Title: Malnutrition and poor food intake are associated with prolonged hospital stay, frequent readmissions, and greater in-hospital mortality: Results from the Nutrition Care Day Survey 2010

Ekta Agarwal[1], Maree Ferguson[1, 2], Merrilyn Banks[1, 3], Marijka Batterham[4], Judith Bauer[1], Sandra Capra[1], Elisabeth Isenring [1, 2]

[1] Centre for Dietetic Research, School of Human Movement Studies, The University of Queensland, Brisbane, QLD 4072, Australia (EA, MF, MDB, JB, SC, EAI)

[2]Department of Nutrition and Dietetics, Princess Alexandra Hospital, Brisbane, QLD 4102, Australia (MLF, EAI)

[3]Department of Nutrition and Dietetics, Royal Brisbane and Women's Hospital, Brisbane, QLD 4029, Australia (MDB)

[4]The Centre for Statistical and Survey Methodology The University of Wollongong, Wollongong, NSW 2522, Australia (MJB)

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List of Abbreviations:

ANCDS- Australasian Nutrition Care Day Survey

ARDRG- Australian Refined Diagnosis Related Group

BMI- Body Mass Index

CI- Confidence Interval

DRG- Diagnosis Related Group

EQ-5Dvas- EQ-5D visual analogue scale

LOS- Length of stay

MDC- Major Diagnostic Category

MST- Malnutrition Screening Tool

PCCL- Patient Clinical Complexity Level

SGA- Subjective Global Assessment

Corresponding Author:

Ekta Agarwal

School of Human Movement Studies

The University of Queensland

St Lucia

Australia 4072

Telephone: +61 422851650

Email: e.agarwal@uq.edu.au

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ABSTRACT

Background and Aims: The Australasian Nutrition Care Day Survey (ANCDS) ascertained if malnutrition and poor food intake are independent risk factors for health-related outcomes in Australian and New Zealand hospital patients.

Methods: Phase 1 recorded nutritional status (Subjective Global Assessment) and 24-hour food intake (0, 25, 50, 75, 100% intake). Outcomes data (Phase 2) were collected 90-days post-Phase 1 and included length of hospital stay (LOS), readmissions and in-hospital mortality.

Results: Of 3122 participants (47% females, 65 ± 18 years) from 56 hospitals, 32% were malnourished and 23% consumed ≤ 25% of the offered food. Malnourished patients had greater median LOS (15 days vs. 10 days, $p<0.0001$) and readmissions rates (36% vs. 30%, $p=0.001$). Median LOS for patients consuming ≤ 25% of the food was higher than those consuming ≥ 50% (13 *vs.* 11 days, $p<0.0001$). The odds of 90-day in-hospital mortality were twice greater for malnourished patients (CI: 1.09-3.34, $p = 0.023$) and those consuming ≤ 25% of the offered food (CI: 1.13-3.51, $p = 0.017$) respectively.

Conclusion: The ANCDS establishes that malnutrition and poor food intake are independently associated with in-hospital mortality in the Australian and New Zealand acute care setting.

(196 words)

Keywords: malnutrition, poor food intake; disease type and severity; length of stay; readmissions; in-hospital mortality

INTRODUCTION

The Australasian Nutrition Care Day Survey (ANCDS) is the largest multicentre study in the Australasian region, reporting the prevalence of malnutrition and poor food intake in 3122 patients across 56 Australian and New Zealand hospitals [1]. With one-in-three patients malnourished; and two-in-three patients not consuming all of the offered hospital food, it was evident that malnutrition and poor food intake are a common occurrence in Australian and New Zealand hospitals [1].

Numerous studies have suggested that in comparison to well-nourished patients, malnourished patients experience worse outcomes such as prolonged length of hospital stay (LOS), increased readmissions, and mortality [2-6]. There is documented evidence to suggest that malnourished patients incur greater hospitalisation costs [7], related to longer LOS, readmissions, and greater utilisation of hospital resources [2, 5].

The ANCDS found that one-in-three malnourished patients (n= 305, 30%), and one-in-five well-nourished patients (n= 371, 18%) consumed nothing or up to 25% of the food offered during the 24-hour data collection period [1]. Since continued sub-optimal food intake can eventually lead to deterioration of nutritional status, it is important to evaluate the effect of poor food intake on health-related outcomes. Two studies have reported the link between poor food intake during hospitalisation and mortality [6, 8], however there is no published evidence regarding the association between poor food intake and readmissions and/or LOS.

