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Food for thought. Malnutrition risk associated with increased risk of healthcare-associated infection

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Background: Infection and malnutrition are interconnected. UK and Irish guidelines recommend the Malnutrition Universal Screening Tool (MUST) for nutritional risk screening. Patients with a MUST score of ≥2 are considered at high risk of malnutrition and referral for nutritional assessment is recommended.
Aim: To explore the association between healthcare-associated infection (HCAI) and the MUST score categories of patients.
Methods: This was a cross-sectional study in May 2017 on ten representative wards in our institution. Patient demographics, MUST score, presence of medical devices, HCAI and antimicrobial use were collected.
Findings: Of 240 patients, the HCAI prevalence was 10.4% ($N = 25$) and 26% ($N = 63$) were at high risk of malnutrition (MUST score ≥2). Patients with HCAI were more likely to have had surgery (odds ratio (OR): 5.5; confidence interval (CI): 2.1–14.3; $P < 0.001$), a central vascular catheter (OR: 10.0; CI: 3.6–27.2; $P < 0.001$), or a urinary catheter *in situ* (OR: 7.5; CI: 2.8–20.0; $P < 0.001$), and to have a high risk of malnutrition (OR: 4.3; CI: 1.7–11.2; $P < 0.001$). A higher MUST score remained a significant predictor of a patient having HCAI on multivariate regression analysis (CI: 0.2–0.6; $P < 0.001$).
Conclusion: Patients at risk of malnutrition when assessed with the MUST were more likely to have HCAI. However, prospective studies are required to investigate the temporal association between MUST and HCAI and which interventions best address malnutrition risk and HCAI reduction in different settings.

Introduction

Malnutrition is surprisingly prevalent in hospitals, ranging from 20% to 50% of inpatients [1]. The association between infection and malnutrition is complex. Malnutrition impacts on immune function, especially cell-mediated immunity, thereby

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predisposing to infection, and in turn, infection influences nutritional state [2–7]. In one study, 40% of patients hospitalized with community-acquired infection were at risk of malnutrition on admission and this risk increased during their hospital stay [8]. Malnutrition has been associated with healthcare-associated infection (HCAI) and with factors that increase HCAI risk including: pressure ulcers, lean body mass loss, and prolonged length-of-inpatient stay [9].

Recognizing malnutrition is the first step in its management and in the prevention of associated complications, including infection. It is recommended that patients are screened for nutritional risk on hospital admission and weekly thereafter [10,11]. In the UK and Ireland, the Malnutrition Universal Screening Tool (MUST) is recommended and is calculated using body mass index (BMI), recent unplanned weight loss and nutritional intake (Figure 1) [10,12,13]. Scores are linked with recommended interventions. Patients with a MUST score of ≥2 are considered at high risk of malnutrition and referral for nutritional assessment by a dietitian is recommended. Nutrition assessment informs the dietetic management plan and uses medical, nutritional, and medication histories, physical examination, anthropometric measurements and laboratory data to determine whether a patient is malnourished.

Though nutritional intervention may reduce HCAI, addressing malnutrition is a frequently overlooked component of HCAI reduction strategies [9,14,15].

The aim was to perform a cross-sectional study to explore the potential association between HCAI and the MUST score categories of patients in an adult hospital population. The study also investigated the risk factors of patients with HCAI to inform and potentially align HCAI and malnutrition prevention programmes.

Methods

Beaumont Hospital is an 820-bed tertiary referral hospital, with national units in neurosurgery, renal transplantation, and cochlear implantation, also providing emergency and acute care services to the local catchment area of 290,000 people.

The study was designed as a point prevalence survey (PPS). Data were collected over a one-week period in May 2017, with ward data collected on the same day. All patients on ten of 28 inpatient wards were included. These wards were chosen as they were representative of the major specialties of the hospital including: care of the elderly, critical care, general and colorectal surgery, general medicine, gastroenterology, oncology, and haematology. Inpatients of the national units were excluded, so that the data might be more representative of patients in any equivalent tertiary hospital. Data were collected according to the national PPS protocol, using standardized definitions, and included patient demographics, presence of medical devices, such as intravascular and urinary catheters, HCAI, and antimicrobial use [16]. In addition, contemporaneous MUST data were collected on all patients using a five step process.

