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Original article

Impact of nutritional status on surgical patients

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SUMMARY

Objective: This study aimed to compare cost and length of hospital stay of malnourished and well-nourished surgical patients.
Methods: A total of 6821 surgical patients were enrolled from January to December 2014 and were divided into 11 groups according to their disease diagnosis: soft tissue; upper gastrointestinal tract; colorectal; hepato-pancreato-biliary; vascular; head-neck breast; urology; cardio-vascular-thoracic surgery; neurology; plastic surgery; and trauma. The patients in each group were categorized as having either malignant or benign disease. All patients received nutritional screening and subjective global assessment, and details of length of hospital stay and cost were collected and analyzed.
Results: There were 4052 benign and 2769 malignant cases. In the benign category, patients with malnutrition in all subdivisions had longer hospital stays than those who were well-nourished. Significantly longer hospital stay was found in hepato-pancreato-biliary, neurology and cardio-vascular-thoracic surgery ($p < 0.01$, $p = 0.01$, $p < 0.001$). Hospital cost was also higher in malnourished patients in all subdivisions, and the differences were significant in the hepato-pancreato-biliary, upper gastrointestinal tract, colorectal, soft tissue, urology and head-neck-breast groups ($p < 0.001$, $p = 0.01$, $p = 0.01$, $p = 0.03$, $p < 0.01$, $p < 0.01$). In the malignant category, patients in all groups with malnutrition had longer hospital stay than those who were well nourished. Significantly longer hospital stay was found in the hepato-pancreato-biliary, upper gastrointestinal tract, colorectal, urology and neurology groups ($p < 0.001$, $p < 0.001$, $p < 0.001$, $p < 0.001$, $p < 0.001$). Hospital cost was also higher with malnourished patients in all groups and significant differences were found in the hepato-pancreato-biliary, upper gastrointestinal tract, colorectal, urology, head-neck-breast and cardio-vascular-thoracic surgery groups ($p < 0.001$, $p < 0.001$, $p < 0.001$, $p < 0.01$, $p < 0.01$, and $p = 0.02$).
Conclusion: Malnourished patients, both with benign and malignant disease, incurred higher costs and had longer hospital stays.

1. Introduction

Insufficient nutrient intake, impaired absorption or loss of nutrients due to illness or trauma, aging, poor socioeconomic situations, surgical procedures, or increased metabolic demands during illness can lead to malnutrition in hospital [1]. Its prevalence is between 15% and 70%, varying with population, institution type, and assessment method [2–4]. The prevalence of hospital malnutrition in Asia is between 27% and 39% [5,6] with a higher incidence in older adults (88%) [7] and surgical patients (56%) [8]. Malnutrition can trigger adverse consequences such as increased morbidity and mortality rates [9], as well as greater length of hospital stay and higher cost [10]. Studies in Portugal and Singapore showed that patients at risk of undernutrition incurred a 19–24% higher hospital cost than those who did not have this condition [5,11]. Although malnutrition has both clinical and economic impacts, there is still a generally low level of awareness of this problem [2]. Nutritional assessment and therapy should be carried out on patients in order to reduce their rates of morbidity and mortality, their hospital cost and duration of stay. Many tools are used to assess nutritional status, and although there is no standard evaluation method, SGA is recommended for clinical outcome predictions [12,13]. Currently, most countries acknowledge that hospital malnutrition is an

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important problem, but studies of cost data and population records are rare in Asian countries; therefore, this study aimed to determine the prevalence of malnutrition in hospitalized surgical patients in super tertiary hospitals under the Ministry of Public Health. The study's secondary objective was to compare both cost and length of hospital stay for malnourished and well-nourished patients.

2. Materials and methods

This retrospective study was approved by the Rajavithi Hospital ethics committee. Informed consent was waived, as there was no intervention, and basic medical history was collected without patient identification. The medical records were reviewed of all surgical patients hospitalized between 1st January and 31st December 2014. Exclusion criteria were patients with did not have complete nutritional screening and assessment data within 72 h of admission, or who had no main diagnosis. Nutritional screening was conducted by a specially pre-trained nurse using a Malnutrition Universal Screening Tool (MUST) [14], and patients with MUST score>2 received further more detailed nutritional assessment with a Subjective Global Assessment (SGA) [15]. In accordance with our hospital protocol for nutrition therapy, SGA classified patients as well-nourished, having mild-moderate malnutrition, or suffering from severe malnutrition. SGA was selected as an assessment tool because it has good prognostic value for clinical outcomes [10].