Although previous studies have investigated associations between malnutrition and patient outcomes, issues such as heterogeneity in patient populations; study design; methods of evaluating nutritional status, food intake and/or outcomes; prevent the

results from these studies being generalised throughout the acute care population. Factors such as type and severity of disease are major causes of malnutrition [9], poor food intake [10], and patient outcomes, and yet they have rarely been controlled for. Without accounting for the confounding effect of disease type and severity most studies fail to distinguish the association between the effect of disease, nutritional issues, and other factors (such as age, gender), and patient outcomes. Therefore, there is a risk of underestimating the independent effects of disease, and overestimating the independent effects of nutritional issues. The aim of this study was to take into account disease type and severity and explore associations between: (1) nutritional status; (2) food intake; and health-related outcomes (LOS, mortality, and readmissions) in participants from the ANCDS.

METHODS

The ANCDS was conducted in two phases. Participants were recruited in Phase 1 of the study and the episode of admission was referred to as “index hospitalisation”. In Phase 1 data were collected by dietitians from participating hospitals [1]. Data included demographic, nutritional status, and 24-hour food intake information for each participant [1]. Participants’ body mass index (BMI) were calculated based on their recorded weight and height [1]. To evaluate nutritional status, each participant was screened using the Malnutrition Screening Tool (MST) [11] and those deemed at risk of malnutrition underwent comprehensive nutritional assessment using Subjective Global Assessment (SGA) [12]. Based on the International Classification of Disease and Related Health Problems (ICD-10-AM) [13], malnutrition was defined as BMI <18.5 kg/m^2 and an SGA rating of moderately malnourished (SGA-B) or severely malnourished (SGA-C). Over a 24-hour period, each participants’ percentage food intake was observed and recorded by meal and snack on a five-point scale (0%, 25%, 50%, 75%, and 100%) [1]. Information on the prescribed diet on the day of the survey was also recorded [11].

The present study (Phase 2) is a prospective cohort study and includes participants from Phase 1. Data were collected 90 days post Phase 1 and includes:

- Admission-related data: Nature of admission, type and severity of disease, discharge status (Appendix 1);
- Outcomes-related data: Length of stay, readmissions, date of death (Appendix 1).
- Quality of life data: Participants’ self-perceived quality of life was assessed using EQ-5D [14], a non-disease specific two part questionnaire (Appendix 1).

Ethical approval for the present study was provided by the Medical and Research Ethics Committee of The University of Queensland and local Human Research Ethics Committees of participating hospitals. Data were collected in accordance with the ethical standards of the ethics committees.

Statistical Analysis

Data were analysed using PASW Statistics 18. The following variables were dichotomised:

- Age- < 65 years, ≥ 65 years;
- PCCL scores- not severe/catastrophic PCCL (i.e. PCCL score of 0, 1 or 2), severe/catastrophic PCCL (i.e. PCCL score of 3 or 4);
- EQ-5Dprofile (i.e. each of the five dimensions (mobility, self-care, activity, pain/discomfort, anxiety/depression)- no problem, some problem (included moderate/severe problem)[14];
- Nutritional status: Malnourished (included SGA-B[12], SGA-C[12], and patients with BMI <18.5 kg/m^2 [13]), well-nourished (included MST < 2 [11]and SGA-A[12]);
- Food Intake- Since food intake of ≤25% (i.e. nil-by-mouth (NBM), 0%, 25% food consumption during Phase 1 of the survey) was significantly associated with the outcomes at the bivariate level, food intake was dichotomised as ≤25% and ≥50% (i.e. 50%, 75%, and 100% food consumption during Phase 1 of the survey).

Appendix 2 describes the steps undertaken to clean the dataset for outcomes variables.

All categorical variables were reported as frequency and percentage. The distribution of LOS, as a continuous variable, was analysed. Length of stay remained skewed after trimming, and is therefore reported using median (range). LOS was transformed

by using the square root for analysis. Bivariate analyses were undertaken using chi-square tests for categorical variables and independent sample t-tests or equivalent non-parametric t-tests for continuous variables, to identify significance between confounders and outcome variables. Variables considered as risk factors from the literature (confounding variables) and those demonstrating a significant association with each outcome variable at a bivariate level (evaluable confounding variables) were entered into regression models (Appendix 3). Preliminary assumption testing were conducted to ensure no violation of the assumptions, including multicollinearity. High intercorrelations were observed between diet type and nutritional status, and therefore diet type was excluded from the regression models. A p-value < 0.05 was considered statistically significant.

