually adapted, multidisciplinary rehabilitation programme during their stay at the Sunnaas Rehabilitation Hospital. When the inpatient rehabilitation programme was completed, all patients were discharged to their homes, and followed up by a local or community-based rehabilitation team or relevant health professionals.

Methods

All patients filled in the self-report questionnaires and checklists on three occasions: (1) within one week after admission (median 35 days, range 6–80 days after injury), (2) shortly before discharge (median 161 days, range 73–290 days after injury), and (3) at follow up (median 24 months, range 12–41 months after injury). The questionnaires were filled in by the patients when they were in the rehabilitation unit (admission and discharge), and mailed to their home (follow up). The questionnaires and checklists were used in Norwegian versions, and were as follows.

Sense of coherence (SOC)

The original instrument contained 29 items. After further analyses a 13-item instrument was suggested.[1] The latter instrument is used here and is shown in detail in Appendix 1. SOC-13 was filled in by all 26 patients three times. One patient had missing SOC-13-data at admission, and was not included in all analyses. The score from each item is summed to a total, with a possible range from 13 to 91. The higher the score, the stronger the sense of coherence. A high level of reliability and content-, face- and construct validity has been found.[2,7,8]

Overall life satisfaction

This was measured using one statement from the LiSat checklist.[9] This instrument has recently been epidemiologically validated in a nationally representative Scandinavian (Swedish) sample.[10] In other reports its test–retest reliability has been demonstrated. The statement used here is phrased along a 6-graded ordinal scale: My life as a whole is very satisfying/satisfying/rather satisfying/rather dissatisfying/dissatisfying/very dissatisfying. For further details see, for example, ref. 5.

The satisfaction with life as a whole questionnaire was filled in by all 26 patients at the three points of time. At admission the patients were asked to report their satisfaction for the time before trauma.

General Health Questionnaire (GHQ-20)

The General Health Questionnaire administered on all three occasions is a screening instrument for distress and psychopathology, also suitable for somatically ill patients.[11,12] Each item measures symptoms compared with what is normal for the patient, and each answer is rated on a Likert scale with points assigned to each position (0, 1, 2, 3). This gives a possible range from 0 to 60. Malt[11] proposed using a cut-off point between 23 and 24, with a score of 24 or more defined to be pathological, i.e., the patient is in a state of psychological distress.

Hospital Anxiety and Depression Scale (HAD)

The Hospital Anxiety and Depression Scale,[13] administered at discharge and at follow up, is designed to measure anxiety and depression in somatically ill patients.[13,14] The scores related to anxiety and depression are summed separately, and the cut-off point for pathological scores can be chosen between 8 and 11. In this investigation the scores for clinical significant depression and/or anxiety were set to 11 or higher, and the HAD scale was in this study regarded as an outcome measure.

Statistics

The internal consistency of the SOC scale was analysed with Chronbach's alpha. To analyse for the stability over time of the SOC, intraclass correlation coefficient (ICC) was computed. An ICC

< 0.90 was, in accordance with the literature, regarded as denoting nonstability. When comparing a dichotomized variable at two different points of time, the two-sided sign test was used. To design whether a mean change within a patient group was statistically significant, the two-sided paired Wilcoxon test was used. Spearman's correlation coefficient (ρ) was used as a measure of the closeness of the association between two continuous (or graded) variables, while the Mann–Whitney nonparametric two-sample test was used to analyse for differences in medians. For comparison of groups of data simple cross-tabulations were performed. The chosen level of significance was $p \leq 0.05$.

Results

SOC score

The Chronbach alphas at the three times measured varied from 0.86 to 0.89, thus demonstrating an acceptable degree of internal consistency at each point of time. The median SOC score on admission was 63 (range 37–86), at discharge 68 (range 40–91) and at follow up 65 (range 25–84). Wilcoxon analysis showed a significant decline in scores from discharge to follow up ($p \leq 0.05$). Such differences did not occur between admission and discharge or follow up.

Figure 1 shows the individual SOC scores at admission versus discharge (a), at discharge versus follow up (b), and at admission versus follow up (c). These demonstrate that no single individual had precisely the same scores at any of the three different times registered. Moreover, the ICC analysed over all three occasions was 0.74. ICC levels below 0.85[15] and even 0.94,[16] have been regarded as inadequate for decision-making. While ICC levels < 0.75 can be regarded[17] as indicating poor to moderate relative reliability. However, for the total group, SOC scores at admission and discharge (Fig. 1a) were rather closely associated (Spearman's $\rho = 0.61$, $p < 0.001$), with approximately the same range at discharge vs follow up ($\rho = 0.59$, $p < 0.01$). As seen (Fig. 1b), two subjects had markedly lower SOC scores at follow up than at discharge. On the other hand, SOC scores at admission versus follow up (i.e., over a period of about two years) were not significantly associated ($\rho = 0.23$, $p = 0.30$).