In this study, patients with mild-moderate or severe malnutrition were defined as having malnutrition. The eligible patients were categorized into 11 subdivisions according to their principle diagnosis on admission to the surgical division. Patients in each surgical subdivision were further divided into those with benign and malignant disease. Details of length of hospital stay and total hospital cost were retrieved from the hospital database by the Department of Analytical Accounting, and statistical analysis was carried out with SPSS version 17.0. Sample size, calculated based on our institute's pilot data of prevalence of malnutrition in hospitalized surgical patients, was 30% with type I error probability of 0.05. This study required a minimum of 3586 cases. Continuous variables were expressed as mean ± sd, median (min–max), and percentage. Comparisons of groups were analyzed using student's t-test or Mann–Whitney's rank-sum test, and Chi-squared test was used for categorical variables. Statistical significance for a two-sided test was set at $p < 0.05$.

3. Results

Of a total of 7643 patients who were admitted to the surgical department in 2014, only 6821 (89.2%) underwent nutritional screening and assessment. The prevalence of malnutrition in these hospitalized surgical patients was 18.5%. Demographic data is shown in (Table 1). Body mass index and serum albumin levels were significantly lower in the malnutrition group. The proportion of malignant patients with malnutrition was significantly higher than that of benign patients in the surgical division of UGI, HPB and Colorectal (Table 2). Regarding length of hospital stay, our data showed a trend towards longer hospital stay in both benign and malignant patients with malnutrition in all surgical divisions; furthermore, significantly greater length of hospital stay was found in malignant patients with malnutrition in the UGI, colorectal, HPB, neurology, and urology groups, and in benign patients with malnutrition in the HPB, neurology and CVT divisions (Table 3).

Total hospital cost tended to be higher in both benign and malignant patients with malnutrition in all surgical divisions, while significantly higher expense was found in malignant patients with malnutrition in the UGI, HPB, Colorectal, Urology, CVT and Head Neck Breast groups as well as in benign patients with malnutrition in the UGI, HPB, Colorectal, Urology, Skin and soft tissue, and Head neck breast divisions (Table 4).

4. Discussion

Malnutrition, which is common in hospitals, is caused by nutritional consumption deficiency or imbalance compared with its requirements. Malnutrition also leads to detrimental outcomes, increased healthcare costs, and more comorbidities [16,17]; therefore, guidelines for nutritional screening and assessment have been established. MUST is used for screening risk of undernutrition in hospital [14] and is recommended by the British Association for Parenteral and Enteral Nutrition; in contrast, the European Society of Clinical Nutrition and Metabolism uses Nutritional Risk Screening (NRS 2002) for this purpose [18]. Many studies have demonstrated that SGA is able to indicate malnutrition-associated risks of poor outcomes [19]; therefore, our study used MUST for nutritional screening and SGA for nutritional assessment. The prevalence of malnutrition in this study was 18.41%, which is lower than that of the study reported by Pham NV et al. (56%) [8]. Research from a similar area in another Asian country, Singapore, indicated that the prevalence of malnutrition was 15%, and this implies that variations in the incidence of malnutrition could result from the use of different nutritional assessment methods and also from the different departments in which patients are hospitalized. The length of hospital stay of malnourished patients is 1.5–1.7 times longer than that of those who are non-malnourished [10,17]. This study showed the same impact of malnutrition on hospital stay particularly in patients with malignant diseases. The PREDyCES study showed that patients who are malnourished on admission tend to have significantly longer hospital stay than those who are not (11.5 ± 7.5 days *vs.* 8.5 ± 5.8 days, $p < 0.001$) [20], which is similar to the findings of our study, {8 (2–120) days *vs* 6 (2–120) days ($p < 0.001$)}. Differences in length of hospital stay translated into higher costs associated with patients malnourished on admission [20]. A variety of scientific evidence shows that patients who are malnourished at

Table 1
Demographic data of hospitalized patients in the surgical department.

Factors	Malnutrition	Well-nourished	p-value
Gender			0.06
Men, n (%)	681 (54.0)	2824 (50.8)	
Women, n (%)	581 (46.0)	2735 (49.2)	
Age (years), (mean ± SD)	53.43 ± 17.13	53.42 ± 16.06	0.98
BMI (kg/m2), (mean ± SD)	18.46 ± 3.23	24.21 ± 4.56	<0.001[a]
Albumin (g/dl), (mean ± SD)	3.77 ± 0.59	3.95 ± 0.53	<0.001[a]
Total lymphocyte count (cells/mm^2), (mean ± SD)	1700 (260–18,900)	1770 (260–18,900)	0.88

[a] Student's t-test: statistical significant $p < 0.05$.

