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SCI-SCREEN: A More Targeted Nutrition Screening Model to Detect Spinal Cord-Injured Patients at Risk of Malnutrition

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Abstract

Purpose: To explore if SCI-SCREEN was applicable as nutritional screening model in a neurorehabilitation unit, able to detect spinal cord injury (SCI) persons at nutritional risk.

Design and Methods: SCI-SCREEN underwent reliability test by 3 specialist nurses, using 10 consecutive SCI in-patients. Audit of 41 SCI-patients was conducted comparing SCI SCREEN with the Danish-Nutritional-Screening-Model-for-hospitalized-persons (DNSM).

Findings: Inter- and intra-tester reliability (Cohen's Kappa: 0.89-0.93) was high. SCI-SCREEN estimated average energy needs 23% lower (mean difference± SD: 2516.2±1349.1kJ) and protein needs 10% lower (9.5±19.7g/day). Risk assessment differed in 61% (CI95: 42.1; 73.7%) of cases and risk-agreement was obtained in 22% (CI95: 10.6; 37.6%). SCI-SCREEN detected 66% (CI95: 44.5; 75.8%) and DNSM 39% at risk of malnutrition.

Conclusions: The SCI-SCREEN model estimates SCI-energy and protein needs more accurately than DNSM by adjusting to SCI-consequences. However, more studies are needed.

Clinical Relevance: SCI-SCREEN is a reasonable starting-point in the screening procedure and may be a valuable instrument to identify SCI-patients at risk of malnutrition.

Keywords: Nutrition; obesity; rehabilitation; screening; spinal cord; injury.

Introduction

A spinal cord injury (SCI) is a traumatic or nontraumatic lesion to the spinal cord. Today, an ageing population has a preponderance of diseases related SCI. Nevertheless, lives are saved and SCI patients can lead their lives to a fuller extent, that is, lead their lives in more productive and active ways than previously possible. Malnutrition (defined by the World Health Organization as undernutrition and overnutrition; Blössner & de Onis, 2005) can have severe consequences after a SCI. A high prevalence of overnutrition and accordingly overweight and obesity (defined as abnormal or excessive fat accumulation that presents a risk to health; World Health Organization, 2016) is common in the SCI population (de Groot, Post, Postma, Sluis, & van der Woude, 2010; Gupta, White, & Sandford, 2006; Hatchett, Mulroy, Eberly, Haubert, & Requejo, 2016; Weaver et al., 2007). This is due to many factors, among other abnormalities in the metabolism of carbohydrate and lipid following the SCI. A more sedentary (or immobile) lifestyle is another factor that contributes to obesity, which comes along with comes a severely raised risk of both insulin-dependent and non-insulin-dependent diabetes mellitus and a substantially increased risk of cardiovascular diseases and, in some cases, early death (Bauman & Spungen, 2002; Myers, Lee, & Kiratli, 2007). Less severely, obesity impedes or precludes mobility and physical training and reduces the SCI patient's ability to participate in rehabilitation and an active lifestyle. Hence, this affects ability to engage in activities of daily living and performing everyday tasks like bathing, dressing, grooming, and emptying bladder and bowels (Blackmer & Marshall, 1997; Johnston, Diab, Chu, & Kirshblum, 2005). Consequently, obesity negatively influences the