For 14 subjects the differences were quite small (less than 10 points), while the 11 remaining subjects differed with 10 points or more from admission to follow up. Of these, four had an increase in SOC score (range 10–23 points), while seven had a lower SOC score at follow up (range 10–55 points). The median age for the subpopulation with the largest differences in SOC scores was higher than for the total group, with a median of 51 years versus median 29 years for all patients ($p < 0.10$). Besides age, this subpopulation did not differ from the remaining population according to gender, main diagnosis (spinal cord injury or extremity fractures), time from injury to follow up or vocational situation.

Satisfaction with life as a whole

At admission 22/26 subjects reported that prior to the trauma life as a whole was satisfying or very satisfying (Table 1). At discharge considerably fewer (15 subjects) reported that they were at least satisfied, and remarkably, only eight subjects were satisfied at follow up. There was thus a continuous statistically significant decline ($p < 0.05/p < 0.05/p < 0.001$) in number of overall satisfied subjects.

SOC versus satisfaction with life as a whole

At all three times satisfaction with life as a whole was significantly correlated with sense of coherence (Figure 2). The significant correlation at admission occurred though the patients were asked to report their experienced life satisfaction before trauma.

Psychological well-being

The number of subjects with case scores (i.e., pathological scores) on the GHQ-20 and the HAD scales are also given in Table 1. Obviously, for none of these parameters were there significant differences between the different points of measurement.

GHQ-20

Ten subjects were in psychological distress (according to GHQ-20) at each time registered. Four of these remained in this situation at all times of measurement. Further, two subjects with

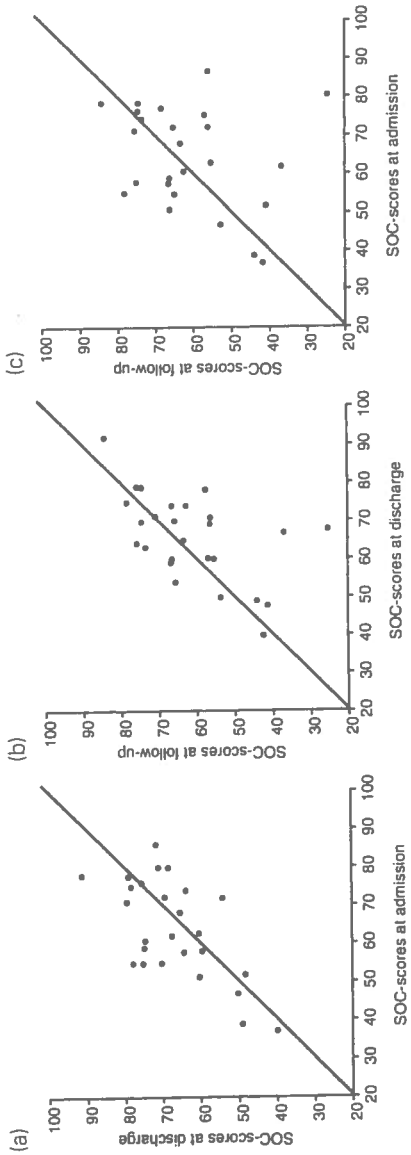

Figure 1 Scatterplots for 25 individual subjects with multiple trauma. The diagrams show correlations of (a) sense of coherence score at admission versus at discharge ($\rho = 0.61$, $p < 0.001$), (b) at discharge versus follow up ($\rho = 0.59$, $p < 0.01$), and (c) at admission versus follow up ($\rho = 0.23$, ns).

Table 1 Proportion of multiple trauma subjects who were satisfied (grades 5–6) with life as a whole, and subjects who had case scores (i.e., pathological scores) on General Health Questionnaire (GHQ-20) and Hospital Anxiety and Depression Scale (HAD)

	Admission	Significance admission versus discharge	Discharge	Significance discharge versus follow up	Follow up	Significance admission versus follow up
Satisfied with life as a whole (5–6)	22/26	$p < 0.05$	15/26	$p < 0.05$	8/26	$p < 0.001$
GHQ-20 score >23	10/23	ns	10/26	ns	10/26	ns
HAD anxiety score >10	–	–	3/26	ns	5/26	ns
HAD depression score >10	–	–	3/25	ns	4/25	ns

Proportions are given for the three times measured: at admission to the rehabilitation centre, at discharge, and at follow up median 24 months after trauma. At admission the subjects were asked to report their satisfaction before trauma.
Numbers of subjects who were satisfied or had pathological scores are given together with the total number of subjects studied. The total number differs due to scattered missing values.

