SHOULD WE WORRY ABOUT NUTRITION OF ADULTS WITH MINOR BURNS? AN AUDIT OF THEIR INTAKES

DEVONS-NOUS NOUS INQUIÉTER DE LA NUTRITION DES ADULTES VICTIMES DE BRÛLURES MINEURES ? UN AUDIT DE LEURS APPORTS NUTRITIONNELS

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SUMMARY. Small burn injuries are managed in an outpatient setting by surgeons and/or nurses. Nutrition in minor burn patients is rarely investigated. This observational study aimed to quantify their nutritional intakes, and to compare them to theoretical adequate values. Their average daily food intakes since injury were evaluated by a dietician using a ten-point visual assessment of consumed portions during the last meal (SEFI tool) and a food anamnesis. Macro- and micronutrient intakes were compared to national recommended dietary allowances (RDA) for healthy subjects: intakes <66% RDA were considered inadequate. Forty-two patients with a median age of 45 (34-56) years, BMI of 25.9 (23.5-28.9) kg/m^2, and burn surface area (BSA) of 2 (1-3) % were included. Energy and protein RDA were reached in 28.6 and 71.4% of the patients, respectively. Intakes of n-3 fatty acids were inadequate in 80.9% of the patients. A SEFI <7 was associated with insufficient intakes regards both energy and proteins. Inadequate intakes of different micronutrients were frequently observed, but no risk factors could be detected. Vitamin A and C were the most impacted: 71.4% of the patients had inadequate intakes. Vitamin D intake was low: 225 (56-431) UI/d. In contrast, intakes of iron, selenium and zinc were adequate in at least 61.9% of the patients. In conclusion, this audit highlighted that a majority of macronutrient and micronutrient intakes did not reach the levels recommended by the RDA. Such data should help in designing further studies aimed at assessing the impact of optimized nutrition on outcomes.

Keywords: nutrition, burns, outpatients, micronutrients, dietary supplements

RÉSUMÉ. *Certains patients, souffrant de brûlures mineures, sont suivis en externe par des chirurgiens et/ou des infirmières. La nutrition de tels patients est rarement étudiée. Cette étude observationnelle a pour but de quantifier leurs apports nutritionnels et de les comparer aux apports théoriques nécessaires. Leurs apports moyens depuis la brûlure ont été évalués par une diététicienne en utilisant une échelle visuelle (0 à 10) d'évaluation des portions consommées lors du dernier repas (échelle SEFI) et un historique de leurs repas. Les apports macro- et micronutritionnels réels ont été comparés aux apports recommandés aux sujets sains, un apport < 66 % étant considéré comme insuffisant. Quarante deux patients d'âge médian de 45 ans (34- 56), à l'IMC de 25,9 (23,5- 28,9) kg/m² et brûlés sur 2 % (1- 3) SCT ont été inclus. Les apports en énergie et protéines étaient suffisants dans 28,6 et 71,4 % des cas. Ceux en acides gras Ω 3 étaient insuffisants dans 80,9 % des cas. Un SEFI < 7 était associé à des apports insuffisants aussi bien en calories qu'en protéines. Des apports insuffisants en micronutriments étaient fréquemment observés, sans facteur de risque particulier, les apports en vitamines A et C étant ceux ayant été le plus souvent considérés comme insuffisants (dans 71,4 % des cas). Les apports de vitamine D (225- 56/431) UI/j étaient faibles eux aussi. À l'opposé, les apports en Fe, Se et Zn étaient considérés comme satisfaisants chez au moins 61,9 % des patients. En conclusion, cette étude montre que les patients, dans leurs majorité, n'ingèrent pas les quantités de macro- et micronutriments recommandés. Elle peut servir de point de départ à des études évaluant l'impact d'une optimisation nutritionnelle dans cette situation.*

Mots-clés *: nutrition, brûlure, suivi en externe, micronutriments, supplémentation*