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level of self-support after SCI (Stenson, Deutsch, Heinemann, & Chen, 2011). Although the body weight does not increase significantly during hospitalization, many SCI patients experience a marked weight gain in the years after discharge (de Groot et al., 2010; Hatchett et al., 2016). In rehabilitation settings, a nutritional screening model is important for evaluating the nutritional status and determining which education and information to provide for the SCI patient to hopefully prevent future malnutrition. However, the available tools are inadequate and may contribute to misleading evaluations of nutritional status. Like the international Malnutrition Universal Screening Tool (MUST), the nutritional screening model currently utilized in Danish hospitals (Danish Nutritional Screening Model for hospitalized persons [DNSM]) is a generalized one designed to cover all hospitalized patients. More importantly, its main aim is screening for and preventing underweight (BAPEN, 2011; Stratton et al., 2004; Sundhedsstyrelsen, 2008). Both MUST and DNSM lack indicators to assess the increased nutritional risk factors related to an SCI. Hence, the SCI-related lower-energy expenditure due to loss of muscle mass, reduced physical activity, and a more sedentary lifestyle are not considered in neither DNSM nor MUST. Therefore, its usage may result in inaccurate estimation of weight and nutritional status. Accordingly, incorrect and energy-dense nutrition may, unwarily, be recommended by health professionals, which, in the worst cases, may lead to devastating weight gain for the SCI patients (Barco, Smith, Peerless, Plaisier, & Chima, 2002; Buchholz, McGillivray, & Pencharz, 2003; Cox et al., 1985; Mollinger et al., 1985; Monroe et al., 1998; Rodriguez, Benzel, & Clevenger, 1997; Sedlock & Laventure, 1990). The validated Spinal Nutrition Screening Tool (SNST) targets SCI patients but focuses on underweight and is based on body mass index (BMI) values obtained from the general population (Wong et al., 2012). Furthermore, SNST has its limitations for the purpose at hand in not including decreased energy consumption, gender differences, the (reduced) level of mobilization, and the higher risk of overweight in the SCI population. Both MUST and SNST lack an assessment of the patient's energy and protein needs (BAPEN, 2011; Stratton et al., 2004; Wong et al., 2012). This is, compared to the arguments and findings above, rather important when guiding nurses in their clinical practice so that they provide energy and protein needs-calibrated diets for the patients in order to prevent malnutrition.

Clearly, the prevalence of obesity underscores the need for an adapted nutritional screening model supporting the clinicians in identifying the nutritional risk status of malnutrition (Prüss-Üstün, Campbell-Lendrum, Corvalán, & Woodward, 2005) Prevention of malnutrition is an important part of nursing care and the complexity of nutrition links to much more than counting calories and proteins. It contains a range of other activities and individualized interventions, for example, motivational interviewing, goal setting, and behavior change counseling (Jay et al., 2015; Perry, Hamilton, Williams, & Jones, 2013). For correct, targeted nursing care, however, the starting point and nutritional status must be as accurate as possible because nursing related to over- and underweight differs.

Purpose

The aim of this study was to develop a nutritional screening method (SCI-SCREEN), with more accurate identification of SCI patients at risk of malnutrition compared with the present nutritional screening method (DNSM). Furthermore, we aimed at investigating whether the method was useful in a highly specialized neurorehabilitation inpatient hospital regarding time consumption and robustness.

Methods

The Clinical Setting

The tool was developed at the Spinal Cord Injury Centre of Western Denmark (SCIWD), which is a highly specialized inpatient and outpatient rehabilitation center. The center provides both the primary rehabilitation and the lifelong follow-up treatment of adults who have sustained an SCI. SCI patients are referred from the Western part of Denmark, which comprises approximately 60% of the Danish population of 5.6 million citizens. The incidence of SCI in Denmark from 1990 to 2012 was, on average, 10.2 per million person-years (Bjørnshave Noe, Mikkelsen, Hansen, Thygesen, & Hagen, 2015).

Ethics

The study was conducted in concordance with the Helsinki II Declaration. It was approved by the Danish Data Protection Agency, and there was no interference in rehabilitation or medical treatment during the testing of the SCI-SCREEN procedure.