Table 2
Comparison of nutritional status in patients with benign and malignant disease within surgery subdivisions.

Disease		Malnutrition, n (%)	Well-nourished, n (%)	p-value
Upper gastro intestinal (n = 805)	Benign	74 (15.6)	400 (84.4)	<0.01[a]
	Malignant	84 (25.4)	247 (74.6)	
Colorectal (n = 1437)	Benign	118 (14.4)	699 (85.6)	<0.001[a]
	Malignant	165 (26.6)	455 (73.4)	
Hepato pancreato biliary (n = 1505)	Benign	153 (19.6)	629 (80.4)	<0.01[a]
	Malignant	187 (25.9)	536 (74.3)	
Urology (n = 769)	Benign	66 (14.4)	392 (85.6)	0.18
	Malignant	56 (18.0)	255 (82.0)	
Neurology (n = 280)	Benign	28 (15.3)	155 (84.7)	0.36
	Malignant	11 (11.3)	86 (88.7)	
Head, neck, breast (n = 845)	Benign	70 (14.3)	419 (85.7)	0.49
	Malignant	57 (16.0)	299 (84.0)	
Skin and soft tissue (n = 284)	Benign	39 (18.8)	168 (81.2)	0.53
	Malignant	12 (15.6)	65 (84.4)	
Cardio vascular thoracic (n = 631)	Benign	66 (16.8)	327 (83.2)	0.12
	Malignant	29 (12.2)	209 (87.8)	
Vascular (n = 43)	Benign	6 (14.0)	37 (86.1)	N/A[b]
	Malignant	0	0	
Plastic (n = 135)	Benign	23 (19.3)	96 (80.)	0.07
	Malignant	0	16 (100)	
Trauma (n = 87)	Benign	18 (20.7)	69 (79.3)	N/A[b]
	Malignant	0	0	

[a] Chi-squared test:Statistical significant $p < 0.05$.
[b] N/A: Data not available.

Table 3
Length of hospital stay of patients with benign and malignant disease within surgery subdivisions.

Disease		Malnutrition day[a] (min −max)	Well-nourished day[a] (min −max)	p-value
Upper gastro intestinal (n = 805)	Benign	7 (2–46)	6 (2–34)	0.05
	Malignant	10 (3–120)	6 (2–45)	<0.001[b]
Colorectal (n = 1437)	Benign	8 (2–120)	6 (2–120)	0.73
	Malignant	8 (2–61)	6 (2–64)	<0.001[b]
Hepato pancreato biliary (n = 1505)	Benign	7 (3–46)	6 (2–48)	<0.01[b]
	Malignant	8 (3–67)	6 (2–72)	<0.001[b]
Neurology (n = 280)	Benign	8 (3–42)	7 (2–38)	0.01[b]
	Malignant	10 (7–16)	6 (2–21)	<0.001[b]
Urology (n = 769)	Benign	8 (3–33)	6 (2–59)	0.07
	Malignant	8 (2–59)	6 (2–38)	<0.001[b]
Cardio vascular thoracic (n = 631)	Benign	9 (2–72)	6 (2–72)	<0.001[b]
	Malignant	8 (3–38)	6 (2–48)	0.17
Skin and soft tissue (n = 284)	Benign	6 (2–20)	5 (2–46)	0.68
	Malignant	6 (4–11)	5 (2–29)	0.47
Vascular (n = 43)	Benign	10 (5–12)	6 (2–30)	0.42
	Malignant	N/A[c]	N/A[c]	N/A[c]
Head, neck, breast (n = 845)	Benign	7 (3–31)	5 (2–46)	0.09
	Malignant	7 (2–38)	6 (2–31)	0.18
Plastic (n = 135)	Benign	7 (3–10)	6 (2–42)	0.19
	Malignant	N/A[c]	5 (3–15)	N/A[c]
Trauma (n = 87)	Benign	7 (3–19)	6 (3–72)	0.25
	Malignant	N/A[c]	N/A[c]	N/A[c]

[a] Median.
[b] Mann–Whitney test: statistical significant $p < 0.05$.
[c] N/A:Data not available.