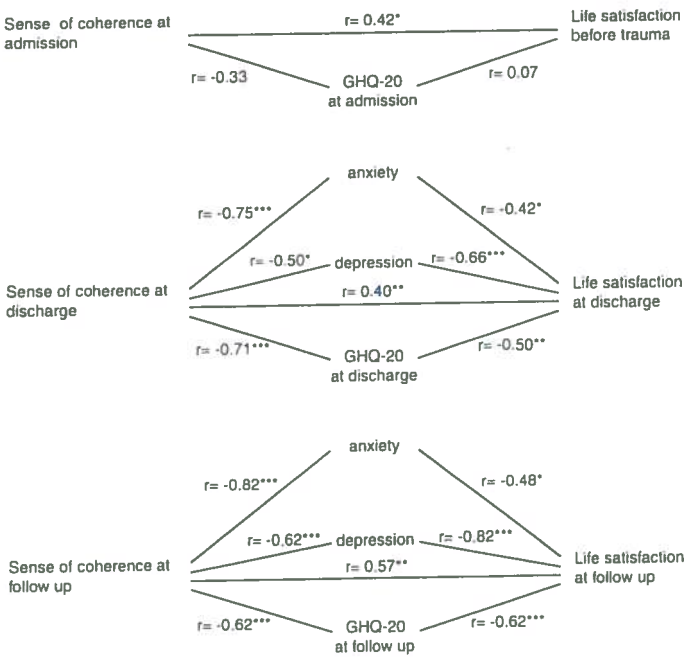

Figure 2 Spearman's correlations between psychological distress (GHQ-20), anxiety, depression and global life satisfaction after severe multiple trauma. The correlations are measured at three times: at admission to the rehabilitation hospital, at discharge from the rehabilitation hospital, and at follow up 1–3 years after trauma. At admission to the hospital, the patients were asked to report their perceived global life satisfaction *before* trauma. All other measurements and associations are simultaneously recorded. Statistical significant correlations are given as: $^{*}p < 0.05$ $^{**}p < 0.01$ $^{***}p < 0.001$.

nonpathological admission scores were in distress at discharge, and one remained at follow up. As many as four of the 10 subjects with case scores at follow up had normal values at discharge. In fact only nine persons had no signs of pathological distress throughout the investigation.

As illustrated in Figure 2, there were negative correlations between SOC scores and scores on GHQ-20 (psychological distress), that reached significant values at discharge and follow up. Also, SOC score at admission was significantly correlated to being or not being in psychological distress at discharge, but not at follow up.

Moreover, psychological distress was significantly associated with gross level of satisfaction with life as a whole, both at discharge and at follow up.

Anxiety

Two of the three who were in a state of anxiety at discharge, remained there at follow up. At this time further three subjects were anxious.

Depression

Among the three subjects who qualified for the label depression at discharge, one remained in

this state, with the addition of a further three subjects at follow up.

Covariations between HAD score and SOC

Both at discharge and at follow up sense of coherence was significantly negatively correlated with scores on the anxiety and depression scales (Figure 2). There were significant differences in SOC scores between those being anxious versus those not being anxious, while being or not being depressed did not covary significantly with SOC (Mann–Whitney test).

Prognostic value of psychological well-being for life satisfaction

Neither gross level of GHQ score, anxiety nor depression measured at discharge were significantly correlated to measures of satisfaction with life as a whole at follow up (i.e., they had no evident prognostic value).

Prognostic value of SOC

SOC scores measured at admission and at discharge were not significantly associated with satisfaction with life as a whole at follow up (i.e., they had apparently no prognostic value for future overall life satisfaction). However, SOC scores measured at admission were significantly higher (Mann–Whitney) in those subjects without anxiety at discharge, than in those who were then anxious. Also, significantly higher SOC scores at admission were found in subjects without than in those with GHQ case scores at discharge. Such significant associations were not found between SOC scores at admission and anxiety/no anxiety or GHQ case/no case at follow up.

Discussion

Major findings of this prospective investigation of people with severe multiple trauma are that although the SOC-13 instrument at each time it was measured had adequate internal consistency, it was neither stable over time nor could it, when used at admission for or discharge from intensive rehabilitation, adequately prognosticate future (1–3.5 years) overall satisfaction with life and level of psychological well-being. In some contrast the SOC-13 appears to have good simultaneous predictive power (or concurrent validity) concerning overall life satisfaction and psychological well-being, as measured by the GHQ-20 and HAD scale.

Clinical messages

- Sense of coherence (SOC) was not stable over time the first years after severe multiple trauma.
- SOC scores were significantly correlated to simultaneously measured levels of satisfaction with life as a whole, and negatively correlated to psychological distress, anxiety and depression.
- Sense of coherence measured at admission could neither predict future satisfaction with life as a whole nor future psychological well-being.

