



## Original article

## Severity of pain is associated with insufficient energy coverage in hospitalised patients: A cross-sectional study



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## SUMMARY

**Background & aims:** The severity of pain is routinely assessed in hospitalised patients but the impact of pain and pain control on energy coverage has been poorly studied. This One-day cross-sectional observational study assessed the association between severity of pain and coverage of energy needs in hospitalised patients.

**Methods:** Foods provided and consumed were assessed on one day by dedicated dietitians for unselected hospitalised patients receiving three meals per day. Severity of pain was evaluated by a visual analogue scale at the mealtimes, averaged over the study day, and categorized as no pain, slight, moderate or severe pain. The coverage of energy needs was expressed in percentage of predicted needs.

**Results:** Among the 755 included patients, 63% reported having pain. Severe pain was associated with a lower energy coverage than no pain ( $p = 0.001$ ) or slight pain ( $p = 0.001$ ). Insufficient energy coverage, defined as  $\leq 70\%$  of predicted needs, occurred in 13% of the patients. In univariate logistic regressions, predictors of insufficient energy coverage were severe pain as compared to no pain (OR 2.38; 95% CI 1.21, 4.64) and treatment with opioid drugs as compared to no pain killer (OR 1.73; 95% CI 1.07, 2.79). When including sex, age, body mass index, treatment with analgesics and severity of pain in a multivariate logistic regression, severe pain more than doubled the risk of insufficient energy coverage (OR 2.32; CI 1.15, 4.66).

**Conclusions:** Patients experiencing severe pain have a high risk of insufficient energy coverage. Optimal pain control is probably critical to prevent underfeeding in the hospital.

**Trial registration:** Identifier no NCT02463565 on [www.ClinicalTrials.gov](http://www.ClinicalTrials.gov).

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## 1. Introduction

Undernutrition occurs in 30–80% of hospitalised patients [1–3] and results in increased length of stay, morbidity, healthcare costs [4] and reduced quality of life. The prevention of undernutrition requires the coverage of energy needs.

The relationship between dietary intake and clinical outcome has been mainly explored in the NutritionDay® survey. This large multinational observational survey showed that eating only the quarter of a meal while hospitalized doubled the 30-day mortality,

as compared to the consumption of the whole meal [5]. In patients hospitalized at the Geneva University Hospitals, an energy intake  $\leq 70\%$  of predicted needs was found to be a risk factor for healthcare-associated infections [1].

As a result, there is an increased interest in identifying the determinants of low dietary intake during hospitalization. In Northern Europe, as shown in the NutritionDay® survey, eating less than the whole meal was associated with age ( $<30$  and  $>90$  yrs), female sex, a body mass index  $<18.5$  kg/m<sup>2</sup> and reduced physical ability [6]. In a hospital survey in Geneva, risk factors for insufficient energy and protein coverage were an evaluation of intake during the first week of hospitalisation, dislike of meals by the patients, and the lack of consumption of oral nutritional supplements [7].

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Haller et al. reported in 2011 that two third of the patients suffered from pain at the Geneva University Hospitals [8]. However, the impact of pain on dietary intake has been poorly studied in unselected hospitalized patients. A retrospective study demonstrated that the severity of pain positively correlated with the nutritional risk in hospitalized patients treated by a fentanyl patch for cancer-related pain [9]. Furthermore, in community-dwelling older persons, chronic musculoskeletal pain was associated with nutritional risk [10]. Although these studies show the relation between pain and nutritional risk, they did not determine whether pain directly affects dietary intake.

This cross-sectional study aims at evaluating the association of dietary intake and the severity of pain and pain control in hospitalised patients. We postulate that the severity of pain negatively influences the coverage of energy needs in hospitalised patients.

## 2. Methods

The study was performed at the Geneva University Hospitals from May 13th to 27th 2016 as part of the 5th quadriannual general audit on food intake in our institution [1,7,11]. It was a one-day cross-sectional study conducted in all adults hospitalised in the wards of medicine, surgery, and psychiatry. All patients receiving 3 meals during the day of the study were included. Exclusion criteria were missing meal(s) for medical reason, refusal to participate, transfer from or to the ward, exclusive or complementary enteral and/or parenteral nutrition, missing data on pain or dietary intake, or post-operative refeeding. The study was approved by the Ethical Committee of the Geneva University Hospital, who waived the need to obtain written consent as the study was part of a general audit of the quality control programme. The study is registered on [www.ClinicalTrials.gov](http://www.ClinicalTrials.gov) identifier no NCT02463565.

