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Impact of nutritional risk screening in hospitalized patients on management, outcome and costs: A retrospective study

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ABSTRACT

Background & Aims: Hospitalized patients should be screened for nutritional risk and adequately managed. Being nutritionally 'at-risk' increases in-hospital mortality, length of stay (LOS) and costs, but the impact on actual costs has seldom been assessed. We aimed to determine nutritional risk screening and management in a Swiss university hospital. The impact of being nutritionally 'at-risk' on in-hospital mortality, LOS and costs was also assessed.

Methods: Retrospective analysis of administrative data for years 2013 and 2014 from the department of internal medicine of the Lausanne university hospital (8541 hospitalizations, mean age 72.8±16.5 years, 50.4% women). Being nutritionally 'at-risk' was defined as a Nutritional risk screening-2002 score≥3 and nutritional managements were collected from medical records.

Results: Screening increased from 16.5% in 2013 to 41.9% in 2014 ($p<0.001$), while prevalence of 'at-risk' patients remained stable (64.6% in 2013 and 62.7% in 2014, $p=0.37$). Prevalence of 'at-risk' patients was highest in patients with cancer (85.3% in 2013 and 70.2% in 2014) and lowest in patients with disease of skin (42% in 2013 and 44.8% in 2014). Less than half of patients 'at-risk' received any nutritional management, and this value decreased between 2013 and 2014 (46.9% vs. 40.3%, $p<0.05$). After multivariate adjustment, 'at-risk' patients had a 3.7-fold (95% confidence interval: 1.91; 7.03) higher in-hospital mortality and higher costs (excess 5642.25±1479.80 CHF in 2013 and 5529.52±847.02 CHF in 2014, $p<0.001$) than 'not at-risk' patients, while no difference was found for LOS.

Conclusion: Despite an improvement in screening, management of nutritionally 'at-risk' patients is not totally covered yet. Being nutritionally 'at-risk' affects three in every five patients and is associated with increased mortality and hospitalization costs.

Keywords: NRS-2002; hospital undernutrition; nutritional management; mortality; Length of hospital stay; costs.

INTRODUCTION

Undernutrition is a critical condition among hospitalized patients, both as a cause and consequence of disease [1]. Notwithstanding over three decades of knowledge development, the worldwide prevalence of hospital undernutrition is still high (20 to 50%) mainly due to difficulties in the identification and adequate management of 'at-risk' patients [2, 3]. Undernutrition status tends to deteriorate during hospital stay, worsening patient's outcome and increasing health costs [4, 5]. Adequate screening and nutritional therapy have been shown to decrease the rate of nutrition-related complications, to decrease in-hospital mortality and to shorten length of stay (LOS) [6]. According to the European Society for Parenteral and Enteral Nutrition (ESPEN) recommendations, the Nutrition Risk Screening (NRS-2002) should be used for screening undernutrition in all hospitalized patients [1]. Still, even nowadays, proper nutritional risk screening is not performed in many European hospitals [7]; only in some countries like the United Kingdom, the Netherlands and part of Denmark nutritional risk screening is mandatory [8, 9].

Switzerland is a small European country with one of the best health systems in the world [10]. Still, screening for nutritionally 'at-risk' patients has been unevenly implemented in hospitals and there is little information regarding prevalence, determinants, management and impact on health outcomes and cost of undernutrition [11]. Such information is important for the adequate management of hospital resources, both in Switzerland and similar countries.

In this study we used data from the department of internal medicine of a Swiss university hospital to assess the implementation of nutritional risk screening. We also assessed the prevalence, determinants and management of 'at-risk' patients, and impact of being nutritionally 'at-risk' on in-hospital mortality, LOS and costs.

METHODS

Data collection

This is a retrospective study using electronic administrative data of the department of internal medicine of the Lausanne university hospital (CHUV) from January 1st, 2013 to December 31st, 2014. The CHUV is one of the five Swiss university hospitals, with a total staff of 10,000 and a bed capacity of 1642 (www.chuv.ch). In 2013, the department of internal medicine of the CHUV started implementing a nutritional risk screening procedure with the use of NRS-2002; this screening focused mainly, but not exclusively, on patients with heart and/or respiratory failure at admission.

This study included all adult (≥ 18 years old) patients who stayed for a minimum of one day (≥ 24 hours) in the department of internal medicine of the CHUV.

Nutritional risk screening and data collection procedure

The patient's nutritional risk status was evaluated by the NRS-2002 [1]. Nutritional screening implementation was defined by the presence of NRS-2002 score in the electronic medical record which contain all the data related to nutritional risk status and managements since January 2013. In brief, according to the CHUV guideline, patients were interviewed by nursing staff at the first 48h of admission about their nutritional risk status and disease severity according to the NRS-2002 criteria. NRS-2002 score is calculated by adding 'nutritional score' of 0 to 3 to the 'disease severity score' of 0 to 3 plus 1 extra score for patients older than 70 years.