The systematic significant associations between SOC score and level of overall life satisfaction, confirm those found in clinical[18] and in nonclinical populations.[19,20] Moreover Diener and Fujita[21] found a significant relationship between personal resources and subjective well-being, and indicated that the influence can be bi-directional. Hence, the sense of coherence may influence experienced life satisfaction, or perceived life satisfaction may influence SOC.

Besides the possibility that SOC-13 is not as stable as initially suggested by Antonovsky,[1] the best explanation for the variations in individual SOC scores may be what Antonovsky[2] suggested as a possible cause of variation: 'major changes in patterns of life experiences'. In this context it is worth noting that it has been found in medical students that SOC scores may decrease as a result of stress.[22] Another feasible explanation for the individual variations in SOC score might have been that younger patients had less stable sense of coherence than their older peers. This is contrary, however, in the present selected sample of multitraumatized patients in whom those with larger variations were significantly older than those with relative minor changes in SOC-13 scores.

Whereas the SOC-13 score for the total sample was significantly higher at discharge than at

follow up – possibly due to changes in life experiences – the median scores at all three endpoints were similar to those previously found by us in a retrospective study of multitraumatized subjects[5] and by authors in nonclinical samples.[2,23] This apparently indicates that multiple traumatized patients are not particularly deviating in their sense of coherence. However, the design of this study imposes some clear limitations, a major one being the small and selected sample, which precludes valid generalizations. Furthermore, the variations of follow up time between one and three and a half years after trauma, may be felt to disturb discussion of the results. Finally, as is so common in the medical literature, it was never possible to register the subjects' pre-morbid SOC-13.

The reported pre-trauma level of satisfaction with life as a whole, 22/26 having been satisfied or very satisfied, is congruent with that previously reported by us,[5] and is somewhat higher than the 75% found among a nationally representative Swedish sample of 18- to 74-year-old people in good health (co-operation with KS Fugl-Meyer, unpublished). This discrepancy may, of course, be due to the small and selected sample. It may, though, be a Polly-Anna effect (i.e., a proportion of the patients idealizes their pre-trauma life).

From the prospective point of view, the proportion of patients satisfied with life as a whole after the trauma was clearly reduced, and continued to decline from discharge to follow up, to a proportion much lower than the 75% found in the above-mentioned clinically healthy sample. The proportion of overall satisfied subjects at follow up in this investigation was in reasonable congruence with the 40% overall satisfied subjects previously reported by us three years after multiple trauma.[5]

Several investigations have shown consistently high negative correlations between sense of coherence and trait- and state-anxiety,[8,24] and in some studies, also with depression.[25,26] The significant relationship between sense of coherence and anxiety also found here has led to the question whether sense of coherence and anxiety are two ways of measuring the same concept.[3]

The proportion of subjects with pathological GHQ scores differs, dependent on the population studied and the cut-off points chosen. This proportion (cf. Table 1) is somewhat higher than that previously reported in another inpatient trauma population in Norway.[27] In our study, a similar proportion reports psychological distress at the end of the rehabilitation process and at follow up, and as previously discussed life satisfaction continued to decrease after discharge. We conclude that interventions to secure psychological well-being during the rehabilitation process may be important for future good satisfaction with life as a whole.

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Appendix – The abbreviated sense of coherence checklist (SOC-13)

The subjects were informed that this checklist had questions concerning different aspects of life, each question graded from 1 to 7, where 1 and 7 were the two opposite answers. They were told to read the questions thoroughly and mark the number which best suited (matched) their own experiences.

1) Doing the things you do every day is:

1	2	3	4	5	6	7
a source of deep pleasure and satisfaction						a source of pain and boredom

2) Do you have very mixed-up feelings and ideas?

1	2	3	4	5	6	7
very seldom or never						very often

3) Does it happen that you have feelings inside you would rather not feel?

1	2	3	4	5	6	7
very seldom or never						very often

4) Many people – even those with a strong character – sometimes feel like sad sacks (losers) in certain situations. How often have you felt this way in the past?

1 2 3 4 5 6 7
very seldom or never — very often

5) When something happened, have you generally found that:

1 2 3 4 5 6 7
you overestimated or underestimated its importance — you saw things in the right proportion

6) How often do you have the feeling that there's little meaning in the things you do in your daily life?

1 2 3 4 5 6 7
very often — very seldom or never

7) How often do you have feelings that you're not sure you can keep under control?

1 2 3 4 5 6 7
very often — very seldom or never

8) Do you have the feeling that you don't really care about what goes on around you?