Development of the Screening Method

The adapted nutritional screening model SCI-SCREEN, which detects both underweight and overweight, was developed according to relevant parameters (Barco et al., 2002; Bauman & Spungen, 2002; Blackmer & Marshall, 1997; Buchholz & Pencharz, 2004; Cox et al., 1985; de Groot et al., 2010; Dorner, Posthauer, & Thomas, 2009; Gupta et al., 2006; Henry, 2005; Hetz, Latimer, Arbour-Nicitopoulos, & Martin Ginis, 2011; Laughton, Buchholz, Martin Ginis, & Goy, 2009; Mollinger et al., 1985; Monroe et al., 1998; Myers et al., 2007; "Academy of Nutrition and Dietetics," 2009; Sedlock & Laventure, 1990; Thompson & Fuhrman, 2005; Weaver et al., 2007). The literature was substantiated by our clinical records containing a large proportion of SCI patients who had developed disabling weight gain at follow-up in our outpatient clinic. This shed a critical light upon our nutritional recommendations and instructions regarding both the inpatients and outpatients. Based on SCI-specific factors, we constructed an algorithm (Figure 1) and programmed a nutritional screening tool for evaluating the nutritional status of SCI patients.

Detailed Descriptions of the Components in the SCI-SCREEN

For transparency and for others to be able to develop a similar tool, we here present the components of the tool. The computation included an algorithm using components affecting the energy and protein expenditure after an SCI: the date of injury (number of days after injury), metabolic stress (<2 months; Y/N), type of injury (level and completeness), function/immobility, physical constitution, and complications (wounds/ulcers) (Barco et al., 2002; Buchholz et al., 2003; Cox et al., 1985; Dorner et al., 2009; Lagerström & Wahman, 2014; Mollinger et al., 1985; "Academy of Nutrition and Dietetics," 2009; Rodriguez et al., 1997; Rodriguez, Clevenger, Osler, Demarest, & Fry, 1991; Sedlock & Laventure, 1990; Thompson & Fuhrman, 2005).

Despite the uncertainty of the time duration of the acute metabolic phase after SCI and other disease entities (Preiser, Ichai, Orban, & Groeneveld, 2014; Thibault-Halman, Casha, Singer, & Christie, 2011), we settled the duration to 2 months.

The factors included in the algorithm are based on Oxford equations for the basal metabolic rate. This equation is the formula recommended by the Nordic Nutrition Recommendations and comprises the categories body weight and height, six different age groups, and gender (Henry, 2005; Nordic Council of Ministers, 2012). The factors used to determine the level of injury, the activity level, the protein needs, and the energy expenditure need for SCI patients are based on the recommendations available in literature (American Dietetic Association, 2011; Barco et al., 2002; Buchholz et al., 2003; Rodriguez et al., 1997). We incorporated Lagerström's proposed BMI cutoffs for SCI patients, differentiating between paraplegics (estimated muscle mass reduction of 7.5%) and tetraplegics (estimated muscle mass reduction of 12.5%; Lagerström, 2006; Lagerström & Wahman, 2014; Figure 1).

Data Collection

To study the time consumption and robustness of the tool, we conducted a study where we tested the inter- and intratester agreement and evaluated the feasibility of the applied method as compared with the standard DNSM.

Inter- and intratester consistency as assessed by the feasibility/pilot study

In order to evaluate the reliability and accuracy of the screening procedure, a pilot study of 10 consecutive