The 'nutritional score' is defined by adequacy of dietary intake due to three different parameters 1) quartile decreased of estimated oral food intake requirements, 2) presence of ≥5% weight loss within the previous 1 to 3 months and 3) low body mass index (<18.5 kg/m^2). The

94 ‘disease severity score’ was categorized as none, slight, moderate and severe with the score of 0
95 to 3, respectively. A total NRS-2002 score ≥3 was considered as nutritionally ‘at-risk’.

96 The nutritional management database of the CHUV included dietary regimen, enteral
97 nutrition (EN) and parenteral nutrition (PN). At the CHUV, all prescriptions given to patients are
98 coded using the Anatomical Therapeutic Chemical (ATC) classification system and procedures
99 are coded according to ICD-9CM. EN was defined as prescribed oral nutrition supplements
100 (ONS) and/or tube feeding according to the ESPEN guideline [12]. PN was defined as any
101 prescription containing the ATC code B05BA (PN solution or premixed multichamber bag
102 containing PN) or as a procedure containing the ICD-9CM code 99.15 (Parenteral infusion of
103 concentrated nutritional substances).

104 *Other variables*

105 Socio-demographic data included age, sex, marital status and coming from home or other
106 health care facilities. Clinical variables included main diagnosis and vital status at discharge
107 (alive or dead). Main diagnoses (the most relevant diagnosis for the hospitalization at discharge
108 according to the responsible physician) were categorized in groups according to the 10th
109 International Classification of Diseases and related health problems (ICD-10). Main diagnosis
110 groups are indicated in **Supplementary Table 1**. Only main diagnosis were used regardless any
111 subsidiary diagnosis except for disease of circulatory system (Ischemic heart disease and Heart
112 Failure) and pulmonary diseases (Pneumonia and Chronic obstructive pulmonary disease).

113 LOS was calculated according to the official Swiss Diagnosis-related group (DRG)
114 guidelines, available at
115 swissdrg.org/assets/pdf/Tarifdokumente/SwissDRG_Falldefinitionen_Version_5_2013_f_def.pdf
116 . According to the “midnight rule”, a patient who is admitted at the hospital before midnight and

who stays at the hospital at midnight is considered as having spent a night at the hospital. Briefly, LOS is computed using the following formula:

[date of discharge – date of admission]/24 – hours of administrative leave/24.

The dates of discharge and admission include hours and minutes, and the number of hours of administrative leave (i.e. periods during which the patient is allowed to leave the hospital; only periods of ≥8 h are taken into account) is rounded to the lowest value. Calculations are made using hours as the primary unit and the values were provided to us by the hospital administration. According to the guidelines, only LOS of at least 24h can be considered as hospital treatment; thus, our inclusion criteria included a minimum stay of 24h.

Contrary to other studies that used DRG costs [13-15], total cost was defined as the actual costs. The cost of each patient's expenditures was extracted from the hospital billing system; this system considers costs related to anesthesia, surgery (including occupation of surgical wards), imagiology (X-rays, MRI, echography), clinical chemistry, pathology, ICU-related costs, medical care, external consultations (i.e. a specialist outside the internal medicine ward who is asked to examine the patient), administrative tasks, food (no-therapeutical), blood products (i.e. transfusions), drugs (including enteral and parenteral nutrition), medical material (catheters,…), transport, etc. Summation of all the costs was done to estimate the actual cost of patient care.

Due to anonymization constraints, only month and year of admission and discharge were available; hence, it was not possible to calculate readmissions within 30 days after discharge as two admissions occurring in the same month could not be sorted.

Statistical analysis

Statistical analyses were performed using Stata version 14 for windows (Stata Corp, College Station, Texas, USA). Descriptive results were expressed as number of participants

(percentage) or as mean ± standard deviation (SD). Bivariate analyses were performed using chi-square or Fisher's exact test for qualitative variables and Student's t-test, analysis of variance or Kruskal-Wallis test for quantitative variables. Multivariate analysis was performed using logistic regression including sex, age, year, coming from home and main diagnosis in the model; the results were expressed as odds ratio (OR) and 95% confidence interval (CI). Statistical significance was assessed for a two-sided test with $p<0.05$.

Ethics

The study was approved by the Ethics Commission of Canton Vaud (www.cer-vd.ch, decision 428-14, of Dec 2, 2014) and by the CHUV board of directors (decision of Dec. 5, 2014). Only routinely collected data was used. Patients were not asked to provide informed written consent and no intervention was performed. All information was extracted and anonymized before being handled for analysis.

RESULTS

Study population

Overall, data from 8541 hospitalizations was analyzed. In 2013, the mean age was 72.7±16.4 years and 50% were women, and in 2014 the mean age was 73.0±16.6 years and 50.7% were women. The main characteristics, prevalence and determinants of nutrition screening and being nutritionally 'at-risk' are summarized in **Table 1**.

Nutritional risk screening

Between 2013 and 2014, total nutrition risk screening increased from 670/4077 (16.5%) to 1869/4464 (41.9%) of hospitalizations (p-value<0.001). While in 2013 no consistent

differences were found regarding patients screened and not screened except for older age, in 2014 screening was significantly higher among women and patients aged ≥80 years. Prevalence of screening was at least 12.2% in all disease categories in 2013, and this value increased to 31.9% in 2014 (**Figure 1**). Patients discharged with cancer or disease of the circulatory system had a higher prevalence of screening, but no difference was found regarding prevalence of screening according to main diagnosis categories between 2013 and 2014 (**Table 1**).