1 2 3 4 5 6 7
very seldom or never — very often

9) Has it happened in the past that you were surprised by the behaviour of people whom you ought to know?

1 2 3 4 5 6 7
never happened — always happened

10) Has it happened that people whom you counted on disappointed you?

1 2 3 4 5 6 7
never happened — always happened

11) Until now, your life has had:

1 2 3 4 5 6 7
no clear goal or purpose at all — very clear goals and purpose

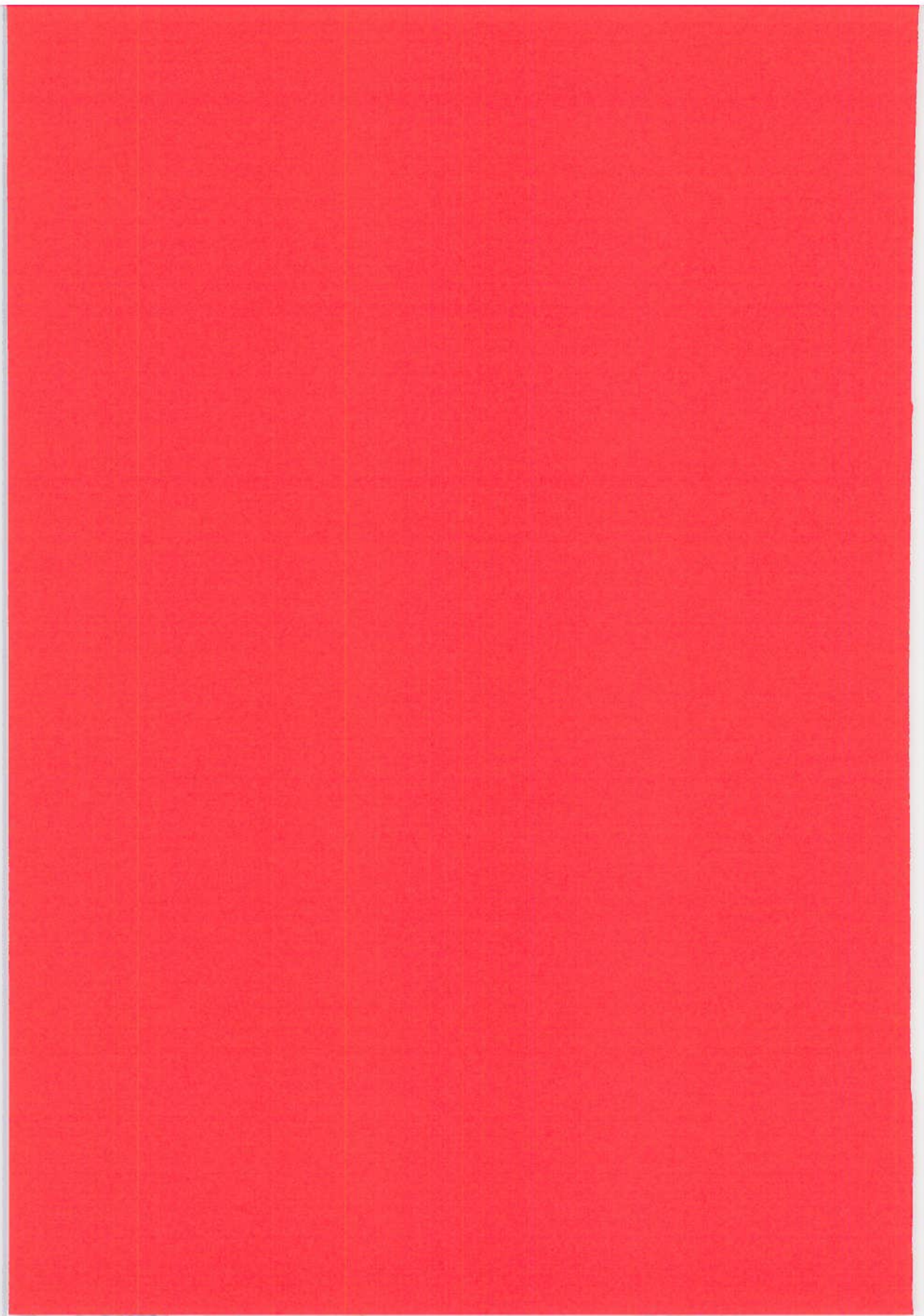
12) Do you have the feeling that you're being treated unfairly?

1 2 3 4 5 6 7
very often — very seldom or never

13) Do you have the feeling that you are in an unfamiliar situation and don't know what to do?