The first three steps included assessment of body mass index (BMI), percentage recent weight loss and acute disease effect on dietary intake. The three scores were then added to calculate overall risk of malnutrition (step 4) as outlined in Figure 1. The final step refers to the care pathway that ensued depending on the level of malnutrition risk identified. For this study MUST was performed by ward nursing staff per usual hospital practice. Thereafter dietitians checked the accuracy of each score by visual patient review, review of recorded weight and height, and confirmed the patient's usual weight with the patient. If patients were unable to provide their usual weight, the dietitian checked previous recorded weights in the medical records. If inaccuracies were suspected, the dietitian repeated the MUST screen and assigned a score which was taken as the correct MUST score. Patients were weighed using calibrated scales (stand on, sitting, or hoist scales). Height was measured using ward stadiometers. In the absence of a measured height (e.g. critically ill patient), a reported height from the patient/relative was used, or a left ulna length measurement was used as a height surrogate.

Patients with a MUST score ≥2 were considered at high risk of malnutrition. The time taken to complete MUST scores was not recorded; however, no delays were reported by nursing or dietetic staff and other investigators have reported that

1. Body mass index (BMI) (kg/m^3)	**2. Unplanned weight loss in past 3–6 months (kg)**	**3. Acutely ill plus has been *or* likely no nutritional intake for >5 days**
• >20: score 0 • 18.5–20: score 1 • <18.5: score 2	• <5%: score 0 • 5–10%: score 1 • >10%: score 2	If yes: score 2

Add scores from 1 to 3 above to calculate overall malnutrition risk

Score	**Action**
0	Low risk: routine clinical care
1	Medium risk: observe/document dietary and fluid intake ×3 days
≥2	High risk: treat, refer for nutritional assessment

Figure 1. Overview of the Malnutrition Universal Screening Tool (MUST) screening tool [12,13].

completion of MUST scoring takes either <2 min or 5–7 min [17,18].

A statistical analysis was performed using Stata version 15.1 (Stata Corp., College Station, TX, USA). A univariate analysis using the Pearson χ^2-test was used to analyse the possible effect of various risk factors. Effect size, for risk factors where an association was identified, were estimated by conducting a bivariate analysis and calculating odds ratios. A multivariate regression analysis was then used to investigate which variables were covariates of HCAI. For statistical comparisons, $P < 0.05$ was considered statistically significant.

Results

In total, 240 patients, 127 (53%) male, with a mean age of 68 years (range = 19–97 years), 25 of whom met a surveillance case definition for 26 HCAI (HCAI prevalence = 10.4%) were surveyed (Table I). More than one-quarter ($N = 63$) of patients were at high risk of malnutrition. HCAI types included: pneumonia ($N = 12$), surgical site infection (SSI) ($N = 4$), clinical sepsis ($N = 3$), urinary tract infection (UTI), gastrointestinal tract (GI) infection (excluding *Clostridium difficile* infection) ($N = 2$ each category respectively), bloodstream infection (BSI), ear–nose–throat/oral cavity infection and osteomyelitis ($N = 1$ each category respectively). Causative organisms were identified in eight HCAIs and included: *Escherichia coli* (BSI, pneumonia, SSI; $N = 1$, respectively) and one HCAI each due to *Staphylococcus aureus* (pneumonia), *Enterobacter aerogenes* (pneumonia), *Candida albicans* (GI infection), *Proteus mirabilis* (osteomyelitis), and *Enterococcus faecium* (SSI).

Results of χ^2-analysis are presented in Table I. Where significant, odds ratio calculations were then conducted, the results of which show that patients with HCAI were more likely to have had surgery (odds ratio (OR): 5.5; confidence interval (CI): 2.1–14.3; $P < 0.001$), a central vascular catheter (OR: 10.0; CI: 3.6–27.2; $P < 0.001$), or a urinary catheter *in situ* (OR: 7.5; CI: 2.8–20.0; $P < 0.001$). In addition, patients with HCAI were more likely to be at high risk of malnutrition (OR: 4.3; CI: 1.7–11.2; $P < 0.001$). As 100% of patients were prescribed antimicrobials, we excluded this variable from OR calculations (Table I). Multivariate regression analysis showed that patients with a higher MUST score (i.e. ≥2) remained a significant predictor of a patient having HCAI (CI: 0.2–0.6; $P < 0.001$) (Table I).