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Introduction

There is a trend towards a worldwide decrease in burn severity, especially in developed countries.[1,2] The majority of burns are small, with two thirds involving less than 10% total body surface area, according to American data.[3] Many burn injuries are now managed in an outpatient setting by surgeons and/or nurses.[4]

Adequate nutritional status is essential for wound healing: the process is extremely energy demanding due to inflammatory and proliferative responses.[5] Besides basic macronutrients, micronutrients (vitamins and trace elements) should not be forgotten: they mitigate the negative effects of oxidative stress, support the immune system, and contribute to tissue repair.[6] In parallel, there is increasing preliminary data suggesting that non-severe burn injuries are associated with systemic inflammatory response, and secondary hypermetabolism.[7-9] This is an additional argument for focusing on nutrition in minor burn patients.

To the best of our knowledge, nutrition in the case of minor burn injury has been rarely investigated. The primary objective of the present observational study was to describe and quantify nutritional intakes in adults with minor burn. In the absence of nutritional recommendations targeting patients with minor burns, their intakes were then compared to the national recommended dietary allowances (RDA) for healthy subjects. The second objective was to search for risk factors of inadequate intakes. We hypothesized that nutritional intakes would not cover RDA, especially with regard to micronutrients.

Materials and methods

This observational study was conducted in a burn center of a tertiary hospital after approval by the local IRB (B707201836016, Local Ref 2018/87, 23th May 2018). Informed consent was obtained from the patients prior to enrollment. The study was registered at clinicaltrials.gov, NCT03914560.

Population

All burned adults treated exclusively on an outpatient basis in our burn center were consecutively screened for inclusion over 35 successive weeks in 2018 and 2019 (convenience sample). Exclusion criteria were cognitive impairments, inability to communicate in the national language, pregnancy and refusal. Each eligible patient was contacted by phone for a presentation of the study and enrollment. In the event of approval to participate, a 1-hour visit with the dietician was then scheduled within the first 10 days following burn injury.

Our outpatient burn clinic is dedicated to minor burn wound care and is mainly managed by nurses. Anesthesiologists are in charge of pain management. Dressings are changed under analgesia medication, without any sedation (patients requiring sedation are generally hospitalized in the burn center). Patients are referred to plastic surgeons in the event of local complications or to determine the need for any surgical procedure. The outpatient clinic team is completed by a physiotherapist and a psychologist, as required. Patients usually attend the clinic until complete closure of the wounds (burn wound and donor sites): this defines the length of care in the outpatient clinic.

Method

Demographic data (age, sex, weight, height, body mass index (BMI)), medical history and burn-related data (burn surface area (BSA), burn depth, localization) were recorded for all patients. Risk of malnutrition, based on clinical parameters, was assessed using the "malnutrition universal screening tool" (MUST), a validated tool for outpatients.[10] Information about occupation was also obtained. Workers and students were considered active. Those who were retired, unemployed, or had a disability pension were considered inactive. Alcohol abuse was defined as a consumption of >14 or 21 glasses of alcohol per week in women or men respectively, according to the Superior Health Council of Belgium.[11]

Food intakes were estimated using two methods. First, we used the Simplified Evaluation of Food Intake scale (SEFI), a ten-point visual assessment of consumed portions during the last meal (lunch or dinner) (*Fig. 1*). The SEFI tool is a validated tool allowing assessment of dietary intakes in either hospitalized patients or outpatients. It allows the detection of undernutrition: this may be suspected when SEFI is less than 7.[12] Secondly, a food anam-