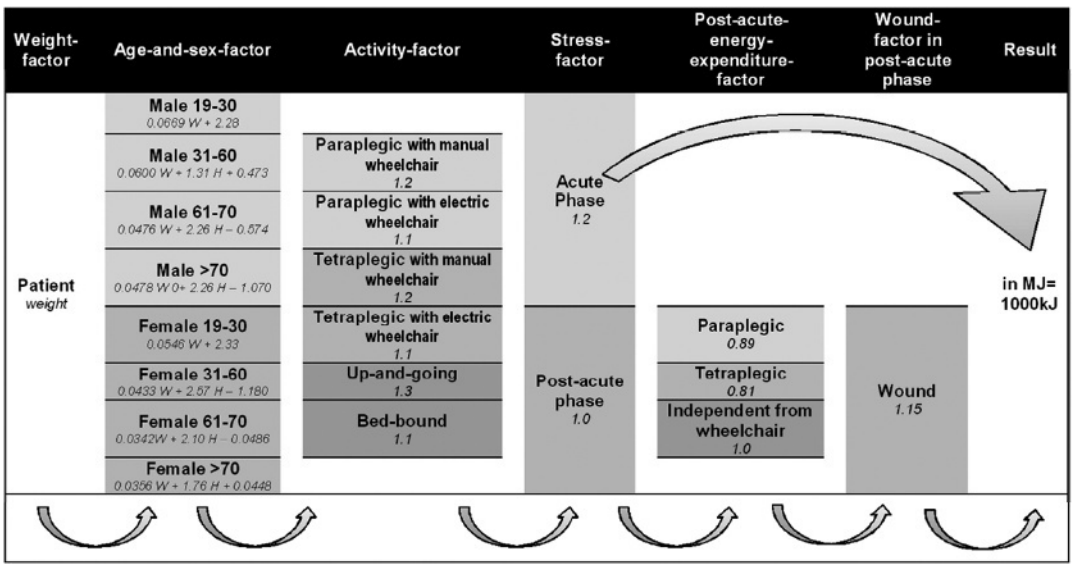

Figure 1. Energy assessment in spinal cord-injured patients. Example of calculation of daily energy expenditure: a female patient, 35 years of age, weight: 70 kg, height: 175 cm, factor 0.0433 * *W* + 2.57 * *H* – 1.180, complete paraplegia, using a manual wheelchair (factor 1.2), in the postacute phase (factor 1.0 * postacute stress factor 0.89) = 6.788 MJ = 6,780 kJ ((0.0433 * 70) + (2.57 * 1.75) – 1.180) * (1.2 * 0.89) = 6.780

inpatients at SCIWD was performed by three specialist neurorehabilitation nurses. The patients were newly injured, admitted for the first time to SCIWD. The data were collected from November 1, 2015, to January 1, 2016, within the first 24 hours of hospitalization at SCIWD. Each patient underwent nutritional status assessment carried out by three specialist neurorehabilitation nurses, and the order of assessment was randomized but had to be performed by each nurse independently on the very same day.

Identification of SCI Patients at Risk of Malnutrition Comparing SCI-SCREEN With DNSM/the Main Study

This was followed up by the main study testing different proportions of the SCI-SCREEN in comparison to DNSM. How did SCI-SCREEN perform regarding identification of the nutritional condition and the patients at risk of malnutrition as compared to the DNSM?

During November 1 and July 1, 2015, the SCI-SCREEN and the gold standard method for hospitalized patients (DNSM) in Denmark were systematically applied on 41 consecutive newly injured inpatients over 18 years. Testing was performed by neurorehabilitation nurses who were trained in using both DNSM and SCI-SCREEN. The height and weight were measured by the same procedure as in the initial study. The standard procedure of DNSM uses the parameters height, weight, stress metabolic rate, and function/immobility (up and about or bedbound). As a consequence, the method was part of the daily routine at the SCIWD Rehabilitation Centre, and the time consumption required by the "double" nutritional evaluation procedure was not uncomfortable for the inpatients.

Measuring Height and Weight

The nutritional status assessment includes measure of height and weight in order to determine BMI and weight development over time. The height used in the study was the self-reported measure documented in the passport.

The weight was measured using the same wheelchair scales (SA-Med Medical Equipment, Model Seca 665) for all included patients. These scales adhered to EU Directive 90/384/EEC consisting of a ramp for wheelchairs, measuring kilos with one decimal precision (Sa-Med, n.d.).