RESULTS

Outcomes data were available for 3017 of the total 3122 participants (97%). After data cleaning (as previously outlined), data analyses for LOS and mortality included 2982 participants (95%), and readmissions data were analysed for 2942 participants (94%).

Table 1 depicts admission-related characteristics of the participants. Malnutrition was significantly associated with age ≥ 65 years, emergency admissions, admissions other than surgical or medical, certain MDCs, severe/catastrophic PCCL scores, discharge status (excluding those who left against medical advice), EQ-$5D_{profile}$ and EQ-$5D_{vas}$ scores, and pre-survey LOS (Table 1). Consumption of ≤ 25% of the offered hospital food was significantly associated with age ≥ 65 years, certain MDCs,

surgical and medical admissions, severe/catastrophic PCCL scores, EQ-$5D_{profile}$ and EQ-$5D_{vas}$ scores (Table 1). Participants who consumed ≥ 50% of the offered food were more likely to be discharged to their home/place of usual residence (Table 1). Percentage food intake was not associated with pre-survey LOS (Table 1).

LOS: The median LOS for all patients was 11 days (Table 2) with 67 patients (2%) having a LOS of ≥90 days. Malnourished participants had longer median LOS (15 days, range: 2 – 119 days) compared to well-nourished participants (median LOS: 10 days, range: 2 – 158 days) ($p < 0.0001$) (Table 2). Severely malnourished participants (SGA-C) had a significantly longer median LOS (21 days, range: 2 – 259 days) versus well-nourished participants (12 days, range: 2 – 291 days) and moderately malnourished (SGA-B) participants (15 days, range: 2 – 467 days) ($p < 0.0001$). The median LOS of participants who consumed ≤ 25% of the offered food was longer (13 days, range: 2 – 158 days) than those who consumed ≥ 50% of the food (11 days, range: 2 – 119 days) ($p < 0.0001$) (Table 2).

The multiple regression analysis model explained 32% of the variance in LOS (R^2= 0.329, adjusted R^2= 0.319, F (34, 2290) = 32.95, $p < 0.0001$). PCCL scores were the largest unique contribution (beta: 0.353, CI: 0.417 – 0.513, p-value < 0.0001). Nutritional status made a statistically significant contribution (beta: 0.084, CI: 0.167 – 0.414, *p*-value < 0.0001). Percentage food intake was not significant.

Readmissions: The overall readmission rate was 30% (n= 882) (Table 2) within 90-days from post-index hospitalisation. While malnourished patients had a significantly higher readmission rate (35%) in comparison to well-nourished patients (27%), no association was found between percentage food intake and readmissions (Table 2).

An ordinal regression model did not find malnutrition to be a significant risk factor for readmissions. Neoplastic disease and discharge to other healthcare facilities were the highest risk factors for significantly increasing the odds of readmissions within 90 days of index hospitalisation (Table 3).

Mortality: The 30-day and 90-day in-hospital mortality rate were 1.5% (n= 46) and 2.4% (n= 72) respectively (Table 2). Malnourished patients and those who ate ≤ 25% of the offered food had significantly higher mortality rates than others (Table 2). Risk factors for in-hospital mortality have been included in Tables 4a and 4b. Logistic regression analysis revealed:

- Although malnutrition was not an independent risk factor for 30-day in-hospital mortality (Table 4a) it increased the odds of 90-day in-hospital mortality by almost two times (OR: 1.91, CI: 1.09-3.34, p= 0.023) (Table 4b).
- Eating ≤ 25% of the offered food increased the risk of 30- and 90-day in-hospital mortality by > 2.5 times (OR: 2.69, CI: 1.31 – 5.52, p= 0.007) (Table 4a) and 2 times (CI: 1.13 – 3.51, p = 0.017) respectively (Table 4b).
- Severe/catastrophic PCCL score and age ≥ 65 years were independent risk factors common for both, 30- and 90-day in-hospital mortality (Tables 4a, 4b).

The hazard ratio of 90-day in-hospital mortality for malnourished patients who consumed ≤ 25% of the offered food was 2.3 times greater (CI: 1.39-3.76, *p*= 0.001) than well-nourished patients (Table 5; Figure 1).

