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

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23

24 **ABSTRACT**

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

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

34 **Results:** Screening increased from 16.5% in 2013 to 41.9% in 2014 ($p < 0.001$), while prevalence
35 of ‘at-risk’ patients remained stable (64.6% in 2013 and 62.7% in 2014, $p = 0.37$). Prevalence of
36 ‘at-risk’ patients was highest in patients with cancer (85.3% in 2013 and 70.2% in 2014) and
37 lowest in patients with disease of skin (42% in 2013 and 44.8% in 2014). Less than half of
38 patients ‘at-risk’ received any nutritional management, and this value decreased between 2013
39 and 2014 (46.9% vs. 40.3%, $p < 0.05$). After multivariate adjustment, ‘at-risk’ patients had a 3.7-
40 fold (95% confidence interval: 1.91; 7.03) higher in-hospital mortality and higher costs (excess
41 5642.25 ± 1479.80 CHF in 2013 and 5529.52 ± 847.02 CHF in 2014, $p < 0.001$) than ‘not at-risk’
42 patients, while no difference was found for LOS.

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

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

48

49 INTRODUCTION

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

63 Switzerland is a small European country with one of the best health systems in the world
64 [10]. Still, screening for nutritionally ‘at-risk’ patients has been unevenly implemented in
65 hospitals and there is little information regarding prevalence, determinants, management and
66 impact on health outcomes and cost of undernutrition [11]. Such information is important for the
67 adequate management of hospital resources, both in Switzerland and similar countries.

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

72 **METHODS**

73 *Data collection*

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

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

83 *Nutritional risk screening and data collection procedure*

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

91 The 'nutritional score' is defined by adequacy of dietary intake due to three different
92 parameters 1) quartile decreased of estimated oral food intake requirements, 2) presence of $\geq 5\%$
93 weight loss within the previous 1 to 3 months and 3) low body mass index (<18.5 kg/m²). 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

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

119
$$[\text{date of discharge} - \text{date of admission}] / 24 - \text{hours of administrative leave} / 24.$$

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

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

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

137 *Statistical analysis*

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

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

146 *Ethics*

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

152 **RESULTS**

153 *Study population*

154 Overall, data from 8541 hospitalizations was analyzed. In 2013, the mean age was
155 72.7 ± 16.4 years and 50% were women, and in 2014 the mean age was 73.0 ± 16.6 years and
156 50.7% were women. The main characteristics, prevalence and determinants of nutrition
157 screening and being nutritionally 'at-risk' are summarized in **Table 1**.

158 *Nutritional risk screening*

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

161 differences were found regarding patients screened and not screened except for older age, in
162 2014 screening was significantly higher among women and patients aged ≥ 80 years. Prevalence
163 of screening was at least 12.2% in all disease categories in 2013, and this value increased to
164 31.9% in 2014 (**Figure 1**). Patients discharged with cancer or disease of the circulatory system
165 had a higher prevalence of screening, but no difference was found regarding prevalence of
166 screening according to main diagnosis categories between 2013 and 2014 (**Table 1**).

167 Multivariate analysis showed that patients aged ≥ 80 years or coming from home had
168 higher likelihood to be screened [Odds ratio (95% CI): 1.81 (1.56; 2.10) and 1.30 (1.07; 1.58),
169 respectively]. Compared to patients with a main diagnosis of cancer, patients with pneumonia,
170 disease of digestive, genitourinary or blood systems had lower odds of screening [Odds ratio
171 (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],
172 while no difference was found for the other diseases (**Figure 1**).

173 *Nutritional status on admission and its determinants*

174 The implementation of the screening procedure resulted in a 2.7 fold increase in the
175 number of patients ‘at-risk’ in year 2014 compared to 2013; conversely, the prevalence of ‘at-
176 risk’ patients remained stable: 433/670 (64.6%) in 2013 and 1172/1869 (62.7%) in 2014 (**Table**
177 **1**). Prevalence of ‘at-risk’ patients was highest in patients with cancer (85.3% in 2013 and 70.2%
178 in 2014) and lowest in patients with disease of skin (42% in 2013 and 44.8% in 2014).

179 Multivariate analysis showed that women and patients aged ≥ 80 years had a higher
180 likelihood of being nutritionally ‘at-risk’ [Odds ratio (95% CI): 1.23 (1.02; 1.48); 4.67 (3.57;
181 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 90th 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

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

205 **DISCUSSION**

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

210 *Nutritional risk screening*

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

224 *Nutritional status on admission and its determinants*

225 Three in every five screened patients were ‘at-risk’ (64.6% in 2013 and 62.7% in 2014), a
226 finding in agreement with previous studies [2, 3] but higher than other studies conducted in
227 Switzerland (18.2% and 27.8%) [11, 19], Brazil (48.1%) [20] or Denmark (23%) [21]. Several
228 explanations might be put forward for the higher prevalence observed in this study; first, the
229 CHUV guideline regarding nutrition risk screening emphasizes screening of high risk patients
230 (i.e. patients with heart failure or respiratory failure), leading to a positive selection bias; second,
231 patients in our study were older (72.8 ± 16.5 years) than those included in the Brazilian study
232 (51.3 ± 18.0 years) and it has been shown that risk of being nutritionally ‘at-risk’ increases with
233 age [11, 22-24].