Results

Pilot Study Findings

In the initial study (10 patients: six female, four male; age at injury = 49.8 ± 19.2, range 14–76; median = 40.5 days after injury, range 11–206; BMI weighted mean = 26.7, SD = 5.4, range 22.3–40.6), the robustness and precision of the SCI-SCREEN was tested to determine the interindividual assessment. The interrater reliability was high, with reliability coefficients ranging from 0.88 to 0.93 (Cohen's kappa: almost perfect agreement) using combined kappa values (three observers) for the main outcome measures: (a) nutritional risk group (combined kappa value of 0.881), (b) recommended protein (g/day; combined kappa value of 0.93), and computation of the (c) recommended energy consumption (kJ/day; combined kappa value of 0.93).

Main Study Findings

By comparing the characteristics from the 41 consecutively included patients who underwent the SCI-SCREEN procedure with a sample of 414 SCI patients admitted to SCIWD between 2008 and 2014, no difference was found regarding age groups (11–18, 19–30, 31–60, 61–70, >70 years; ANOVA, F = 1.34, $p > .25$), gender (ANOVA, F = 2.53, $p > .11$), and the severity (paraplegia incomplete, paraplegia complete, tetraplegia incomplete, tetraplegia complete; ANOVA, F = 0.98, $p > .4$). The mean age was 55.3 (range 19–83). Table 1 shows details of the distribution of participants in the main study regarding age, level, and completeness of SCI and time after injury.

As can be observed in Table 2, SCI-SCREEN estimated that energy consumption was on average 23.7% lower per day (mean difference ± SD = 2,516.5 ± 1,332.5 kJ) as compared to DNSM estimates. The mean kilojoules per day estimated by SCI-SCREEN was of 8,111.9 kJ, ranging from 4,925 kJ to 14,368 kJ, whereas DNSM computed a higher mean value of 10,428.6 kJ and was

Table 1 Group characteristics of 41 consecutive inpatients who underwent SCI-SCREEN

Group Characteristics	*n*	Percentage	95% CI
Sex			
Male	24	57.14%	42.11%, 73.68%
Female	17	42.86%	26.31%, 57.89%
Age groups			
19–39 years	7	17.07%	7.15%, 32.06%
40–59 years	16	39.02%	24.20%, 55.49%
60–85 years	18	43.90%	28.47%, 60.25%
Level and completeness			
Incomplete paraplegic	10	24.39%	12.36%, 40.30%
Complete paraplegic	6	14.63%	5.56%, 29.17%
Incomplete tetraplegic	22	53.66%	37.42%, 69.34%
Complete tetraplegic	3	7.32%	1.53%, 19.92%
Time after injury			
Up to 1 month	14	34.15%	20.08%, 50.59%
1–2 months	3	7.32%	1.53%, 19.92%
3–6 months	21	51.22%	35.13%, 67.12%
6–12 months	2	4.88%	0.01%, 16.53%
Above 12 months	1	2.44%	0.001%, 12.85%

Table 2 Description of the 41 observations comparing energy and protein recommendations using SCI-SCREEN and Danish Nutritional Screening Model for hospitalized persons

Variable	Observations	Mean	*SD*	Min	Max
SCI-SCREEN (kJ)	41	8,111.9	2,245.2	4,925	14,368
Danish Nutritional Screening Tool (kJ)	41	10,487.8	1,737.4	7,000	14,000
SCI-SCREEN–protein (g)	41	101.6	32.5	54	192
Danish Nutritional Screening Tool–protein (g)	41	111.1	21.2	75	170
Age (year)	41	55.3	16.6	19	83
Weight (kg)	41	79.9	19.1	51	130
Height (cm)	41	177.2	8.3	163	200
Body mass index	41	25,4	5.5	18.4	39.2