DISCUSSION

The ANCDS is the first multicentre study in acute care hospitals across Australia and New Zealand to report the association between patients' nutritional status, food intake and health-related outcomes. The study found that patients who were malnourished or consumed ≤ 25% of the hospital offered food had significantly longer LOS and higher in-hospital mortality rates. Malnourished patients also had significantly higher readmissions rates than well-nourished patients.

Considering there are several non-nutritional factors that can influence LOS [15], readmissions [16], and in-hospital mortality, it is important to account for these factors. Although three studies have previously used multivariate regression analyses to control for the effect of confounders in a general, adult acute care population [2, 5, 6], they have limited comparability as they did not control for disease severity. They also did not evaluate readmissions as an outcome [2, 6], participants' food intake [2, 5] or participants' nutritional status using validated and reliable methods [6]. To the best of our knowledge, the ANCDS is the only study to control for disease severity (using PCCL scores) and other non-nutritional factors (age, gender, disease type, QoL indicators) in multivariate regression models to report the independent association between malnutrition and poor food intake and LOS, readmissions, and mortality in a general, adult acute care population. Multivariate regression analyses confirmed that non-nutritional factors associated with all three outcomes were severe/catastrophic disease severity and age ≥ 65 years. Respiratory disease was a common risk factor for readmissions and 90-day in-hospital mortality.

LOS: Three other studies have used regression analyses to report associations between malnutrition and LOS [2, 5, 17]. Pirlich et al used number of prescriptions per day as a surrogate marker for disease severity, although they acknowledged the

limitation of this method [17]. Lim et al did not control for disease severity per se, however, they used the DRG-matching technique and controlled for diagnosis, investigations, and treatment costs. Their study demonstrated that malnutrition was an independent risk factor for longer LOS [5]. Other nutrition studies have not controlled for disease severity [2] while establishing associations between malnutrition and LOS. Results from the ANCDS establish that malnutrition is a contributor to prolonged LOS, independent of the disease status.

Studies evaluating the association between food intake and LOS in hospitals are extremely limited and conflicting. Kandiah et al reported a positive association between extended LOS and greater plate waste [18]. Conversely, Dupertuis et al found that patients with a hospital LOS of more than eight days were less likely to "be underfed" and speculated that the extended duration of hospital stay helped with adapting to the taste of hospital food, and mealtimes [19]. The present study could not find a significant difference in the median pre-survey LOS of patients consuming ≤ 25% of the hospital offered food versus those consuming ≥ 50% of the food. Given that the present study demonstrated a significant association between malnutrition and LOS, and poor food intake during hospitalisation is a risk factor for malnutrition, it is important to recognise and provide timely nutrition support to patients with poor food intake during hospital admission.

Readmissions: The ANCDS reported that one-in-three patients (30%) are readmitted within three months of index hospitalisation. The readmission rate at three months in this study is substantially higher than the 19 – 24% rate previously reported [20].

Although analyses found that the readmission rate of malnourished patients was 1.3 times higher than that of well-nourished patients, this effect was lost during ordinal

regression analysis. Five previous studies have reported a positive association between malnutrition and readmissions [3-5, 21, 22]. The findings from three of these studies cannot be compared to the present study as they were conducted in small cohorts of participants ≥ 50 years of age, and used anthropometric and/or biochemical measures to define malnutrition [3, 21, 22]. The findings by Planas et al have limited application as despite having a larger cohort and using a validated method to define malnutrition (i.e. SGA), they did not control for the effect of confounding variables [4]. The study by Lim et al is comparable as they included a large cohort (n: >800 participants, age: >18 years), used the validated SGA to define malnutrition, and controlled for various confounders (age, gender, ethnicity, DRG) [5]. Similar to the ANCDS, their study could not find an association between malnutrition and readmissions within 90-days of index hospitalisation [5]. However, they found that malnourished patients had a 60% higher readmission risk within 15-days post-hospital discharge [5]. It was beyond the scope of this study to record the nutritional status of the participants at each episode of readmission. Further research evaluating the effectiveness of hospital- and/or community-based nutrition interventions in preventing readmissions will be valuable in filling this gap in the literature.

The ANCDS found that neoplastic disease, discharge destinations, severe/catastrophic disease severity, and age ≥ 65 years were associated with increased readmissions. Several studies, as summarised in one meta-analysis [16] and two systematic reviews [23, 24], have previously reported these associations.