Discussion

Patients with HCAI were more likely to be at risk of malnutrition when assessed by the MUST. In addition, HCAI was associated with recent surgery and presence of a central vascular or a urinary catheter. Whereas the association between HCAI and surgery/device use has been well described, to our knowledge, this is the first study to report an association between malnutrition risk when assessed using the MUST tool and HCAI [19].

Undernutrition and weight loss have been consistently found to increase mortality risk, at all ages and across care settings. Malnutrition (risk score using the MUST) has been shown to double the risk of mortality in hospital patients and to triple mortality in older patients [20]. A large multi-centre study in 26 hospitals in 12 countries ($N = 5051$ patients) reported that patients with malnutrition (using the Nutritional Risk Screening (NRS)-2002 tool) had a 12-fold increase in hospital mortality [21]. The components of the NRS-2002 are almost identical to MUST, with the addition of a question regarding whether a patient is 'severely ill e.g. in critical care'. Likewise, a prospective cohort study of newly admitted adult patients to an acute tertiary hospital found that malnutrition was a significant

Table I

Patient demographics, prevalence of malnutrition risk, healthcare-associated infection (HCAI) risk factors and HCAI, and covariates of HCAI

Variable	Patients with no HCAI ($N = 215$)	Patients with HCAI ($N = 25$)	Total ($N = 240$)	Predictors of HCAI covariates: Univariate analysis		Bivariate analysis		Multivariate regression analysis	
				χ^2	*P*-value	OR (95% CI)	*P*-value	OR (95% CI)	*P*-value
Mean age (years) (range)	69 (17–97)	62 (26–93)	68 (19–97)						
Male	111 (52%)	16 (64%)	127 (53%)	1.4	0.24				
Consultant specialty									
Medical	151 (70%)	14 (56%)	165 (69%)	2.1	0.15				
Surgical	64 (30%)	11 (44%)	75 (31%)						
MUST ≥2[a]	49 (23%)	14 (56%)	63 (26%)	12.8	<0.001	4.3 (1.7–11.2)	<0.001	0.4 (0.2–0.6)	<0.001
Surgery since admission	31 (14%)	12 (48%)	43 (18%)	17.2	<0.001	5.5 (2.1–14.3)	<0.001	0.58 (0.3–1.2)	0.2
End of life or life-limiting prognosis (McCabe score)	85 (40%)	14 (56%)	99 (41%)	2.5	0.11				
Prescribed antimicrobials[b]	88 (41%)	25 (100%)	113 (47%)	31.4	<0.001	Not calculated			
Device(s) present									
Central vascular catheter	21 (10%)	13 (52%)	34 (14%)	32.9	<0.001	10.0 (3.6–27.2)	<0.001	1.5 (0.7–3.4)	0.3
Peripheral vascular catheter	105 (49%)	15 (60%)	120 (50%)	1.1	0.29				
Urethral catheter	36 (17%)	15 (60%)	51 (21%)	25	<0.001	7.5 (2.8–20.0)	<0.001	0.7 (0.3–1.4)	0.3

OR, odds ratio; CI, confidence interval.

[a] Patients with a Malnutrition Universal Screening Tool (MUST) score ≥2 were considered at high risk of malnutrition.

[b] Excluded from OR calculations as 100% of patients with HCAI were on antimicrobials.

predictor of mortality (adjusted hazard ratio (HR) of 4.4; 95% CI: 3.3–6.0; $P < 0.001$) [22].