Multivariate analysis showed that patients aged ≥ 80 years or coming from home had higher likelihood to be screened [Odds ratio (95% CI): 1.81 (1.56; 2.10) and 1.30 (1.07; 1.58), respectively]. Compared to patients with a main diagnosis of cancer, patients with pneumonia, disease of digestive, genitourinary or blood systems had lower odds of screening [Odds ratio (95% CI): 0.96 (0.75; 1.24); 0.70 (0.55; 0.88); 0.68 (0.51; 0.91); 0.62 (0.44; 0.88), respectively], while no difference was found for the other diseases (**Figure 1**).

Nutritional status on admission and its determinants

The implementation of the screening procedure resulted in a 2.7 fold increase in the number of patients ‘at-risk’ in year 2014 compared to 2013; conversely, the prevalence of ‘at-risk’ patients remained stable: 433/670 (64.6%) in 2013 and 1172/1869 (62.7%) in 2014 (**Table 1**). Prevalence of ‘at-risk’ patients was highest in patients with cancer (85.3% in 2013 and 70.2% in 2014) and lowest in patients with disease of skin (42% in 2013 and 44.8% in 2014).

Multivariate analysis showed that women and patients aged ≥80 years had a higher likelihood of being nutritionally ‘at-risk’ [Odds ratio (95% CI): 1.23 (1.02; 1.48); 4.67 (3.57; 6.09), respectively] while patients who came from home had lower odds of being nutritionally

182 'at-risk': 0.52 (0.35; 0.76); compared to patients with cancer, patients discharged with another
183 diagnosis had a lower odds of being nutritionally 'at-risk' (**Figure 2**).

184 *Nutritional managements among patients at risk*

185 Fewer than half of the patients considered as nutritionally 'at-risk' received at least one
186 type of nutritional management (46.9% in 2013 and 40.3% in 2014, p-value<0.05). Also,
187 approximately one in six of the patients considered 'not at-risk' received at least one type of
188 nutritional management (13.5% in 2013 and 16.3% in 2014, **Table 2**). The most frequent
189 management was EN, followed by dietary regimen alone and PN. There were no significant
190 differences between year 2013 and 2014 regarding dietary regimen and PN, but prevalence of
191 EN decreased significantly in 2014 compared to 2013 (**Table 2**).

192 *Impact on in-hospital mortality, length of stay and costs*

193 The impact of being nutritionally 'at-risk' on in-hospital mortality, LOS and costs is
194 summarized in **Table 3**. In-hospital mortality was higher in patients who were nutritionally 'at-
195 risk' in year 2014 but not in 2013. Multivariate analysis confirmed those findings: in 2014,
196 patients 'at-risk' of undernutrition had a 3.7-fold higher risk of dying than patients 'not at-risk'.

197 Patients 'at-risk' had a longer LOS than patients 'not at-risk' in 2013 and 2014, but this
198 difference was no longer significant after multivariate adjustment. Similarly, after multivariate
199 adjustment, the likelihood of being above the 90^{th} percentile of LOS did not differ between 'at-
200 risk' and 'not at-risk' patients (**Table 3**).

201 Patients 'at-risk' had higher healthcare costs compared to patients 'not at-risk' in both
202 years, and these findings were further confirmed after excluding patients whose costs were

higher than 100,000 CHF: compared to ‘not at-risk’ patients, ‘at-risk’ patients had an excess cost of 5642.25±1479.8 CHF in 2013 and 5529.52±847.02 CHF in 2014.

DISCUSSION

This study showed that nutrition screening improved between 2013 and 2014 in the department of internal medicine of the CHUV; however, nutritional management is not totally covered yet. Patients nutritionally ‘at-risk’ have higher in-hospital mortality and hospitalization costs than patients ‘not at-risk’, while no differences were found for LOS.

Nutritional risk screening

Nutritional risk screening more than doubled between 2013 and 2014. Still, in 2014, screening was performed in less than half of admitted patients, in contrast with the generally accepted standards and guidelines [1]. Nevertheless, the 42% screening rate observed in 2014 is in line with the NutritionDay study which reported a 43% screening rate in western European countries (including Switzerland) [4] and with a cross-sectional multicenter study which reported a 40.3% screening rate in the Netherlands [16]. Further, according to one study conducted in Scandinavia, nutrition screening rates were as low as 40% in Denmark, 21% Sweden and 16% in Norway [17]. Possible explanations for this low screening rate are lack of sufficient nutrition-related education, clearly defined responsibilities and time of the medical team [18], and it would be of interested to replicate this study in the forthcoming years in order to confirm if the observed increase in screening has been maintained. As being nutritionally ‘at-risk’ is highly prevalent and commonly under-recognized and/or under-treated, universal screening is paramount among in-hospital patients at admission.