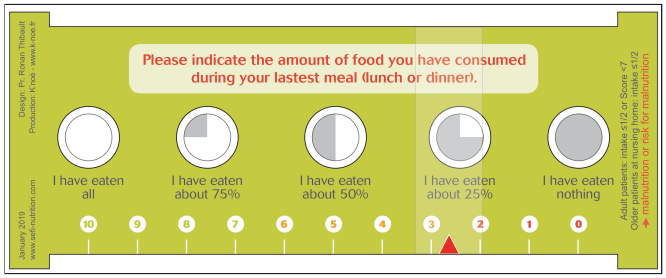

Fig. 1 - SEFI tool (reproduced with the permission of Ronan Thibault, https://www.sefi-nutrition.com/?lang=en)

nesis was performed, including a semi-structured food consumption survey and a food frequency questionnaire. The anamnesis focused on the days between burn injury and dietetic visit. Photographs of utensils and containers were used to help quantify serving sizes. The following daily average intakes were determined: calories, proteins, omega-3 (n-3) and omega-6 (n-6) fatty acids, selenium, copper, zinc, and main vitamins (A, C, D, and E). The foods were converted into nutrients using the Belgian Food composition database.[13] In case some foods were not listed in the Belgian database, the French food composition database was used.[14] This latter was also used to calculate vitamin E intakes. Additionally, intakes from vitamin or micronutrient supplements were also recorded.

Daily nutritional requirements were defined according to the Nutritional Recommendations for the Belgian Population, edited in 2016 by the Superior Health Council of Belgium.[15] Henry formula was used to calculate the resting energy expenditure (REE).[16] The total energy expenditure (considered as daily caloric requirements) was then calculated by multiplying REE by the physical activity level (PAL). PAL is a number expressing the patient's daily physical activity: 1.4 if sedentary or light activity lifestyle, office work, 1.6 if active or moderate activity lifestyle, 1.8 if vigorous activity lifestyle. Daily protein, fatty acid and micronutrient requirements were defined as the respective recommended dietary allowances (RDA) *(Table I)*.

Actual weight was used for patients with BMI <25 kg/m^2. Ideal body weight (IBW) was considered as the expected weight for BMI 25 in overweight patients. In obese patients (BMI ≥30), adjusted body weight was calculated as follows: IBW + 0.25 × (actual weight - IBW).

Table I - RDA, average daily intakes, micronutrients deficit and tolerable upper intakes. Data are expressed as median (P25-P75)

		Daily requirements (RDA)	Average daily intakes	Micronutrient intake deficit to reach RDA	Tolerable upper intakes
Calories (kcal)		REE + PAL	1679 (1396 – 2255)		
Calories (kcal/kg)			23.6 (19.6 – 29.9)		
Proteins (g)			70.02 (51.6 – 97.8)		
Proteins (g/kg)		0.83 g/kg	1.08 (0.76 – 1.45)		
Omega-3 fatty acid (g)		1% of caloric intakes	0.98 (0.4 – 1.4)		
Omega-6 fatty acid (g)		4% of caloric intakes	5.6 (2.6 – 8.1)		
Calcium (mg)		950	486.3 (284.2 – 713.6)	520 (296 – 665)	2500
Magnesium (mg)	Male (n=24)	350	228.1 (146.3 – 308.4)	116 (51 – 165)	2500
	Female (n=18)	300	175.2 (144.2 – 235.8)		
Iron (mg)	Male (n=20)	9	9.55 (5.76 – 13.38)	0 (-3 – 4)	45
	Female (n=15)	15	7.83 (5.25 – 13.69)		
	Post-menopausal or > 60y (n=7)	9	11.17 (10.11 – 14.5)		
Zinc (mg)	Male (n=24)	11	10.36 (7 – 15.18)	1 (-2 – 3)	25
	Female (n=18)	8	7.56 (5.74 – 10.33)		
Copper (mg)	Male (n=22)	1.7	0.93 (0.58 – 1.27)	1 (0 – 1)	5
	Female (n=18)	1.2	0.84 (0.58 – 1.95)		
	>70y (n=2)	1.7	0.61 (0.53 – 0.69)		
Selenium (µg)		70	53.27 (31.81 – 74.25)	18 (-5 – 37)	200
Vitamin A (µg)	Male (n=24)	750	298.5 (147.9 – 637.3)	473 (162 – 589)	3000
	Female (n=18)	650	226 (139.3 – 466.5)		
Vitamin C (mg)		110	45.12 (25.99 – 79.14)	69 (34 – 83)	2000
Vitamin D (µg)	≤ 70y (n=40)	10	5.63 (1.39 – 10.88)	7 (2 – 9)	50
	>70y (n=2)	20	5.37 (4.9 – 5.84)		
Vitamin E (mg)	Male (n=24)	13	6.1 (4.86 – 8.89)	6 (4 – 8)	150
	Female (n=18)	11	6.4 (3.45 – 8.36)		