Mortality: The ANCDS also found that malnourished patients consuming ≤ 25% of the offered food had more than a two-fold risk of 90-day in-hospital death compared to well-nourished patients who consumed at least half the offered food. This effect was not significant for 30-day in-hospital mortality. Our results contrast with the

nutritionDay Survey by Hiesmayr et al, which was also a one-day multicentre study (involving >16000 patients from >250 hospitals in 25 European countries), reported an adjusted hazard ratio of 2.10 (CI: 1.53 – 2.89) for 30-day in-hospital mortality in patients who consumed a quarter of the offered meal [6]. More detailed analysis of disease severity and nutritional status characteristics of the sub-group of patients in the ANCDS who experienced 30-day in-hospital mortality indicated that there was no significant difference in the number of well-nourished (n= 20, 45%) and malnourished patients (n= 24, 55%) ($p > 0.05$) and that a majority of these patients (n= 44, 96%) had a severe/catastrophic PCCL score during index hospitalisation. Since disease severity is associated with increased mortality, and highly correlated with malnutrition, this could explain why malnutrition was not a significant independent risk factor for 30-day in-hospital mortality.

LIMITATIONS: The ANCDS could record readmissions only within participating hospitals. Even though the readmission rate was higher than that reported by other studies, considering that readmissions to other hospitals can account for approximately 25% of all readmissions [25], this study may have underreported readmission rates.

The ANCDS has provided in-hospital mortality data only. Mortality data for those that may have occurred post-discharge in a different setting were not recorded making it likely that mortality rates may have also been underreported in this study.

Participating hospitals represent at least 20% of acute care hospitals in Australia [26] and 40% of acute care hospitals in New Zealand [27] (that have more than 60 beds) limiting the generalisability of the results across the acute care population in Australia and New Zealand. Nevertheless, the ANCDS is the first and largest multicentre study

to provide a snapshot of the association between malnutrition, poor food intake and patient outcomes in this region.

The ANCDS reported point prevalence malnutrition for a majority of the patients and food intake was recorded for a 24-hour period only. In addition, being a cross-sectional observational study it cannot determine if poor food intake caused in-hospital mortality within 30-days of hospital admission. It is noteworthy that regardless of the type and severity of disease, age, nutritional status, and other potential confounders, consuming ≤25% the offered food (during Phase I) independently increased the odds for 30- and 90-day in-hospital mortality. It was beyond the scope of this study to calculate the nutritional intake for participants who consumed ≤25% the offered food; however, it can be speculated that consumption of ≤25% of the offered food would be unlikely to meet participants' nutritional requirements.

STRENGTHS: The ANCDS is the first study to highlight the independent association of malnutrition and poor food intake during hospitalisation on health-related outcomes in Australian and New Zealand acute care patients, after controlling for various confounders including disease type and severity. Evidence regarding the association between poor food intake and negative outcomes is scarce. Even though previous studies have reported the association between nutritional status and negative outcomes, they have seldom controlled for disease severity and other confounding factors, thus providing an incomplete analysis of association. It is possible that controlling for disease severity was a challenge for previous studies, particularly when there is no universally accepted measure for disease severity [6]. There are a variety of generally accepted comorbidity indices [28] that can reduce all the

coexisting diseases and their severities to a single score to allow comparisons with other patients with the same score [28]. However, they measure comorbidity at a given time and are either designed for a specific patient group or consist of a limited number of disease categories [28]. The ANCDS cohort was anticipated to include patients with a vast variety of acute care condition/s, limiting the application of any particular comorbidity index. In addition, comorbidity indices require data abstraction by reviewing patients' medical charts [28]. Given the large cohort, it would not only be time-consuming and impractical to review individual hand-written medical charts to record each participants' comorbidities, missing data would also be a risk [28]. Therefore, the ANCDS used a novel approach to overcome the challenge of controlling for disease type and severity- by using diagnostic codes (AR-DRG) and PCCL scores respectively. Moreover, PCCL scores are reflective of the cumulative effect of patients' complications and comorbidities for the entire episode of admission, and thus a more accurate measure of patients' disease severity.

PRACTICAL IMPLICATIONS: The ANCDS is the first study that we know of which demonstrates that poor food intake, independent of disease type and severity, and malnutrition is associated with in-hospital mortality in acute care patients. While one-in-three malnourished patients consumed ≤ 25% of the offered food, one-in-five well-nourished patients also consumed ≤ 25% of the offered food [1]. These results call for more consistent monitoring of hospitalised patients' food intake levels. Perhaps protocols for recording patients' food intake after each meal need to be implemented akin to those for authorising medication charts soon after medications are administered. In light of our results, and those from the European NutritionDay

Survey, perhaps consumption of ≤25% of the offered food should be used as a screening (and rescreening) tool to commence appropriate medical nutrition therapy.