Nutritional status on admission and its determinants

Three in every five screened patients were ‘at-risk’ (64.6% in 2013 and 62.7% in 2014), a finding in agreement with previous studies [2, 3] but higher than other studies conducted in Switzerland (18.2% and 27.8%) [11, 19], Brazil (48.1%) [20] or Denmark (23%) [21]. Several explanations might be put forward for the higher prevalence observed in this study; first, the CHUV guideline regarding nutrition risk screening emphasizes screening of high risk patients (i.e. patients with heart failure or respiratory failure), leading to a positive selection bias; second, patients in our study were older (72.8±16.5 years) than those included in the Brazilian study (51.3±18.0 years) and it has been shown that risk of being nutritionally ‘at-risk’ increases with age [11, 22-24].

The prevalence of being nutritionally ‘at-risk’ was highest among patients with cancer or pulmonary disease, in accordance with another study where cancer patients had an almost three-fold higher undernutrition rate than non-cancer patients [20]. Importantly, prevalence of being nutritionally ‘at-risk’ was above 10% in all main diagnosis categories, which is in line with the results reported by one Norwegian [25] and one multicenter [3] studies. Thus, our results strengthen the recommendation that nutritional risk screening should be performed in all hospitalized patients, as the prevalence of ‘at-risk’ status is high irrespective of the main diagnosis considered. Still, in the absence of adequate screening capacities, focusing on patients with cancer, COPD and endocrine, nutritional and metabolic diseases might be an option.

Nutritional managements

Evidence shows that management of undernourished or nutritionally ‘at-risk’ patients should be initiated immediately to improve clinical outcomes [6]. In this study, less than half of

246 the nutritionally ‘at-risk’ patients received at least one type of nutritional managements during
247 their hospitalization. Still, this low management rate is in accordance with two observational
248 multicenter studies conducted in the Netherlands [21] and Denmark [16], where fewer than half
249 of all ‘at-risk’ patients received nutritional managements. Further, the management rates
250 observed in our study are higher than in Brazil (10.1% of patients on EN) [20], the Netherlands
251 (27.9% of patients receiving ONS) [26] or Switzerland (23.2% of patients receiving a nutritional
252 management) [19]. Overall, our results suggest that, despite being far from optimal, the
253 nutritional management rates among ‘at-risk’ patients observed in this study are comparable or
254 even slightly better than reported in the literature; notwithstanding, improvements should be
255 made so that all ‘at-risk’ patients might benefit from an adequate nutritional management.
256 Finally, the fact that the proportion of ‘at-risk’ patients benefiting from nutritional managements
257 decreased from 46.9% in 2013 to 40.3% in 2014 is of concern and should be monitored in future
258 studies.

259 *Impact on in-hospital mortality, length of stay and costs*

260 Being nutritionally ‘at-risk’ significantly increased in-hospital mortality, a finding in line
261 with other studies [3, 19, 21] which shows the importance of adequate management of such
262 patients in order to reduce fatal events.

263 On bivariate analysis, ‘at-risk’ patients showed a significant higher LOS than ‘not at-risk’
264 patients, a finding also in accordance with previous studies [3, 5, 21]. One study conducted in
265 Switzerland reported a two-fold increase in LOS among undernourished patients compared to
266 well-nourished patients (10.2±16.0 vs. 5.1±8.2 days, respectively) [27], and another Swiss study
267 reported a stepwise increase in LOS from 6 days among patients with NRS-2002<3 to 10 days
268 among patients with NRS-2002≥3 [19]. Conversely, after multivariate adjustment, no significant

association was found between nutritional risk status and LOS, although LOS tended to be one day higher among ‘at-risk’ compared to ‘not at-risk’ patients. Although significant association between being nutritionally ‘at-risk’ and increased LOS has been reported by several studies [3, 5, 21], most of these studies were not adjusted for possible confounding factors such as age, sex, social factors such as living alone or lack of social/family support, and main diagnosis category, which could explain the weaker association in our study.

After excluding extreme expenditures, being nutritionally ‘at-risk’ was associated with approximately 5500 CHF (€ 5085 as of December 2015) higher actual healthcare costs, which is consistent with our previous review where being undernourished led to an additional cost ranging between 1640 € and 5829 € [5]. In addition, another study also showed that early nutrition therapy for ‘at-risk’ patients is highly cost-effective compared to delayed nutrition therapy [28]. As LOS did not differ significantly between ‘at-risk’ and ‘not at-risk’ groups, it is unlikely that these extra costs are solely due to an increase in LOS. Thus, it will be of interest to further assess the different types of health expenditures (i.e. related to treatments, X-rays, nutritional support…) among nutritionally ‘at-risk’ patients in Switzerland.

Overall, our results indicate that the increase in nutritional screening which occurred between 2013 and 2014 at the department of internal medicine of the CHUV was not followed by a similar improvement in nutritional. Thus, future actions should aim at improving nutritional management of nutritionally ‘at-risk’ patients, by issuing institutional guidelines and by implementing a more thorough training and collaboration between doctors, nurses and dieticians. Automatic notifications to the department of clinical nutrition of the presence of an ‘at-risk’ patient could also be implemented, so that a better quantification of the resources used/needed to manage in-hospital malnutrition and their impact on health outcomes and cost can be performed.