Nutrition Adequacy Ratio (NAR) was computed to determine the adequacy of caloric, macro- and micronutrient intakes of the participants. The following formula was used to estimate the NAR of a particular nutrient: NAR = Actual intake / RDA. Inadequate intake was defined as NAR <0.66.[17] Patients who did not take daily micronutrient supplements were analyzed separately. In those patients, micronutrient deficits were calculated as the difference between micronutrients RDA and actual intakes. For each micronutrient, tolerable upper intakes without adverse events were defined according to the Superior Health Council of Belgium[15] and the European Food Safety Authority (EFSA).

Statistical analysis

As no relevant previous data were available, no sample size was calculated.

Statistical analysis was performed using Graphpad Prism (version 6.0 for Mac OSX, Graphpad Inc., San Diego, CA, USA) and R statistical packages (version 3.3.1 for Windows, Revolution Analytics, Mountain View, CA, USA). Normality was assessed using the Shapiro-Wilk test. Results are expressed as medians (P25-P75) for quantitative parameters or as proportions for qualitative parameters. Univariate

associations between all potential predictors and adequate intakes of macronutrients or micronutrients were analyzed using Mann-Whitney test, Kruskal-Wallis test, Fisher's exact test or logistic regression analysis, as required. Only the significant variables according to the univariate analyses were included in multivariate models with a significance level of $p < 0.20$. In all analyses, a p value < 0.05 was considered to be statistically significant.

Results

Of the 130 patients who met the inclusion criteria and were reachable by phone to schedule a visit, 42 adults completed the study (*Fig. 2*). Descriptive characteristics of the included subjects are detailed in *Table II*. The vast majority of patients were considered at low risk of malnutrition, according to MUST. Of the 3 patients at medium risk, only one had SEFI <7. The other adults who could not be analyzed (refusal, not reachable, appointment impossible or lost to follow-up) had the same sex ratio but were slightly younger (39, 28-51 years, p=0.0435) and were less severely burned (BSA: 1 (0.5-2)%, p=0.0007) than the 42 analyzed patients.

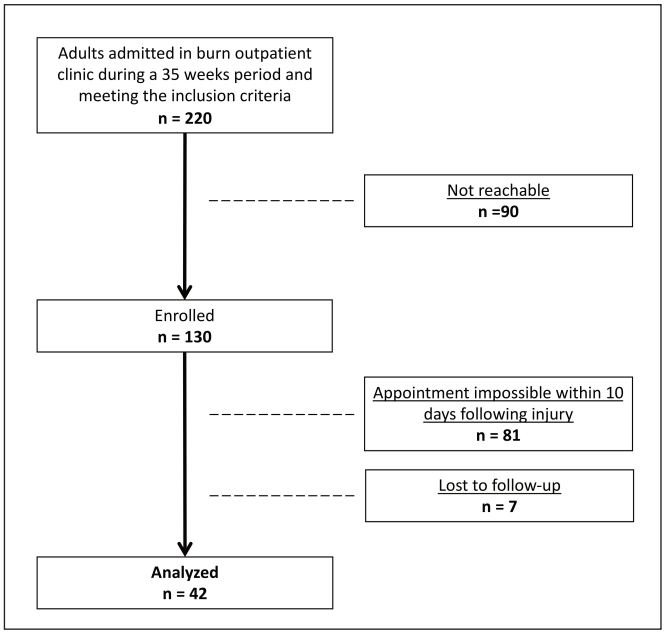

Fig. 2 - Flow chart

Burns were related to thermal injuries in 29 patients (69%), to chemical injuries in 6 patients (14.3%) and to electric injuries or sunburn in the remaining 7 patients (17.7%). Burn depth was mainly 1st degree in 4 patients (9.5%), 2nd degree (superficial and deep) in 35 patients (83.4%) and 3rd degree in 3 patients (7.1%). Patients were admitted to the burn outpatient clinic 1 (0-4) day after burn injury. The closing visit at the clinic occurred 11 (7-17) days after injury.