ranging from 7,000 to 14,000 kJ. When we examined the distribution of the difference between the two nutrition models (DNSM-SCI-SCREEN) in the age groups (19–39, 40–59, 60–85 years), there was a significantly higher difference between the estimated energy needs in the old participants (Kruskal–Wallis, $p < .004$) and female gender (Kruskal–Wallis, $p < .027$). A general linear model subanalysis revealed that difference between groups was due to age and not gender. UNIANOVA (age group: $F = 7.4$, $p < .002$; gender: $F = 2.7$, $p < .11$; Age group * Gender: $F = 0.86$, $p < .92$). According to SCI-SCREEN, the estimated mean protein need per day was 101.5 g and 110.5 g using DNSM, as shown in Figure 2b. We calculated the difference in estimated needs for protein (g/day) between DNSM and SCI-SCREEN (mean difference ± *SD* = 9.9 ± 19.6 g protein/day). When we looked at age groups (Kruskal–Wallis, $p > .28$) and gender (Kruskal–Wallis, $p > .25$), there were no statistical significant difference. In addition, 4.8% (95% CI [0.01%, 16.5%]) patients suffered from pressure ulcers, and this was not taken into account by DNSM. The graphs in Figure 2a and 2b present the computed needs for energy and protein in 41 individual SCI patients as depicted by area graphs for the SCI-SCREEN and the DNSM model. Of 41 consecutive SCI patients, the DNSM found 53.6% (95% CI [37.4%, 69.3%]) to be in the low-risk nutritional status group, whereas SCI-SCREEN with the Lagerström cutoff values only assigned 29.3% (95% CI [16.1%, 45.5%]) of the patients to the low-risk nutritional status group. DNSM found that 43.9% (95% CI [28.5%, 60.3%]) of patients belonged to the overweight or obese groups, and in contrast SCI-SCREEN identified 70.7% (95% CI [54.5%, 83.7%]) of patients belonging to the overweight or obese groups. DNSM found 2.4% (95% CI [0.00%, 0.12%]) with underweight, and SCI SCREEN did not register any SCI patients with underweight.

Discussion

The results from this study highlighted that SCI-SCREEN nutritional evaluation produces a more SCI-sensitive estimation of the nutritional needs and risks as compared to the DNSM.

First, SCI-SCREEN is capable of identifying a larger proportion of SCI patients at risk of malnutrition as SCI-SCREEN considers both underweight and overweight as risk factors, whereas DNSM only detected patients in risk of underweight (Sundhedsstyrelsen, 2008).

Second, the average energy consumption was estimated 23.4% lower by using SCI-SCREEN when comparing SCI-SCREEN to the Danish hospital standards DNSM.