1 2 3 4 5 6 7
very often — very seldom or never

Paper V



Increased mortality after discharge in multiple trauma subjects

- A ten year follow-up

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Abstract

This study presents mortality data after discharge from a regional injury centre: Ninety-one multitraumatised patients with Injury Severity Score (ISS) ≥16, were followed from 1990 until death or ten years. Based on mortality rates in Norway 1995, expected death were calculated and compared with observed mortality. The main finding was a significantly higher mortality rate than in the general population, most pronounced the first year following discharge. Higher ISS, lower Glasgow Coma Scale Scores and severe brain injuries were predictors for death the first year. Later, regarding dominating injuries, only patients with severe chest or abdominal injuries had higher death rate than the general population. Furthermore, only mortality for the younger (<45 years) still exceeded the general population. None of the deaths more than one year postinjury were related to organic consequences of sustained injuries. Main causes of death were associated with psychosocial factors (intoxication, overuse of alcohol and drugs).

In summary, mortality rates were increased after discharge. Causes of death were only related to organic consequences of the trauma the first year postinjury.

Introduction

This study concentrate on post-discharge mortality after severe multiple trauma. There has been promulgated a tri-modal distribution of death following trauma [7], with the first peak of mortality immediate at the time of injury (within seconds to minutes). As much as 25% of patients who sustain major trauma die before hospital arrival [12]. The second peak occurs within 24-72 hours due to severe head, neck and chest injuries, and profuse bleeding [1,5,16], while the third peak is said to occur several days to weeks after the initial injury and is attributed to infection and multiple organ failure [1]. However, several authors have reported that also late deaths are predominantly caused by severe cerebral injury [5,7,13]. Hadfield [7] reported that deaths after the first 24 hours after admission to ICU, occurred mean 7 days (range 2-49 days) after admission, and 75% were due to severe brain injury.

In contrast to the situation for spinal cord injuries [6,9] and traumatic brain injuries [3,17,18], literature on long-term survival in multiple trauma cases is scarce. The aims of this study are to examine ten years mortality rate of those discharged from the acute care hospital compared to the general population, identify causes of death, and to analyse how demographic and injury-related variables predict mortality.

Subjects and Methods

In 1990, 146 subjects with severe multiple trauma were admitted within 24 hours of injury to the department of surgery at Ullevål University Hospital in Oslo, a regional injury centre. As reported by Pillgram-Larsen, Solheim and Birkeland [16], 105 were discharged alive, which gave an in-hospital lethality rate of 28%. Median Injury Severity Score (ISS) was 26 for all patients admitted to the hospital, and 41 for those who died in hospital [16]. Among the 105 discharged patients 14 were excluded from follow-up (nine were living abroad, three were

under the age of 12 at the time of injury, and two subjects were lost to follow-up). Results concerning long-term follow up could be estimated for 91 patients.

Demographic and Injury related variables. Data obtained from the department of surgery at Ullevål Hospital in Norway Oslo included gender, age, ISS, Glasgow Coma Scale (GCS), date of injury and date of discharge.

All patients had an Injury Severity Score (ISS) of 16 and above, and injuries to two or more body regions [4]. In addition, the most severely injured body region was defined (highest body region score): Scores due to external region (skin) injury were excluded. For simplification, patients with injuries to the thorax and abdomen were combined into one group, and the highest score from either thorax or abdomen was used. With identical scores in two or more body regions, it was chosen to let head take precedence over extremity, extremity over face, and face over thorax/ abdomen. Spinal cord injuries were included in thorax/abdominal injuries.

Case fatality rate and statistics. In the autumn of year 2000, the Norwegian population register was used to identify those patients who were deceased. Each individual was followed until death or to 30.06.2000. Mortality rates of the multiple trauma study population are compared to the general population by calculating Standardised Mortality Ratios (SMRs). SMR is defined as actual number of deaths in a study population divided by expected number of deaths over an equivalent time period. Expected number of deaths were calculated after matching each multitrauma subject by gender and age to the general population, using the Norwegian lifetables from 1995 (Statistics Norway 1996).

The individual expected death rates were classified by age groups, gender or groups formed by trauma-related factors, to yield group SMRs. An SMR of 1.0 indicated that the multiple trauma group had identical death rate compared to the general population. An SMR greater than 1.0 indicates that the mortality rate in the multitrauma group is greater than the general

population. Ninety-five percent confidence intervals are given for each SMR, and were computed according to Poisson distribution. Analyses of mortality were performed with the SAS® - system.

The Mann-Whitney nonparametric two sample test was used to analyse differences in medians, while simple cross tabulations were performed for comparisons of groups of data (χ^2 test or Fisher's exact test when appropriate). Values of $p \leq 0.05$ were considered statistically significant.

Causes of death. Information was obtained from the National Registry of Causes of Death, Statistics Norway.