### 2.1. Energy coverage

The procedure of this audit has been previously described in details [1,7,11]. In brief, the patients select their menu and the chosen meals are delivered on a tray, three times per day. For the purpose of this study, a team of 98 trained dietitians assessed the dietary intake of the patients during each meal, on one day. All dietitians were trained by the same teachers (AMM, MC, CP) before the study in order to standardize the assessments. For each meal, they calculated the energy intake using the dietary service software Winrest® (FSI, Noisy-le-Grand, France). For each patient, the overall oral energy intakes were calculated based on the amount of food consumed from meals, oral nutritional supplements and snacks. Energy needs were calculated by the Harris–Benedict formula because it is one of the most accurate equations to predict resting energy expenditure [12–14], but also by some other commonly used equations [15], as those published by Mifflin et al. [16], Owen et al. [17] or the FAO [18]. An insufficient energy coverage was defined as an energy intake  $\leq 70\%$  of resting energy expenditure, calculated by each of the afore-mentioned formula.

### 2.2. Other collected data

The severity of pain, prescription of analgesics and nutritional risk were assessed on the study day. The severity of current pain was self-assessed by the patients during each meal, thus thrice during the study day, using a 10 cm visual analogue scale, where 0 corresponded to no pain and 10 to the worst pain ever. For each patient, we considered the average score over the three meals, which was rounded up to the higher or lower unity if the decimal was  $\geq 5$  or  $< 5$ , respectively. The severity of pain was categorized

into four stages, as described elsewhere [19]: no pain (score 0), slight pain (score 1–3), moderate pain [4–6] and severe pain [7–10].

The prescription of analgesics on the study day were retrieved from the computer database of the Geneva University Hospitals and stratified into three categories, independently of their mode of administration: 1) absence of analgesics, 2) analgesics other than opioid drug including nonsteroidal anti-inflammatory treatment and paracetamol, and 3) opioid drug.

The nutritional risk was determined using the Nutritional Risk Score 2002 (NRS), as recommended by the guidelines of the European Society for Clinical Nutrition and Metabolism, for hospitalized patients [20]. The NRS ranges from 0 (absence of nutritional risk) to 7 (severe nutritional risk). It takes into account the impairment of nutritional status (0 = absent, 1 = mild, 2 = moderate, 3 = severe), the severity of the disease (0 = absent, until 3 = severe), and the age (0 =  $< 70$  year, 1 =  $\geq 70$  year). Patients with an NRS  $\geq 3$  are considered to be at nutritional risk [20].

We further retrieved from the computer database of the Geneva University Hospitals, the length of hospital stay and the ward of hospitalization of each included patient, namely medicine, surgery or psychiatry.

### 2.3. Statistical analyses

All statistical analyses were conducted by Stata software, release 13.0 (Stata Corporation, College Station, Texas, USA). Statistical significance was set at  $p < 0.05$ .

Shapiro–Wilk tests were used to evaluate the normality of distribution of continuous variables. Continuous variables were not normally distributed and were therefore reported as median (interquartile range). For the purpose of subsequent logistic regression models, age and BMI were categorized as following:  $< 65$  (reference category) and  $\geq 65$  years for age, and  $< 18.5$ ,  $18.5–24.9$  (reference category),  $25.0–29.9$  and  $> 29.9$  for body mass index [21]. Categorical variables were described as frequencies and percentages.

Categorical variables between the four groups of pain severity were compared by Chi-squared tests. Statistical significance remained at  $p < 0.05$  after adjustment for multiple comparisons by the Benjamini–Hochberg method [22].

Energy coverage (%) was expressed as continuous value. Energy coverage (%) based on the Harris–Benedict formula was compared between sex and categories of, age, body mass index, analgesics, NRS and ward speciality by Mann–Whitney U tests or Kruskal–Wallis tests followed, in case of significance, by a post-hoc test using the `kwallis 2` command from the Stata software. Energy coverage was plotted against the categories of pain severity. A multivariate linear regression model was performed to determine the predictors of energy coverage, using the following variables: sex, categories of age, body mass index, pain analgesics, and severity of pain. We calculated the regression coefficients and 95% confidence intervals (95% CI), and the adjusted  $R^2$  which corresponds to the variance of energy coverage explained by the models.