Table II - Descriptive characteristics of the included patients. Data are expressed as medians (P25-P75) for quantitative parameters or as proportions for qualitative parameters

		n. = 42
Age, y		45 (34-56)
Male, n (%)		24 (57)
Weight, kg		76 (67-87)
Height, cm		170 (165-178)
BMI, kg/m^2		25.9 (23.5-28.9)
BSA, %		2 (1-3)
Active, n (%)		29 (69)
Smoker, n (%)		13 (31)
Alcohol abuser, n (%)		5 (11.9)
SEFI <7, n (%)		12 (28.6)
MUST	0 = Low risk, n (%)	39 (93)
	1 = Medium risk, n (%)	3 (7)
Length of care (d)		11.5 (7-17)

Included patients were evaluated by the dietician 6 (4-8) days after the first visit in the clinic. Most of the included patients (28, 66.7%) declared they had not changed their amount of food intake since burn injury. Ten patients (23.8%) reduced food intakes due to pain, anxiety or decreased appetite, while 4 others increased their intake. Average daily intakes are detailed in *Table I*. Ratio between actual intakes and estimated requirements of calories, studied macronutrients and micronutrients are expressed in *Fig. 3*. Proportions of patients who reached the esti-

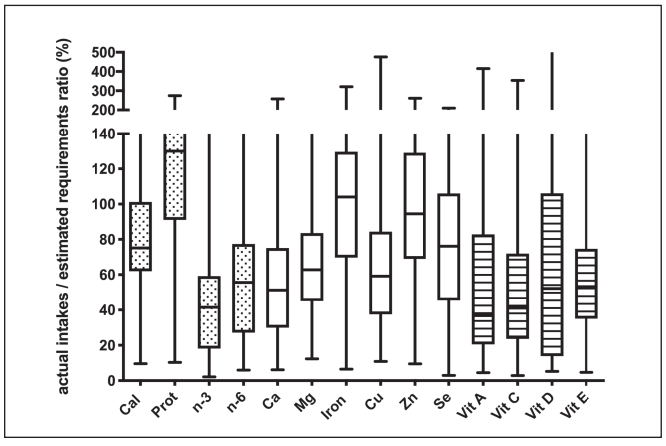

Fig. 3 - Difference between actual intakes and estimated requirements of calories, macronutrients and micronutrients (expressed as percentage)

mated requirements in the studied macro- and micronutrients are expressed in *Fig. 4*, as well as the proportion of patients considered to have inadequate intakes. Inadequate intakes in both energy and proteins were observed in 11 patients (26.2%). Only protein and iron RDA were reached by >50% of the patients. This was attributed to an important consumption of meat. Omega-3 fatty acid, vitamin C and vitamin E were the three most deficient nutrients. Two-thirds of the patients had inadequate intakes (intakes <66% RDA) in n-3 fatty acid, calcium, vitamins A, C and E. Half of the patients had additional inadequate intakes in n-6 fatty acid, copper, magnesium and vitamin D.