Moreover, future studies should allow a better characterization of the costs specifically associated with being nutritionally 'at-risk'.

Strengths and limitations

This study was built on real-life data from the CHUV; namely, all adult hospitalizations occurring in years 2013 and 2014 were included and costs were evaluated based on actual expenditures and not on DRG-related codes.

Some limitations should also be acknowledged. First, there is no standard procedure regarding nutritional screening for all hospitals in Switzerland, so these findings might not be applicable in other hospitals. Still, our results provided a baseline frame for further comparisons. Second, the analysis was limited to a single department, and it is possible that nutritional screening might be performed differently in other departments. Still, some studies also rely on data from single departments [26, 29, 30]. Finally, due to the selection process in the hospital guideline, a possible selection bias might occur, i.e. diagnoses with a high prevalence of 'at-risk' patients (such as heart failure and COPD) being selected. Although this procedure might increase the prevalence of patients 'at-risk', it would not influence neither their management nor the effect of being 'at-risk' on outcomes.

Conclusion

Between 2013 and 2014, the increase in nutritional risk screening at the department of internal medicine was not followed by a similar increase in nutritional management of 'at-risk' patients. Being nutritionally 'at-risk' affects three in every five patients and is associated with increased mortality and hospitalization costs. Implementation of adequate nutritional care and evaluation of its impact on health outcomes and expenditures are needed.

CONFLICT OF INTEREST

None of the authors has a conflict of interest.

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Table 1. Number and main characteristics of all hospitalizations (eligible), hospitalizations where nutritional risk screening was performed (screened) and hospitalizations with a positive ('at-risk') nutritional screening, department of internal medicine of the CHUV, 2013 and 2014.

	Eligible			Screened (yes)			At-risk (yes)		
	2013	**2014**	**p-value**	**2013**	**2014**	**p-value**	**2013**	**2014**	**p-value**
N	4077	4464		670	1869	<0.001	433	1172	0.37
Women	2037 (49.9)	2264 (50.7)	0.48	328 (49.0)	1019 (54.5)	<0.05	232 (53.6)	672 (57.3)	0.17
Age categories									
18-59	809 (19.8)	879 (19.7)	0.23	107 (16.0)	269 (14.4)	<0.05	42 (9.7)	117 (9.1)	0.02
60-79	1544 (37.8)	1620 (36.3)		255 (38.0)	628 (33.6)		162 (37.4)	353 (30.1)	
80+	1724 (42.3)	1965 (44.0)		308 (46.0)	972 (52.0)		229 (52.9)	702 (59.9)	
Living in a couple §	1638 (41.4)	1830 (42.2)	0.48	257 (39.7)	717 (39.2)	0.82	162 (38.5)	422 (36.9)	0.56
Coming from home	3794 (93.1)	4103 (91.9)	<0.05	622 (92.8)	1750 (93.6)	0.47	393 (90.8)	1088 (92.8)	0.16
Main diagnosis									
Cancer	409 (10.0)	505 (11.3)	<0.05	61 (9.1)	225 (12.1)	0.70	52 (12.0)	158 (13.5)	0.85
Infection	330 (8.1)	346 (7.7)		47 (7.0)	137 (7.3)		32 (7.4)	85 (7.3)	
Pulmonary disease	224 (5.5)	266 (6.0)		38 (5.7)	113 (6.1)		26 (6.0)	76 (6.5)	
Pneumonia	397 (9.7)	352 (7.9)		58 (8.6)	129 (6.9)		38 (8.8)	85 (7.3)	
COPD	149 (3.6)	159 (3.5)		19 (2.9)	62 (3.3)		13 (3.0)	40 (3.4)	
Digestive system	361 (8.8)	397 (8.9)		56 (8.4)	130 (7.0)		39 (9.0)	81 (6.9)	
Endocrine, nutritional and metabolic	140 (3.4)	141 (3.2)		21 (3.1)	52 (2.8)		13 (3.0)	36 (3.1)	
Circulatory system	346 (8.5)	367 (8.2)		57 (8.5)	152 (8.1)		26 (6.0)	90 (7.7)	

Ischemic heart disease	126 (3.1)	123 (2.7)	23 (3.4)	57 (3.1)	13 (3.0)	30 (2.5)
Heart Failure	341 (8.4)	334 (7.5)	57 (8.5)	153 (8.2)	39 (9.0)	91 (7.7)
Symptoms, abnormal findings + injury	448 (11.0)	572 (12.8)	90 (13.4)	283 (15.2)	58 (13.4)	171 (14.6)
Genitourinary system	162 (4.0)	199 (4.5)	23 (3.4)	68 (3.65)	17 (3.9)	36 (3.1)
Blood	115 (2.8)	138 (3.1)	14 (2.1)	44 (2.35)	8 (1.8)	27 (2.3)
Nervous system	94 (2.3)	83 (1.8)	20 (3.0)	39 (2.1)	11 (2.5)	24 (2.0)
Skin	55 (1.3)	64 (1.4)	12 (1.8)	29 (1.6)	5 (1.2)	13 (1.1)
Musculoskeletal system	119 (2.9)	154 (3.5)	20 (3.0)	66 (3.5)	9 (3.0)	44 (3.8)
Rehabilitation	261 (6.4)	264 (5.9)	54 (8.1)	130 (7.0)	34 (7.8)	85 (7.2)

408 COPD, Chronic obstructive pulmonary disease. § 3% of observations had missing data. Results are presented as number of
409 hospitalizations and (column percentage). Between-year comparisons performed by chi-square.