The predictors of insufficient energy coverage ( $< 70\%$  of predicted needs) as binary variable were evaluated by univariate and multivariate logistic regression models, using the same variables as for the linear regression models. We reported odds ratios (OR), 95% CI, and the adjusted  $R^2$ . We focused on the energy coverage based on the Harris–Benedict equation. We repeated this analysis while 1) using energy coverage based on the equations of Mifflin et al., Owen et al., or the FAO, in order to evaluate the impact of the equation used to predict energy needs and 2) replacing the body

mass by the NRS to determine if the association between energy coverage and pain was related to nutritional risk.

### 3. Results

Out of 1965 eligible patients, 755 patients were included (Fig. 1). Missing at least one meal during the study day was the main exclusion criteria. The median (interquartile range) age, BMI, and length of hospital stay of the included patients were 75.9 (57.7, 85.1) years, 24.6 (21.4, 28.5) kg/m<sup>2</sup> and 12.3 (4.6, 37.5) days, respectively. Their energy intake was 1503 (1136, 1819) kcal and the predicted energy needs were 1289 (1131, 1514) kcal, leading to an energy coverage of 113 (84, 142)%. The categorical characteristics of the patients are presented in Table 1.

Sixty-three percent of the included patients complained about pain and approximately half of them evaluated it as moderate or severe. The severity of pain significantly differed between sex, and categories of age and analgesics (Table 1).

Coverage of energy needs was associated with sex and the categories of body mass index, analgesics, NRS and ward speciality (Table 2). Coverage of energy needs was lower in the group treated with opioids than with other analgesics or no analgesics. Figure 2 shows that the coverage of energy needs was lower in patient with severe pain than with no pain or slight pain. The multivariate linear regression model showed that energy coverage was significantly lower in men, and in patients who were overweight or obese, under opioid treatment and with severe pain (Supplementary Table 1).

Energy coverage, based on the Harris–Benedict formula, was insufficient ( $\leq 70\%$  of predicted energy needs) in 101 (13%) of the included patients. Among them, 69 (78%) reported having slight, moderate or severe pain. Univariate logistic regression models showed that severe pain increased the risk of insufficient energy coverage by 2.4 as compared to no pain, and that the consumption of opioid drugs increased it by 1.7, as compared to no pain killer (Table 3). The multivariate logistic regression model confirmed that

severe pain more than doubled the risk of insufficient energy coverage but the significance of opioid drugs disappeared. This relationship was confirmed when energy coverage was estimated using the equations of Mifflin et al. [16], Owen et al. [17] or the FAO [18] (Supplementary Table 2). When replacing the body mass index, the association between severe pain and energy coverage based on the needs calculated by the Harris–Benedict equation disappeared (Supplementary Table 3).

### 4. Discussion

This study shows a high prevalence of pain (63%) in unselected hospitalized patients who were being fed orally and self-selecting their food items. Coverage of energy needs was lower in men, and in patients who were overweight or obese, under opioid treatment and with severe pain. Insufficient energy coverage ( $\leq 70\%$  of predicted energy needs) was associated with severe pain and treatment with opioid drugs. When adjusting for sex, age, body mass index, and treatments with analgesics, severe pain more than doubled the risk of insufficient energy coverage. When adjusting for the NRS instead of the BMI, severe pain was no longer associated with energy coverage, suggesting that the components of the NRS partly capture the severity of pain.

This study is the first one who assessed simultaneously the severity of pain and the energy intake in an unselected hospital population. It shows that pain negatively affects food intake and suggests that pain should be considered during nutritional screening and assessment. The negative association of pain and energy intake or coverage has been highlighted mostly in patients with head and neck cancer. In these patients, pain was shown to be a major cause of weight loss, along with dysphagia [23]. One study showed a high risk of reduced food intake with pain, as compared to no pain, in 635 patients before chemoradiotherapy [24]. Oral energy intake evaluated by a 24 h dietary recall was also inversely associated with mucosal sensitivity and xerostomy at 4–10 months after chemoradiotherapy [25]. Finally, another study demonstrated that the higher the cumulative irradiation dose during radiotherapy, the higher was the pain intensity and the lower was the energy coverage, evaluated by the ratio of calorie intake to estimated basal energy expenditure [26]. The inverse relationship between pain and dietary intakes has also been shown in hospitalized patients with advanced cancer in general [27], in outpatients with advanced pancreatic cancer [28] and in older community-dwelling persons [29]. Our study confirms the findings of the aforementioned studies but in hospitalized unselected patients.