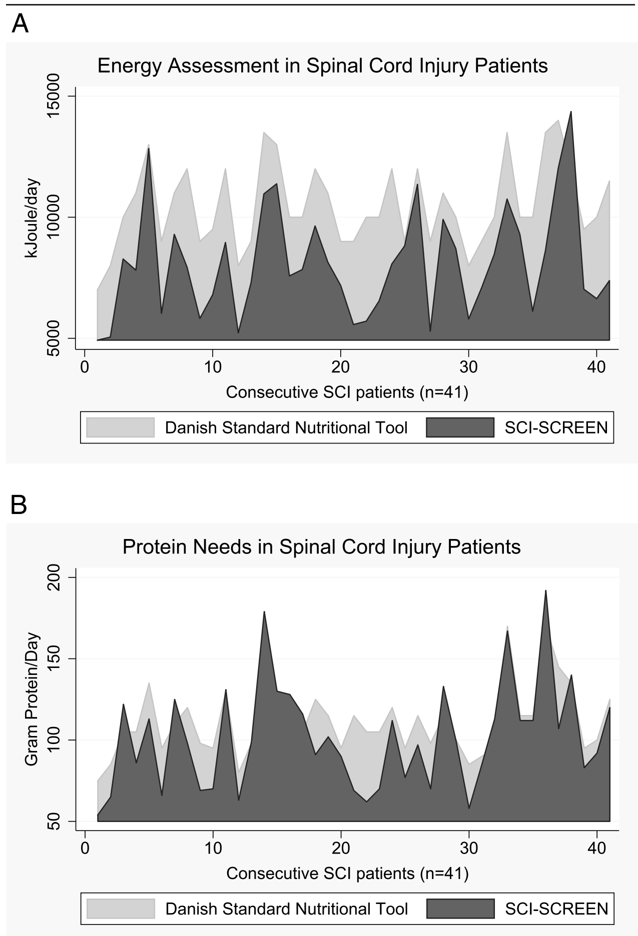

Figure 2. A, Energy assessment in spinal cord injury patients. B, Protein needs in spinal cord-injured patients.

Third, the calculated protein requirement was 9.9% lower when using SCI-SCREEN in comparison to DNSM. Protein requirements are important to consider in the overall evaluation of energy expenditure due to enhanced protein degradation during the stress metabolic phase. Concurrently, it is important that patients in the stress metabolic phase are subjected to/provided with energy-rich diets in order to restore and stimulate healing processes sufficiently (Rodriguez et al., 1991).

Finally, comparing the range of energy consumptions of the SCI-SCREEN (4,925–14,368 kJ) to the range of the DNSM (7,000–14,000 kJ), we found a larger span in the SCI-SCREEN model. The difference can be explained by the many different variables (metabolic stress response, gender, age, activity level, level of injury, wounds, etc.) in the SCI-SCREEN, whereas the DNSM only uses the variables: metabolic stress response, bed-bound, or normal activity level. The distribution of age groups and gender groups showed significant difference between the methods when estimating energy consumption needs. Because age and gender as factors are part of the algorithm of the SCI-SCREEN model, this should be addressed cautiously; however, this finding should be approached in future studies. Subanalysis of the material showed discrepancies in the two methods regarding age groups, in which overestimation of recommended caloric intake in the elderly seemed to be the case in DNSM. This, however, has to be examined in future trials.

In a hospital-based patient population of consecutive, first-time admitted SCI patients, the SCI-SCREEN identified 65.9% at risk of malnutrition, whereas the DNSM only detected 39.0%. Nevertheless, our results have to be discussed in the following context: According to Cragg, Ravensbergen, Borisoff, and Claydon (2015), BMI is a strong predictor of obesity. However, it has been debated how BMI should act as a marker in accessing overweight and obesity and the necessity of cutoffs in BMI scales in SCI populations is widely supported in the literature, but the precise values are still missing (Buchholz & Bugaresti, 2005; Cragg et al., 2015; Gupta et al., 2006; Laughton et al., 2009; Rajan, McNeely, Warms, & Goldstein, 2008). Hence, the Lagerström BMI cutoff scale used in SCI-SCREEN needs further validation to make SCI-SCREEN even more precise. Even though there is some uncertainty about the right BMI cutoffs, it is easily applied in both the inpatient and outpatient clinics, and the intra- and interobserver reliability is high in studies of height and weight and BMI. According to Haugen, Chan, and Li, 2007, the indirect calorimetric method is considered the gold standard. This method, however, is time-consuming, is comprehensive, requires both equipment and specialized techniques and training, and is not easily applicable in the general rehabilitation centers, often with no or only few dieticians associated. Waist circumference has been argued to be another reliable predictor of obesity in the spinal cord population (Buchholz & Bugaresti, 2005; Cragg et al., 2015). However, the change caused in body composition is characterized by tissue undergoing marked alterations in nerve supply and control, and long-lasting subcutaneous and muscle edema and contractures may change and deform inactive tissue as well.

According to Green and James (2013), the importance of nutritional screening is underestimated by the nurses, and there are barriers related to routinely screening patients for malnutrition (Green & James, 2013). The SCI-SCREEN nutritional screening method is timesaving and easily performed by way of tablets and PCs, as there are several calculations and recommendations that are automatically accessed when the nurses enter the patient's data (e.g., date, type of injury, and gender).