Table 2. Nutrition management of nutritionally ‘not at-risk’ and ‘at-risk’ adult patients in the department of internal medicine of the CHUV, 2013 and 2014.

	2013		2014		p-value
	Not at risk	At-risk	Not at risk	At-risk	At-risk
N (row %)	237 (35.4)	433 (64.6)	697 (37.3)	1172 (62.7)	0.37
Dietary regimen	10 (4.2)	37 (8.6)	19 (2.7)	103 (8.8)	0.87
Enteral nutrition	29 (12.2)	196 (45.3)	106 (15.2)	458 (39.1)	<0.05
Parenteral nutrition	1 (0.4)	4 (0.9)	0 (0)	9 (0.8)	0.75 †
Overall	32 (13.5)	203 (46.9)	114 (16.3)	473 (40.3)	<0.05

‘At-risk’ status defined by a NRS-2002 $\geq$ 3. Results are presented as number of patients and (column percentage). Between-year comparisons by chi-square or Fisher’s exact test (†). Overall number of patients is lower than the sum of all managements due to the fact that several patients received multiple managements (i.e. dietary regimen + enteral nutrition).

Table 3. Impact of being nutritionally 'at-risk' on in-hospital mortality, length of stay and costs for patients admitted in the department of internal medicine of the CHUV, 2013 and 2014.

	2013			2014		
	Not at risk	**At-risk**	**P-value**	**Not at risk**	**At-risk**	**P-value**
N	228	402		685	1084	
In-hospital mortality						
Bivariate	9 (3.8)	31 (7.2)	0.08	12 (1.7)	88 (7.5)	0.001
Multivariate, OR (95% CI) §	1 (ref.)	1.57 (0.65 - 3.79)	0.30	1 (ref.)	3.67 (1.91 - 7.03)	0.001
Length of stay (days)						
Bivariate, mean ± SD	12.9 ± 9.8	16.0 ± 13.6	0.01	13.3 ± 10.2	16.7 ± 14.3	0.001
Multivariate, mean ± SE §	14.1 ± 0.9	15.2 ± 0.6	0.319	14.8 ± 0.5	15.6 ± 0.4	0.155
LOS>90th percentile						
Bivariate	23 (9.7)	56 (12.9)	0.215	68 (9.75)	186 (15.9)	0.001
Multivariate, OR (95% CI) §	1 (ref.)	0.86 (0.46 - 1.61)	0.64	1 (ref.)	1.13 (0.80 - 1.60)	0.50
Actual costs (CHF)						
Bivariate, mean ± SD	20,707.7 ± 17,433.4	31,300.5 ± 39,597.8	0.001†	23,535.0 ± 24,754.9	33,649.1 ± 51,594.7	0.001†
Multivariate, mean ± SE §	19,672.7 ± 2313.0	31,566.3 ± 1656.3	0.001	21,670.3 ± 1681.2	34,419.3 ± 1282.85	0.001
Actual costs (CHF) (< 100,000)						
Bivariate, mean ± SD	20,006.1 ± 13,785.5	25,726.2 ± 18,206.2	0.001†	20,541.2 ± 14,355.0	25,868.7 ± 18,683.5	0.001†
Multivariate, mean ± SE §	19,888.8 ± 1154.7	25,531 ± 839.4	0.001	20,291.8 ± 656.2	25,821.3 ± 505.8	0.001

NRS-2002, nutrition risk screening 2002; CI, confidence interval; SD, standard deviation; SE, standard error. 'At-risk' status defined by a NRS-2002 $\geq$ 3. § adjusting for year, sex, marital status and main disease categories. Statistical analysis by chi-square and logistic