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

243 *Nutritional managements*

244 Evidence shows that management of undernourished or nutritionally ‘at-risk’ patients
245 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

269 association was found between nutritional risk status and LOS, although LOS tended to be one
270 day higher among ‘at-risk’ compared to ‘not at-risk’ patients. Although significant association
271 between being nutritionally ‘at-risk’ and increased LOS has been reported by several studies [3,
272 5, 21], most of these studies were not adjusted for possible confounding factors such as age, sex,
273 social factors such as living alone or lack of social/family support, and main diagnosis category,
274 which could explain the weaker association in our study.

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

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

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

294 *Strengths and limitations*

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

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

308 *Conclusion*

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

314 **CONFLICT OF INTEREST**

315 None of the authors has a conflict of interest.

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405 **Table 1.** Number and main characteristics of all hospitalizations (eligible), hospitalizations where nutritional risk screening was
 406 performed (screened) and hospitalizations with a positive ('at-risk') nutritional screening, department of internal medicine of the
 407 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.

410 **Table 2.** Nutrition management of nutritionally ‘not at-risk’ and ‘at-risk’ adult patients in the
 411 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

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

416 **Table 3.** Impact of being nutritionally ‘at-risk’ on in-hospital mortality, length of stay and costs for patients admitted in the
 417 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

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

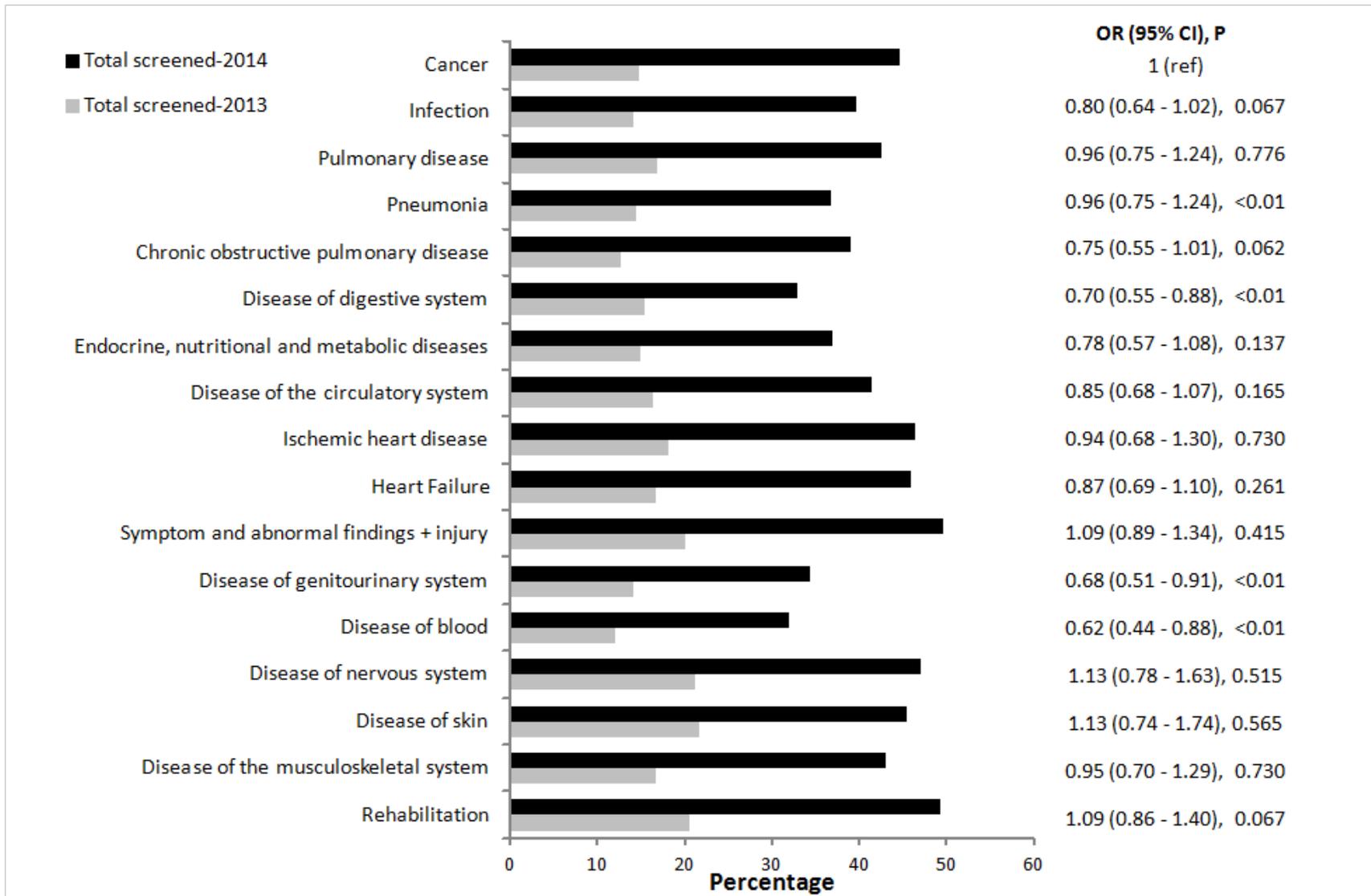
420 regression for in-hospital mortality and LOS>90th percentile, and by Kruskal-Wallis (†) or analysis of variance for length of stay and
421 actual costs.