The strength of this study relies on a logistic organisation already tested thrice since 1999 [1,7,11]. The calculation of energy intake has been standardized among the dieticians, and the severity of pain was assessed by the patient with a recognized tool [19]. It included patients with different primary diseases and co-morbidities who reflect an unselected hospitalized study population. This study has several limitations. In the absence of indirect calorimetry, we estimated the energy needs by the Harris–Benedict formula. The Harris–Benedict formula was shown to be among the most accurate equations to predict resting energy expenditure, as compared to indirect calorimetry, in normal-weight, obese and elderly patients [12–14]. However, accurate prediction, defined as  $\pm 10\%$  of measured resting energy expenditure, was present in only 72, 64 and 70% of these patients, respectively. The needs may have been underestimated as we did not take into account thermogenesis or physical activity and could result in a higher number of patients with insufficient energy coverage. Furthermore, Jesus et al. have shown that the accuracy of HB equation worsens in the extreme BMI ranges. Thus, even if the HB equation is among the most accurate one to predict resting energy expenditure, it shows discrepancies

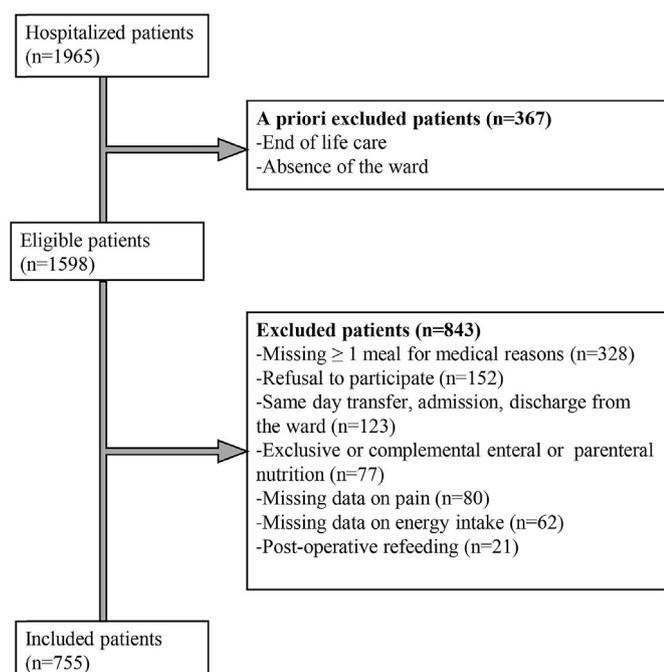


Fig. 1. Study flow chart.

**Table 1**  
Description of the patients according to the severity of pain, presented as n (%).

	Total		Categorization according to the severity of pain <sup>a</sup>								p <sup>b</sup>
	(n = 755)		Absence (n = 279)		Slight (n = 239)		Moderate (n = 169)		Severe (n = 68)		
<b>Sex</b>											
Female	432	(57.2)	139	(32.1)	134	(30.0)	111	(25.7)	48	(11.1)	0.001
Male	323	(42.8)	140	(43.3)	105	(32.5)	58	(18.0)	20	(6.2)	
<b>Age (years)</b>											
<65	243	(32.2)	74	(30.5)	87	(35.8)	63	(25.9)	19	(7.8)	0.035
≥65	512	(67.8)	205	(40.0)	152	(29.7)	106	(20.7)	49	(9.6)	
<b>Body mass index (kg/m<sup>2</sup>)</b>											
<18.5	62	(8.2)	16	(25.8)	27	(43.6)	13	(21.0)	6	(9.7)	0.118
18.5–24.9	337	(44.6)	137	(40.7)	98	(29.1)	70	(20.8)	32	(9.5)	
25.0–29.9	217	(28.7)	82	(37.8)	61	(28.1)	58	(26.7)	16	(7.4)	
>29.9	139	(18.4)	44	(31.7)	53	(38.1)	28	(20.1)	14	(10.1)	
<b>Analgesics</b>											
Absence of analgesics	465	(61.6)	201	(43.2)	134	(28.8)	97	(20.9)	33	(7.1)	<0.001
Analgesics other than opioid drug	123	(16.3)	47	(38.2)	43	(35.0)	20	(16.3)	13	(10.6)	
Opioid drug	167	(22.1)	31	(18.6)	62	(37.1)	52	(31.1)	22	(13.2)	
<b>Nutrition risk score</b>											
<3	433	(57.3)	171	(39.5)	133	(30.7)	94	(21.7)	35	(8.1)	0.359
≥3	322	(42.7)	108	(33.5)	106	(32.9)	75	(23.3)	33	(9.0)	
<b>Ward speciality</b>											
Medicine	487	(64.5)	188	(38.6)	136	(27.9)	115	(23.6)	48	(9.9)	<0.001
Surgery	130	(17.2)	31	(23.9)	64	(49.2)	29	(22.3)	6	(4.6)	
Psychiatry	138	(18.2)	60	(43.5)	39	(28.3)	25	(18.1)	14	(10.1)	

<sup>a</sup> Categorization according to a visual analogue scale, into absence (score 0), slight (score 1–3), moderate [4–6] and severe pain [7–10]. The % was calculated from the number of patients in the column “Total”.