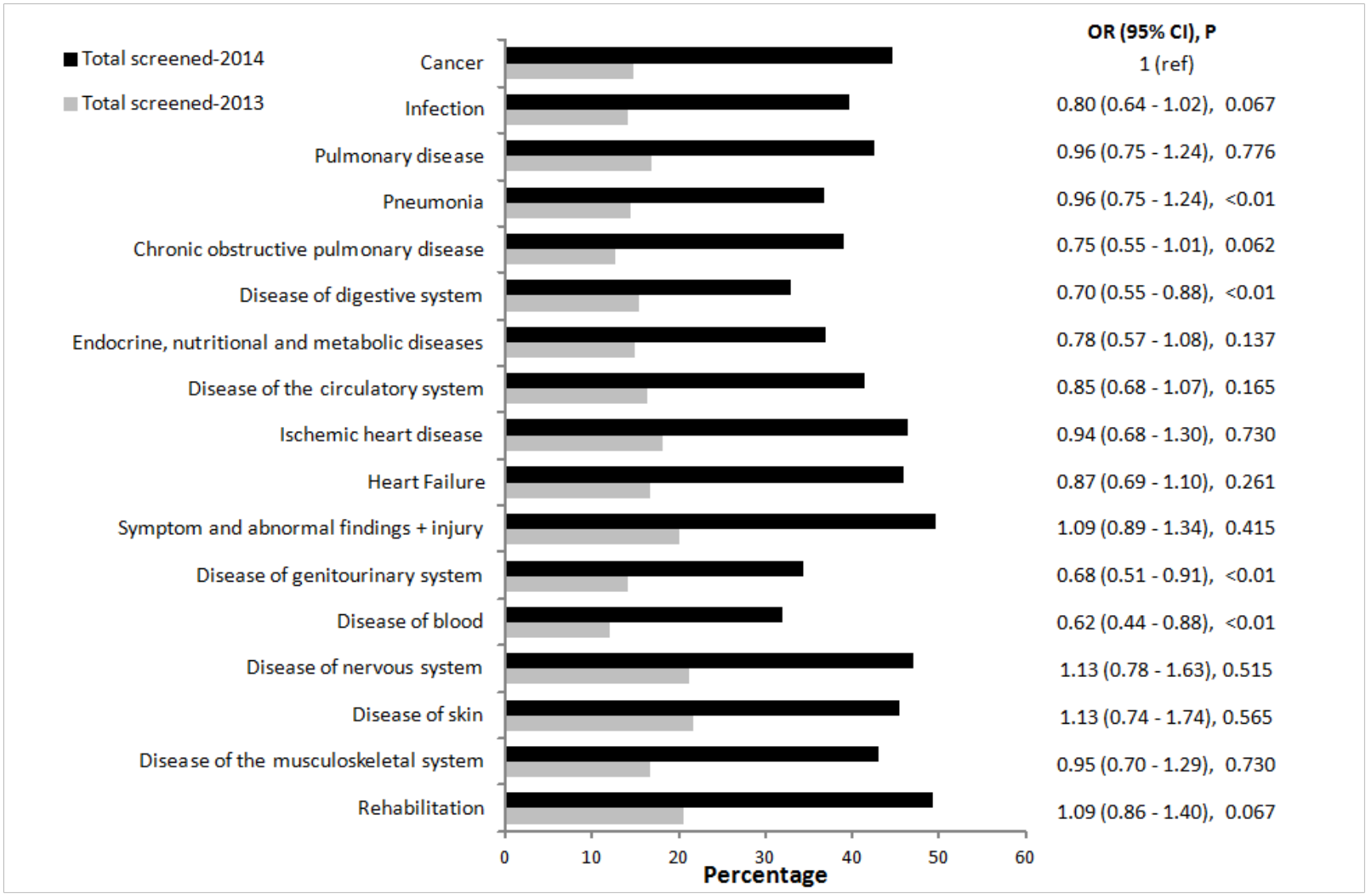
regression for in-hospital mortality and LOS>90th percentile, and by Kruskall-Wallis (†) or analysis of variance for length of stay and actual costs.