Results

Among the 91 included patients with severe multiple trauma discharged from the acute stage hospital, 63 were men (69%) and 28 women (31%) with a median age of 30 years (range 12-80) at the time of trauma. Sixteen patients (17.6%), nine men and seven women, were deceased 10 years following trauma. Seven patients died within a year after discharge, all of these within a year postinjury. The mortality rate for the multiple trauma group from the time of injury until 10 years follow-up was 41%. Ten years survival probability for those who were discharged was 82%.

Table 1 summarises crude data concerning some characteristics of the study population. The only statistical significant finding was that median age was higher in the deceased group than in those who were alive after ten years (40.5 *vs.* 26 years). In the age group> 64 years 56% of the patients were dead after ten years, compared to 13% of the younger patients ($p< 0.01$).

Table 1. *Demographic and injury-related characteristics according to vital status at ten years after hospital discharge.*

	Status at the end of 10 years follow-up Alive N= 75	Death N= 16	All patients discharged N= 91	P- value
Gender (n)				0.22
Men	54	9	63	
Women	21	7	28	
Age at injury				< 0.01
Median (range)	26 (12-76)	40.5 (20-80)	30 (12-80)	
Injury Severity Score				0.16
Median (range)	22 (17-50)	24 (17-50)	22 (17-50)	
Glasgow Coma Scale				0.63
Median (range)	14 (3-15)	13.5 (6-15)	14 (3-15)	
Most severe injury				0.66
Head	29 (39%)	6 (38%)	35 (38%)	
Thorax/ abdomen	26 (35%)	7 (44%)	33 (36%)	
Extremities	14 (19%)	3 (19%)	17 (19%)	
Face	6 (8%)	0 (0%)	6 (7%)	

Table 2 shows the calculated Standardised Mortality Ratios (SMRs). After ten years the SMR of the discharged subjects compared to the age- and gender- matched general population, was 5.1 (95%CI <2.9, 8.2>); i.e. a statistically increased mortality. SMR was as much as 27.2 calculated one year after discharge, but even for the period 1-10 years after discharge numbers of deaths are statistically and clinically significant higher than in the general population (SMR 3.1, 95% CI <1.4, 5.9>).

Analyses of individual survival probabilities categorised by age, gender and injury related factors (ISS, GCS, dominating injury type) were done. In consensus with more simple statistical analyses (table 1), there were no significant gender differences in SMR. Regarding age, however, SMR was found to be particularly high in the younger age group (less than 45

Table 2. *Standardised Mortality Ratios (SMRs) for 91 subjects discharged from the acute care hospital after severe multiple trauma. Results are given separately for those who died within one year after discharge, vs. those who died later, but within ten years after trauma.*
Obs= Observed.

		Total deceased. 10 years follow-up		Deceased first year		Deceased after first year	
	N	Obs	SMR (95%CI)	Obs	SMR (95% CI)	Obs	SMR (95% CI)
Age							
12-44	66	8	12.9 (5.6, 25.4)	1	19.4 (0.0, 108.3)	7	12.3 (4.9, 25.3)
45-64	17	4	3.3 (0.9, 8.5)	3	32.7 (6.7, 95.7)	1	0.9 (0.0, 5.0)
65+	8	4	3.0 (0.8, 7.7)	3	26.2 (5.4, 76.5)	1	0.8 (0.0, 4.6)
Glasgow Coma Scale							
13 – 15	60	9	3.7 (1.7, 7.0)	3	14.7 (3.0, 43.0)	6	2.7 (1.0, 5.8)
9 – 12	15	5	18.3 (5.9, 42.8)	2	90.2 (10.8,325.8)	3	12.0 (2.5, 35.0)
< 8	16	2	4.5 (0.5, 16.1)	2	63.0 (7.5, 227.7)	0	0.0 (0.0, 8.9)
Injury Severity Score							
16 – 30	74	12	4.1 (2.1, 7.2)	4	17.4 (4.8, 44.7)	8	3.0 (1.3, 5.9)
31 – 45	14	2	11.0 (1.3, 39.6)	2	124.0 (14.8,447.9)	0	0.0 (0.0, 22.3)
46 – 50	3	2	26.9 (3.2, 97.0)	1	81.9 (0.0, 456.4)	1	16.1 (0.0, 89.5)
Dominating injury							
Head	35	6	6.1 (2.2, 13.3)	5	56.3 (18.3,131.4)	1	1.1 (0.0, 6.2)
Thorax/Abdomen	33	7	11.0 (4.4, 22.7)	2	32.0 (3.8, 15.4)	5	8.7 (2.8, 20.4)
Extremities	17	3	2.0 (0.4, 6.0)	0	0.0 (0.0, 37.0)	3	2.2 (0.5, 6.4)
Face	6	0	0.0 (0.0, 47.9)	0	0.0 (0.0, 593.9)	0	0.0 (0.0, 52.1)
All	91	16	5.1 (2.9, 8.2)	7	27.2 (10.9, 56.0)	9	3.1 (1.4, 5.9)

years). In fact, after the first year, the death rate for subjects older than 45 years was no longer higher than for the general population, with SMRs around 1.0.