<sup>b</sup> Chi-squared tests were used to compare the data between the four categories of pain severity. Significance was set at  $p < 0.05$ , even after correction for multiple comparisons (Benjamini-Hochberg method).

with indirect calorimetry. It would therefore be indicated to confirm our result when resting energy expenditure is measured by indirect calorimetry. It included patients with chronic and acute pain, but in the hospital setting, it is complicated to distinguish them. It did not

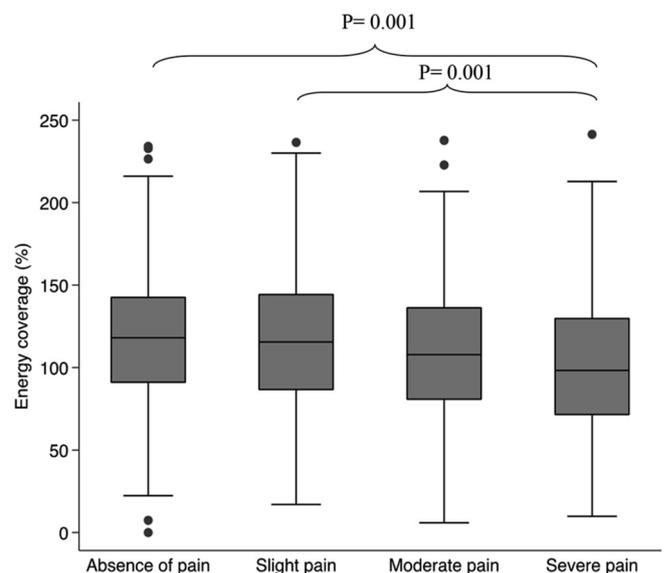
take into account other drugs than analgesics, although they may influence the food intake. We did not into account other symptoms which may limit food intake and could be confounders of the analysis, as for instance dysphagia, dysgueusia, nausea, vomiting. This study is cross-sectional and therefore does not reflect the entire hospital stay of the patient and cannot evaluate whether a better pain control increases energy coverage.

**Table 2**  
Description of the patients according to energy coverage (n = 755).

	Energy coverage (% of predicted needs)		p <sup>#</sup>
	Median	Interquartile range	
<b>Sex</b>			0.001
Female	119.2	(88.1, 148.7)	
Male	106.9	(82.4, 133.7)	
<b>Age (years)</b>			0.085
<65	108.1	(81.0, 137.7)	
≥65	115.7	(86.3, 142.8)	
<b>Body mass index (kg/m<sup>2</sup>)</b>			<0.001
<18.5	139.1 <sup>a,c</sup>	(104.5, 170.8)	
18.5–24.9	122.2 <sup>b,d</sup>	(90.1, 147.9)	
25.0–29.9	104.9 <sup>a,b</sup>	(81.3, 131.3)	
>29.9	97.9 <sup>c,d</sup>	(79.5, 126.5)	
<b>Analgesics</b>			<0.001
Absence of analgesics	116.8 <sup>e</sup>	(89.3, 145.2)	
Analgesics other than opioid drug	122.8 <sup>f</sup>	(93.4, 145.0)	
Opioid drug	97.4 <sup>e,f</sup>	(73.8, 124.2)	
<b>Nutrition risk score</b>			0.019
<3	116.3	(94.7, 140.1)	
≥3	106.9	(72.2, 144.3)	
<b>Ward speciality</b>			<0.001
Medicine	119.0 <sup>g</sup>	(90.6, 144.2)	
Surgery	95.1 <sup>g,h</sup>	(76.0, 121.1)	
Psychiatry	114.0 <sup>h</sup>	(83.5, 145.9)	

<sup>#</sup>Wilcoxon rank sum test for comparisons of 2 groups, Kruskal–Wallis tests for  $\geq 3$  groups.