Figure legends

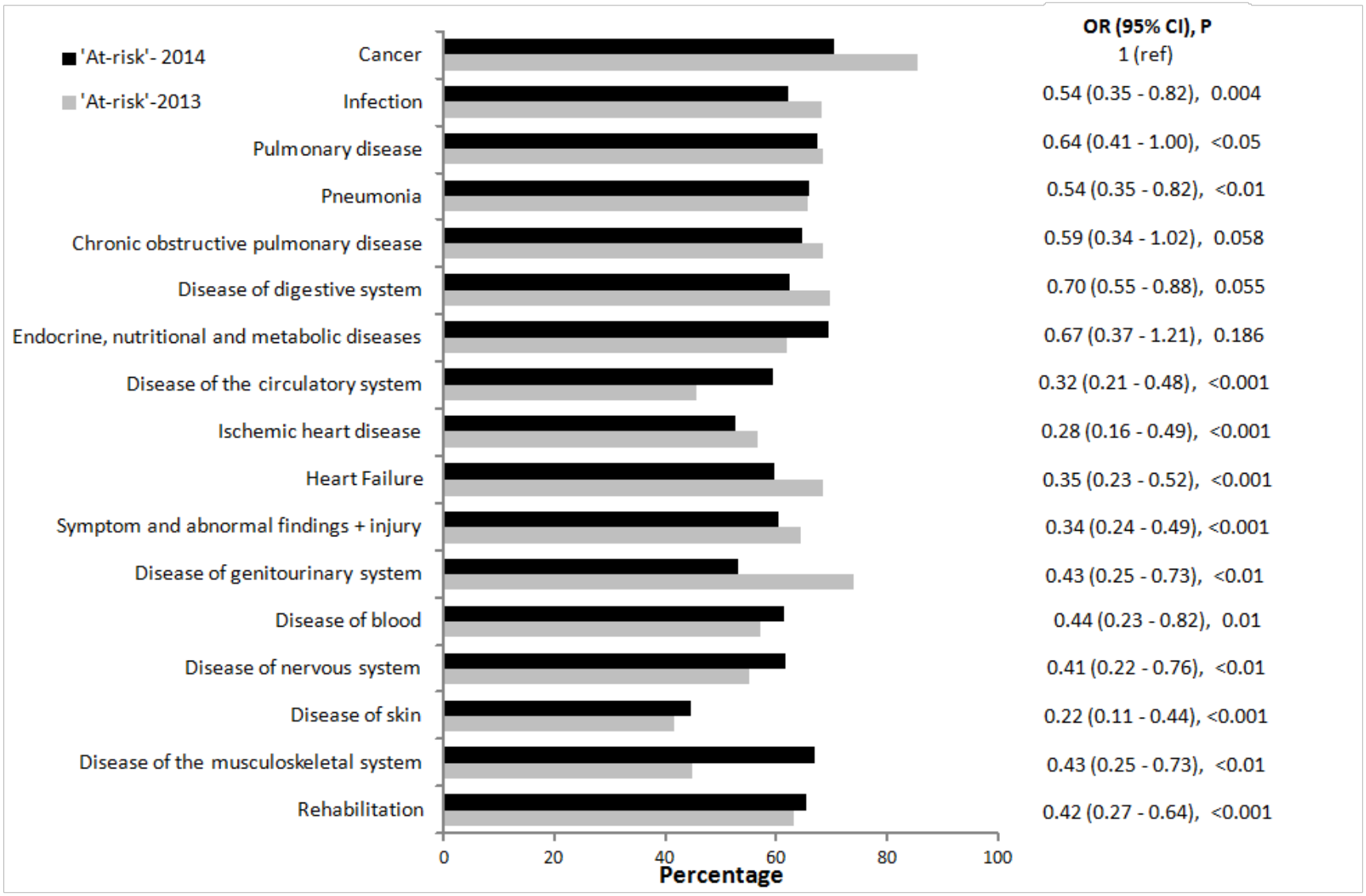
Figure 1. Prevalence of nutrition screening among adult patients hospitalized in the department of internal medicine of the CHUV for years 2013 and 2014. Results are shown according to the main disease at discharge and expressed as percentage and as multivariate-adjusted (sex, age, year and coming from home or elsewhere) Odds ratio (OR) and 95% confidence interval (CI). P, p-value testing the OR against unity.

Figure 2. Prevalence of being nutritionally 'at-risk' among adult patients hospitalized in the department of internal medicine of the CHUV for years 2013 and 2014. Results are shown according to the main disease at discharge and expressed as percentage of screened patients and as multivariate-adjusted (sex, age, year and coming from home or elsewhere) Odds ratio (OR) and 95% confidence interval (CI). P, p-value testing the OR against unity.

Figure 1


Total screened-2014
Total screened-2013
Cancer
Infection
Pulmonary disease
Pneumonia
Chronic obstructive pulmonary disease
Disease of digestive system
Endocrine, nutritional and metabolic diseases
Disease of the circulatory system
Ischemic heart disease
Heart Failure
Symptom and abnormal findings + injury
Disease of genitourinary system
Disease of blood
Disease of nervous system
Disease of skin
Disease of the musculoskeletal system
Rehabilitation
OR (95% CI), P
1 (ref)
0.80 (0.64 - 1.02), 0.067
0.96 (0.75 - 1.24), 0.776
0.96 (0.75 - 1.24), <0.01
0.75 (0.55 - 1.01), 0.062
0.70 (0.55 - 0.88), <0.01
0.78 (0.57 - 1.08), 0.137
0.85 (0.68 - 1.07), 0.165
0.94 (0.68 - 1.30), 0.730
0.87 (0.69 - 1.10), 0.261
1.09 (0.89 - 1.34), 0.415
0.68 (0.51 - 0.91), <0.01
0.62 (0.44 - 0.88), <0.01
1.13 (0.78 - 1.63), 0.515
1.13 (0.74 - 1.74), 0.565
0.95 (0.70 - 1.29), 0.730
1.09 (0.86 - 1.40), 0.067
0
10
20
30
40
50
60
Percentage

433 **Figure 2.**



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Supplementary Table 1: 10th International Classification of Diseases and related health problems (ICD-10) codes used.

Main diagnosis	ICD-10 codes
Cancer	C00-D09
Infection	A00-B00
Pulmonary disease	J00-J99
Pneumonia	J12-18
Chronic obstructive pulmonary	J40-J47
Disease of digestive system	K00-K93
Endocrine, Nutritional and metabolic diseases	E00-E90
Disease of the circulatory system	I00-I99
Ischemic heart disease	I20-I25
Heart Failure	I50
Symptom and abnormal findings + injury	R00-R99; S00-S99
Disease of genitourinary system	N00-N99
Disease of blood	D50-D89
Disease of nervous system	G00-G99
Disease of skin	L00-L99
Disease of the musculoskeletal	M00-M99
Rehabilitation	Z50.80-Z50.89