admission tend to have higher hospital costs: a study in Singapore showed that malnourished patients' hospital costs were 24% higher than those without malnutrition [5], while another similar study in Portugal indicated that malnourished patients had 121.93% higher hospital costs than non-malnourished patients [11]. It is often argued that length of hospital stay, mortality, and hospitalization costs are primarily determined by the patient's medical condition, and that any association with malnutrition is due to confounding factors [21]; however, a study conducted by Lori Jane Curtis et al. showed that malnutrition affects the patients' hospitalization costs more than any other covariate excluding age and number of diagnoses [22]. The study of Lim SL et al. compared the impact of nutritional status of patients with similar diagnostic related groups (DRG) within the hospital by matching DRG in a case–control design. Each DRG involved a group of patients with similar disease diagnosis and complexity, and it was reported that malnutrition played a role in increasing hospitalization costs and duration [5]. The results of our study are consistent with prior work [22]. Although our study did not compare hospital cost of well–nourished and malnourished patients with similar DRG or

Table 4
Hospital cost of patients with benign and malignant disease within surgery subdivisions.

Disease		Malnutrition, baht[a] (min–max)	Well-nourished,baht[a] (min–max)	p-value
Upper gastro intestinal (n = 805)	Benign	33,917 (5682.3–894,610)	21,994 (1705–64,8576)	0.01
	Malignant	38,685 (6418–618,383)	25,290 (1487–335,617)	<0.001[b]
Colorectal (n = 1437)	Benign	32,788 (5843–919,345)	23,000 (1600–1,824,996)	0.01
	Malignant	46,326.3 (5919–875,466)	23,536 (2154–428,426)	<0.001[b]
Hepato pancreato biliary (n = 1505)	Benign	42,123 (5730–447,017)	25,024 (1250–311,584)	<0.001[b]
	Malignant	42,365 (7210–1,165,109)	25,902 (3100–1,542,088)	<0.001[b]
Neurology (n = 280)	Benign	37,929.5 (4890–218,011)	29,628.8 (1890–492,925)	0.27
	Malignant	43,043 (10,709–799,708)	23,885 (3048–242,440)	0.13
Urology (n = 769)	Benign	33,325 (5237–314,227)	25,098.5 (1108–296,537.3)	<0.01[b]
	Malignant	42,733.3 (5270–474,425)	28,217 (2446–288,234.3)	<0.01[b]
Cardio vascular thoracic (n = 631)	Benign	27,167 (5124–702,120)	29,358.9 (2009–827,133)	0.97
	Malignant	47,961 (7510–305,866.3)	24,889 (1250–338,924)	0.02
Skin and soft tissue (n = 284)	Benign	35,717 (3431–899,837)	20,689 (2558–259,845)	0.03
	Malignant	32,035.5 (7469–424,988.8)	20,952 (2166–112,240)	0.09
Vascular (n = 43)	Benign	95,136.8 (46,024–141,980)	20,392.3 (2445–1,314,048)	0.94
	Malignant	N/A[c]	N/A[c]	N/A[c]
Head, neck, breast (n = 845)	Benign	34,179.5 (5180–152,660)	23,012.5 (1467–284,535)	<0.01[b]
	Malignant	35,588 (4653.75–255,102)	23,873 (2135–244,621)	<0.01[b]
Plastic (n = 135)	Benign	27,411 (11,237–587,564)	26,497.4 (3631–209,939.5)	0.44
	Malignant	N/A[c]	111,901.6 (3521–143,544.3)	N/A[c]
Trauma (n = 87)	Benign	55,596.3 (11,307–193,449.8)	27,007.6 (4215–393,381)	0.09
	Malignant	N/A[c]	N/A[c]	N/A[c]

[a] Thai monetary unit 1 bath = 0.03 us dollar: median.
[b] Mann–Whitney test: statistical significant $p < 0.05$.
[c] N/A:Data not available.

after adjustment for confounding factors, we did compare these two conditions of patients within the same surgical division. It is striking that the effect of malnutrition was very significant, and that it was also a strong driver of hospital costs.

5. Conclusions

Malnourished patients, whether with benign or malignant diseases, were found to incur higher costs and have longer hospital stays.

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Authorship statements

Somboon Subwongcharoen: Conception and design of study, data collection and analysis, drafting manuscript, final approval of manuscript.

Pruet Areesawangvong:Data collection and analysis, drafting manuscript, final approval of manuscript.

Teeraporn Chompoosaeng: Data collection and analysis, drafting manuscript, final approval of manuscript.

Conflict of interest

None.

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.clnesp.2019.03.016.

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