422 **Figure legends**

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

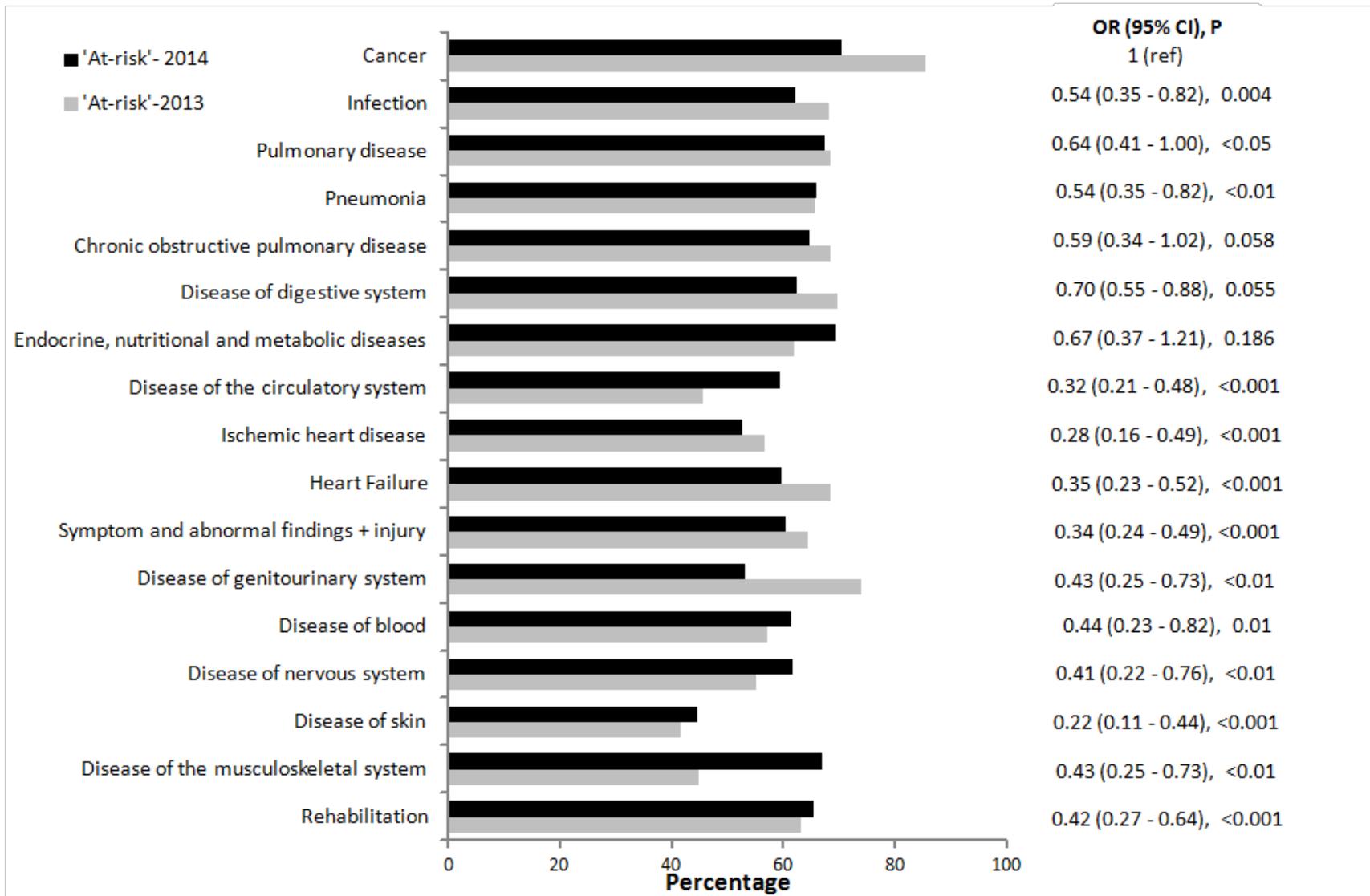
427 **Figure 2.** Prevalence of being nutritionally ‘at-risk’ among adult patients hospitalized in the department of internal medicine of the
428 CHUV for years 2013 and 2014. Results are shown according to the main disease at discharge and expressed as percentage of
429 screened patients and as multivariate-adjusted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

431 **Figure 1**



432

433 **Figure 2.**



434

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