An audit of all patient records in September 2016 showed that 90% of all patients received a nutritional screening. However, the total number of nutritional screenings within the center should be continuously monitored to evaluate the long-lasting effect of the adapted model.

To estimate caloric needs among SCI patients, we used the Oxford equations to estimate the basal metabolic rate. This was chosen over, for example, Schofield and Harris-Benedicts. The Oxford equations are based on healthy people's metabolic rate. The equation has previously been applied and validated in healthy subjects. However, it has not been used in SCI patients. For this reason, the method was modified in order to reflect differences at reduced level of activity after SCI and in order to consider the inevitable development of muscle atrophy in the first months postinjury based on the extent of paralysis/atrophic regions (Barco et al., 2002; Buchholz et al., 2003; Rodriguez et al., 1997). The level of evidence concerning caloric and protein needs for SCI patients is still sparse, and further research in this field can be used to make the screening method considerably stronger than it already is.

To further validate the SCI-SCREEN method, we are now planning further studies: (a) extended Dexa scans with body composition measures in collaboration with clinical physiologists, (b) the application of transsectional MRI scans to evaluate tissue composition of limbs and trunk, and (c) the application of indirect calorimetric testing in a minor series (Cragg et al., 2015; Singh, Rohilla, Saini, & Kaur, 2014). The SCI-SCREEN method is also planned to undergo validation and assessment in other rehabilitation centers.

In the pilot study, patients had a wide range in age and BMI, but a high degree of replicability was obtained

Key Practice Points

- Standardized screening tools are not accurate enough to detect malnutrition in the SCI population.
- More SCI-related variables (metabolic stress response, gender, age, activity level, level of injury, wounds) in the nutritional status assessment increase the sensitivity.
- SCI-SCREEN is a low-cost procedure, and it is easily applicable in nursing practice, easily performed, and timesaving due to automatic calculations and recommendations.
- SCI-SCREEN is a reasonable starting point in the screening procedure and may be a valuable instrument to individually target nursing interventions in rehabilitation of SCI persons.
- SCI-SCREEN may be further developed and validated by testing the accuracy and inter- and intraobserver agreement in a larger and more diverse group (long-term disabled SCI patients, different diagnostic groups, e.g., nontraumatic and traumatic SCI patients).

in the assessment by the rehabilitation nurses. However, both in the pilot study and the main study, the groups consisted mainly of newly injured patients, ranging from American Spinal Injury Association Impairment Scale A to American Spinal Injury Association Impairment Scale C. Based on these facts, future studies would need to include both long-term disabled SCI patients and different diagnostic groups, for example, nontraumatic and traumatic SCI patients. Besides, we suggest that the nutritional screening should not be used as a stand-alone test but must be accompanied by the clinical evaluation and a nutritional dietary regime for and in collaboration with the individual patient. In addition, the results obtained from the screening should invariably be accompanied by nutritional and activity-related advice aimed at the patients and their relatives. It is considered fruitful to make re-estimation of energy consumption once the patient is stabilized in their home environment to continue a targeted effort conducted by a specialist at the rehabilitation center in order to prevent development of obesity and to promote active lifestyles.

In this way, the development of hypertension, diabetes mellitus, hypercholesterolemia, and other long-term complications commonly encountered after SCI may be deferred or even prevented.

Conclusion

SCI-SCREEN is an emerging screening model with a high sensitivity for identifying SCI patients at risk of long-term obesity. It is apparently more precise in estimating energy expenditures and needs in terms of kilojoule and protein quantities than the national general screening model for hospitalized patients (DNSM).

The SCI-SCREEN model was robust and precise and showed almost perfect reliability (in terms of Cohen's kappa) with very low interindividual variability in a clinical setting. The implementation and further validation of the method must be expanded and tested in other clinical settings. Furthermore, more time-consuming and expensive methods from the paraclinical fields would be of benefit for nutritional risk evaluation after SCI.

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