In variables with  $\geq 3$  groups, the same superscripts indicate significant difference between groups with the post-hoc test (kwallis 2 command from the Stata software).



**Fig. 2.** Box plot between coverage of energy needs and categories of severity of pain. This figure shows that the higher the severity of pain, the lower is the coverage of energy needs (Kruskal–Wallis test:  $p = 0.004$ ). Post-hoc analysis show that patients with severe pain had a significant lower coverage of energy needs than patients with absence of pain or slight pain.

**Table 3**Univariate and multivariate logistic regressions to predict an insufficient energy coverage ( $\leq 70\%$  of the predicted needs) (N = 755).

	univariate			multivariate		
	OR (95% CI)	p	R <sup>2</sup>	OR (95% CI)	p	R <sup>2</sup>
Sex						0.036
Female	1		0.004	1		
Male	1.37 (0.90, 2.09)	0.143		1.51 (0.98, 2.35)	0.065	
Age (years)						
<65	1		0.003	1		
$\geq 65$	0.76 (0.49, 1.17)	0.220		0.86 (0.54, 1.35)	0.509	
Body mass index (kg/m <sup>2</sup> )						
<18.5	0.95 (0.40, 2.21)	0.897		1.07 (0.45, 2.56)	0.882	
18.5–24.9	1		0.006	1		
25.0–29.9	1.14 (0.69, 1.91)	0.603		1.11 (0.66, 1.87)	0.691	
>29.9	1.63 (0.94, 2.80)	0.079		1.72 (0.98, 3.00)	0.058	
Analgesics						
Absence of analgesics	1		0.010	1		
Analgesics other than opioid drug	0.86 (0.46, 1.63)	0.652		0.87 (0.45, 1.66)	0.668	
Opioid drug	1.73 (1.07, 2.79)	0.024		1.60 (0.96, 2.66)	0.070	
Severity of pain <sup>a</sup>						
No pain	1		0.016	1		
Slight pain	0.90 (0.52, 1.57)	0.715		0.82 (0.46, 1.44)	0.482	
Moderate pain	1.53 (0.89, 2.65)	0.126		1.44 (0.82, 2.56)	0.183	
Severe pain	2.38 (1.21, 4.64)	0.011		2.32 (1.15, 4.66)	0.019	

OR: Odds ratio, CI: confidence interval.

<sup>a</sup> Categorization according to a visual analogue scale, into absence (score 0), slight (score 1–3), moderate [4–6] and severe pain [7–10].

## 5. Conclusion

This cross-sectional study showed that severe pain more than doubled the risk of insufficient energy coverage in unselected hospitalized patients. This suggests that pain control is essential to prevent undernutrition. Future studies on subgroups of patients with different primary diseases and with a longitudinal follow-up after pain control would bring more light on the influence of pain and pain control on the coverage of energy needs and subsequent nutritional state.

## Contributors

AMM designed the study, carried out the collection of data, performed the statistical analyses, and drafted the manuscript. LG and MPK performed the statistical analyses and drafted the manuscript. MC carried out the collection of data. FG and SP drafted the manuscript. CP designed the study, carried out the collection of data, performed the statistical analyses, drafted the manuscript, and rose funding.

All authors had full access to all the data in the study and can take responsibility for the integrity of the data and the accuracy of the data analysis.

## Ethical approval

The study was approved by the Ethical Committee of the Geneva University Hospital, who waived the need to obtain written consent as the study was part of a general audit of our institutional quality control programme. The study is registered on [www.ClinicalTrials.gov](http://www.ClinicalTrials.gov) identifier no NCT02463565.

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## Transparency

The lead author affirms that this manuscript is an honest, accurate, and transparent account of the study being reported; that no important aspects of the study have been omitted; and that any discrepancies from the study as planned (and, if relevant, registered) have been explained.

## Data sharing

Patient level data and statistical code are available at the Nutrition Unit of the Geneva University Hospital. Consent was not obtained but the presented data are anonymised and risk of identification is low.

## Conflict of interest

All authors have completed the ICMJE uniform disclosure form at [www.icmje.org/coi\\_disclosure.pdf](http://www.icmje.org/coi_disclosure.pdf) and declare: no support from any organisation for the submitted work; no financial relationships with any organisations that might have an interest in the submitted work in the previous three years; no other relationships or activities that could appear to have influenced the submitted work.

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## Appendix A. Supplementary data

Supplementary data related to this article can be found at <https://doi.org/10.1016/j.clnu.2018.03.005>

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