Malnutrition is also associated with significant morbidity risk, including HCAI [21,23–25]. A retrospective analysis of more than 900,000 patient records reported an association between malnutrition/weight loss and SSI, postoperative pneumonia and catheter-associated UTI [24]. In a prospective study of hospitalized elderly patients, the Geriatric Nutritional Risk Index (GNRI) tool, which grades patients according to their risk of malnutrition-related complications, stratified patients according to their HCAI risk [25]. In this study, well-nourished patients (GNRI >98) were less likely to acquire HCAI, with low GNRI associated with increased HCAI risk. However, the GNRI is a more complex tool than MUST, designed for nutritional assessment, and it requires anthropometric measurement, clinical and laboratory assessment including measurement of serum albumin, and calculation of the GNRI with a mathematical formula.

Surgical patients at nutritional risk as assessed by the NRS-2002 tool were 1.81 times more likely to develop SSI as compared to those patients who were not [26]. By contrast, an HCAI PPS reported no association between HCAI and nutritional risk when assessed by the NRS-2002, though patients with HCAI were more likely to be identified with decreased energy intake [27]. Nutritional risk prevalence was similar to our study at 30% of patients, whereas HCAI was less prevalent (6.8%). The authors proposed dietary intake assessment to identify patients with HCAI and to perform this in all patients with HCAI. However, dietary assessment requires dietitian review. The attractiveness of the MUST tool lies in its brevity and potential for ongoing use by non-dietitians to prompt specialist dietitian evaluation and intervention [11]. This ensures that dietitians focus their time on those patients most at risk. There is no ideal malnutrition screening tool; however, MUST and NRS-2002 are two of the most frequently studied tools and are comparable in specificity and sensitivity [28]. MUST can be used across healthcare settings, whereas NRS-2002 is limited to the hospital setting. In Ireland, MUST is the recommended screening tool and is used in the majority of Irish hospitals that perform malnutrition screening, including our institution, whereas NRS-2002 is not used [12,29].

Limitations of this study include: its single-centre, cross-sectional design and potential selection bias from not including the entire hospital population. Because of the cross-sectional design and the complex association between malnutrition and infection, causality between MUST and HCAI cannot be inferred. Patients at risk of malnutrition are potentially more likely to develop HCAI and patients with HCAI are potentially more likely to be at risk of malnutrition. Therefore, further prospective studies are required to examine this further. However, the association between MUST score and HCAI offers the opportunity to consider inclusion of malnutrition screening as a component of HCAI prevention bundles.

The MUST tool is a simple (three questions) fast tool that does not require specialist input, laboratory investigations, or mathematical calculations and therefore has potential to be readily used on an ongoing basis. The limitations of MUST include the need for height measurement. However, alternative measurements are suggested and it is simple and easy with initial training requirements of <1 h [13]. Whereas we did not study all inpatients, the subset of wards chosen was representative of the total patient population and specialties in our hospital (predominately medical specialties) and many other larger non-specialist hospitals, and the HCAI prevalence was similar to that previously reported from our hospital [30]. Prospective hospital-wide HCAI surveillance is preferred, but this would require extensive resources, not currently feasible in our setting. Assessing a representative sample of patients using a PPS is more pragmatic, easier to perform, less expensive, and provides a baseline on HCAI and malnutrition risk, to identify future priorities. In addition, we did not measure inter-rater reliability of the data collectors. However, we ensured that only qualified dietitians collected the MUST data, and members of the clinical microbiology and infection prevention and control team who had attended national training collected the remaining PPS data.

Study strengths included: use of robust HCAI definitions by trained data collectors using a standardized protocol; collection of MUST data by trained nursing staff, thereafter validated by dietitians and inclusion of a representative sample of hospital wards/clinical units.

Integrating nutritional screening, followed by targeted assessment and appropriate nutritional intervention, has clear benefits for patients. Addressing malnutrition would also have economic benefits for the healthcare system [31]. Because of the cross-sectional design of our study, the temporal association between malnutrition risk and HCAI cannot be elucidated. Prospective interventional studies are therefore required to further examine this association and design possible interventions to evaluate whether correcting malnutrition prevents HCAI and whether improving nutrition in patients with HCAI improves patient outcomes.

In conclusion, MUST is an easy-to-use objective screening tool that enables timely recognition of patients at risk for malnutrition. However, its validity to detect patients with HCAI and which interventions best address malnutrition risk and HCAI reduction in different settings warrant further study.

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Conflict of interest statement

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