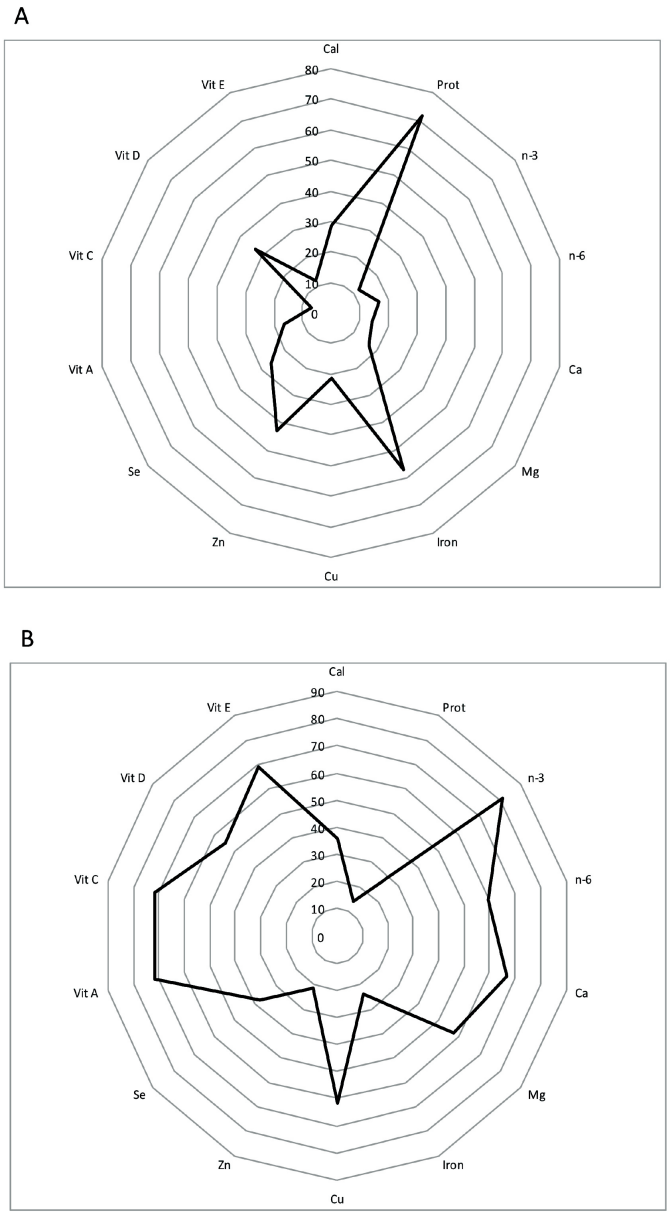

Fig. 4 - Radar graph representing the proportion of patients who reached RDA (graph A) or the proportion of patients with insufficient intakes (<66% RDA) (graph B). The radar graph provides one axis for each studied nutritional intake, clockwise respectively: energy (cal), proteins (prot), n-3 and n-6 fatty acids and micronutrients. The proportion of patients is expressed as concentric circles (ranging from 0 to 80% in graph A, and from 0 to 90% in graph B)

In univariate analysis, a SEFI <7 was associated with insufficient intakes regards both energy and proteins (p=0.0183). Conversely, SEFI scale was not associated with micronutrient intake adequacy. A BMI >25kg/m2 was associated with insufficient intakes regards both energy and proteins (p=0.03). After adjustment for potential confounding factors, BSA was independently associated with a deficit in energy and/or protein intakes. However, no discriminant BSA threshold was highlighted. No risk factors for insufficient intakes in fatty acids or micronutrients were detected in univariate analysis.

When adjusted for burn depth, length of care in the outpatient clinic was not influenced by inadequate intakes of macro- or micronutrients in this limited cohort.

Seven patients were supplemented either by vitamin D alone or a mix of vitamins B, C and D. Three of them also took calcium or trace element supplements. Deficits in the studied micronutrients were calculated for the remaining 35 patients and are detailed in *Table 1*.

Discussion

The present study was a pragmatic real-life audit performed in a poorly studied population. The majority of adults with minor burn treated in an outpatient clinic had inadequate intakes of n-3 and n-6 fatty acids, and of most of the studied micronutrients, compared to RDA. Intakes covered >66% RDA regards energy and proteins in respectively 64 and 86% of the patients. Only protein and iron RDA were covered by diet in >50% of the patients. Most of the patients did not change their dietary behavior following burn injury, so observed insufficient intakes could be considered as poor eating habits, with an insufficiently diversified diet. There is no reason to believe that the observed inadequate intakes could be the consequence of burn injury.