Table 2 further shows that the first year following discharge, the estimated SMRs were higher for those with more severe GCS- and ISS- scores. In five of those seven patients that died within a year, head-injury was the most severe injury (SMR 56.3). After the first year, the mortality rate for patients with head injuries was close to the general population (SMR 1.1). Furthermore, among the dominating injury types, only those with thorax/abdominal injuries had a statistically increased death rate.

As shown in table 3, five of seven deaths that occurred within a year after discharge were caused by consequences of the sustained injuries: Four died from consequences of severe brain injuries and one from abdominal injury/ a myocardial infarction few weeks postinjury. In contrast, none of the deaths among the nine subjects who died after the first year, were directly related to organic disorders caused by the trauma, and eventual impairments due to the trauma were not mentioned in the data coded by the National Registry of Causes of Death.

Table 3. *Main diagnosis for 16 subjects that were discharged alive after a severe multiple trauma, and died within 10 years thereafter.*

Main diagnosis	Total	Death within 1 year	Death 1-10 years after
Injury	5	5	0
Acute intoxication	4	0	4
Abuse of alcohol	3	1	2
Arteriosclerosis, Pneumonia	2	1	1*
Acute gastritis	1	0	1
Sudden death	1	0	1*
Total	16	7	9

*) Abuse of drugs was mentioned as a possible contributing causes of death

Four of these deaths were due to acute intoxications (narcotics or drugs) and two more subjects died due to abuse of alcohol. Furthermore, use of drugs or narcotics were mentioned as possible contributing causes of death in two of the three remaining subjects.

Discussion

The small number of studied multiple trauma subjects limits generalisation of the results. However, the in-hospital mortality found in the original sample [16], is in congruence with results in other outcome studies [5,12,21]. Our focus was the period beginning at discharge, and one major finding was that subjects in this study had higher mortality than expected in the general population, after adjustment for age and gender. The first year after discharge seems to be part of the third peak in the trimodal distribution of trauma deaths, with causes for death mainly related to severe brain injury. Recent studies [7,17] in multiple trauma patients have found that when severe brain injury accompanies multiple trauma, it is likely to be the major determinant also for late mortality.

It is known that drug and alcohol use is widespread in patients with injuries [10]. Also in the present study as many as six of the nine subjects who died after the first year postinjury, were in medical journals noted to have problems with excessive use of alcohol/ drugs at the time of trauma. Furthermore, psychosocial and psychological problems manifested by overuse of alcohol, drugs or narcotics, and intoxications, were main causes of death among those who died more than one year after discharge. Though not registered, some of the intoxications leading to death were probably a result of suicide. Others have shown increased risk of suicide after severe multiple trauma [21], traumatic brain injury [20] and spinal cord injury [9].

In a Dutch follow up investigation of comparable multiple trauma subjects [21]; twelve of 537 discharged patients (2.2%) died within two years following injury. This is a considerably

lower number than in our study (seven of 91 subjects, 7%). The difference in lethality rate might be explained by differences in discharge routines, as the mean hospital stay for the survivors in the Netherlands was 30.4 days while in Norway it was 11 days. Only half as many patients in Norway as in the Netherlands were discharged directly home (25% *vs.* 50%), indicating that local hospitals in Norway to a greater degree are used as intermediate treatment facilities. We assume that some of the early post-discharge deaths occurred at local hospitals. Different results due to different discharge-routines could be avoided if trauma deaths were related to postinjury follow-up time, and not to discharge status [8].

Higher age has also previously been related to mortality following multiple trauma [11,15,21] and spinal cord injury [6,19]. However, not surprisingly increased death rate compared to the age- and gender-matched general population was more pronounced in the younger.

While our investigation found that mortality in subjects with traumatic brain injury no longer was increased after the first year postinjury, other outcome studies have demonstrated increased lethality [3,17] and reduced life expectancy [18]. The diverging results could be due to small numbers, and the 95% CI includes more than 6 times higher lethality than in the general population. Why chest and abdominal injuries should be particularly frequent in persons with late deaths after multiple trauma, is difficult to explain. Several studies have reported that neither of these injuries (when excluding spinal cord injuries), tend to lead to serious impairments [2,4].

This investigation indicates that trauma care and rehabilitation should include intervention attempts directed towards the subject's psychosocial situation. Further research is needed to improve our understanding of how the latest deaths following severe multiple trauma may be prevented.

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