As demonstrated in the present study, basic screening of patients at risk of macronutrient deficiency could be based on SEFI score.

This tool can easily be administered by any healthcare provider, including nurses. A SEFI <7 should lead to additional investigations, ideally by a dietician, to specify actual intakes and suggest diet adaptation or enrichment as required.

The risk of energy and protein deficits was multiplied by 6 for each 1% increment of BSA. Unfortunately, this study could not help to define any precise BSA threshold allowing identification of patients who would deserve special attention regarding food intakes.

We were unable to define risk factors for insufficient micronutrient intakes. However, this was a widespread problem in the studied population, which may be attributed to undernutrition or to consumption of food with low content in vitamins or trace elements. Nutritional advice could easily be given to burn outpatients, aiming to increase their micronutrient intakes. If necessary, an oral daily complementation could be prescribed. Only major micronutrients were analyzed in the present study, but we can assume that other micronutrient intakes would have been low too.

From this perspective, it would make sense to use daily multivitamin and multimineral complements: there is a number of commercial mixtures that vary widely in terms of composition and characteristics.[18] According to the National Institute of Health, doses of commercial micronutrient complements are generally equal to RDA.[19]

Supplementation with such doses would cover the needs of the majority of the patients without reaching the tolerable upper intakes. Further studies should be dedicated to assessing the benefits of optimized nutritional intakes on healing.

Dietary intakes of minor burn patients were compared to theoretical nutritional requirements for healthy people, but the relevance of such comparison is unclear.

Minor burn patients might require greater amounts of macronutrients and micronutrients during wound healing.

Such postulate is mainly related to nutritional recommendations for adults with pressure ulcers.[20,21]

However, those patients differ from minor burn patients in terms of comorbidities, type and severity of wounds. There is currently limited data about nutritional requirements in patients facing wounds. Indirect calorimetry could be a first step towards building such knowledge: it can now be easily performed in a canopy dilution mode in spontaneously breathing patients.[22]

It should help to determine if requirements of minor burn patients are actually comparable to those of healthy subjects.

Some limitations need to be acknowledged. First, the cohort was quite small due to low consent rate, and probably too small to allow the detection of predictive factors for inadequate nutritional intakes. However, although small, this cohort is quite similar (relatively young patients, small BSA) to the populations described in the literature dedicated to burn outpatients,[23,24] and was representative of the 130 patients meeting the inclusion criteria. Secondly, the external validity of a single-center study may be questionable, but similar profiles of nutritional intakes have been observed in food consumption surveys in Belgium (Belgian Health Institute) and France (French Agency for Food, Environmental and Occupational Health and Safety). Lastly, there was no control group or outcome assessment.

The aim of this precursor audit was basically to characterize the nutritional intakes of non-severe burns by comparing them to the most accurate guidelines (i.e. RDA), in order to build useful knowledge to design further interventional studies.

Conclusion

We hereby present the first nutritional audit that focuses on outpatients with minor burns. It has highlighted that a majority of macronutrient and micronutrient intakes did not reach the levels recommended by the RDA. Protein intakes were less worrying.

The nutritional condition of these patients can probably be optimized simply.

Benefits of such a strategy on outcomes such as wound healing should be further studied.

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Availability of data and material. The datasets used and/or analyzed during the current study are available from the corresponding author on reasonable request.
Transparency declaration. The lead author affirms that this manuscript is an honest, accurate, and transparent account of the study being reported. The reporting of this work is compliant with STROBE guidelines. The lead author affirms that no important aspects of the study have been omitted and that any discrepancies from the study as planned (registered at clinicaltrials.gov, NCT03914560) have been explained.
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