CONCLUSION: The ANCDS is the first multicentre study in acute care patients across Australia and New Zealand to examine the association between nutritional status and food intake, and health-related outcomes (LOS, readmissions, and in-hospital mortality), after controlling for a range of confounding factors (including disease type and severity). The ANCDS confirms that malnutrition and poor food intake have independent associations with health-related outcomes in acute care patients. Both these risk factors are modifiable, in contrast to other risk factors such as age and disease. Findings from the ANCDS accentuate the importance of implementing every step of the nutrition care process (nutrition screening and assessment, nutrition support, nutrition monitoring and evaluation of nutrition support) as standardised practice across acute care hospitals.

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Authors' contributions to manuscript:

EA designed and coordinated the study; acquired, analysed and interpreted the data; and wrote the manuscript. MF, MB and EI provided significant advice on the study design. MBatterham provided statistical advice. All authors participated in editing and final revisions of the manuscript. All authors have read and approved the final manuscript.

Conflict of Interest: EA, MBatterham, JB, and SC have no conflict of interest to declare. MF, MB and EI are employed by Queensland Health, Australia.

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Table 1: Admission-related characteristics of the participants:

Characteristics	Overall Results	Results as per Nutritional Status			Results as per % Food Consumption		
		Well-nourished[a]	Malnourished[b]	*p*-value	≥50% intake[c]	≤ 25% intake[d]	*p*-value
Age group[e]							
< 65 years	1314 (44%)	911 (46%)	382 (40%)	0.003	981 (43%)	316 (48%)	0.028
≥ 65 years	1650 (56%)	1064 (54%)	564 (60%)		1294 (57%)	343 (52%)	
Admission Status (n (%))[e]							
Emergency	2173 (73%)	1426 (72%)	719 (76%)	0.027	1669 (73%)[g]	483 (73%)[g]	0.935
Elective	623 (21%)	433 (22%)[g]	180 (19%)[g]	0.075	468 (21%)[g]	148 (22%)[g]	0.302
Other[h]	183 (6%)	127 (6%)[g]	51 (5%)[g]	0.321	149 (7%)[g]	32 (5%)[g]	0.110
Main Diagnostic Categories (MDC) (n (%))[e]							
Digestive, Hepatobilliary	562 (19%)	335 (17%)	222 (23%)	0.000	351 (15%)	206 (31%)	0.000
Musculoskeletal	445 (15%)	326 (16%)	108 (11%)	0.000	348 (15%)[g]	86 (13%)[g]	0.150
Circulatory	388 (13%)	295 (15%)	87 (9%)	0.000	329 (14%)	55 (8%)	0.000
Respiratory	372 (13%)	231 (12%)	135 (14%)	0.045	296 (13%)[g]	76 (12%)[g]	0.311
Nervous	277 (9%)	192 (10%)[g]	80 (8%)g	0.285	220 (10%)[g]	56 (9%)[g]	0.360
Skin, Subcutaneous Tissue, Burns, Breast	124 (4%)	100 (5%)	24 (2%)	0.002	113 (5%)	10 (2%)	0.000
Kidney, Urinary Tract	109 (4%)	64 (3%)[g]	43 (5%)[g]	0.075	90 (4%)[g]	17 (3%)[g]	0.096
Others	110 (4%)	64 (3%)	45 (5%)	0.041	96 (4%)[g]	14 (2%)[g]	0.013
Pre-MDC	100 (3%)	54 (3%)	46 (5%)	0.003	58 (3%)	40 (6%)	0.000
Infectious & Parasitic	99 (3%)	56 (3%)	42 (4%)	0.023	77 (3%)[g]	22 (3%)[g]	0.950
Neoplastic	82 (3%)	46 (2%)	36 (4%)	0.023	67 (3%)[g]	15 (2%)[g]	0.357
Endocrine, Metabolic and Nutritional	82 (3%)	56 (3%)[g]	25 (3%)[g]	0.779	64 (3%)[g]	16 (2%)[g]	0.590
Injuries, Poisoning, Drug and Alcohol abuse	80 (3%)	56 (3%)[g]	20 (2%)[g]	0.258	62 (3%)[g]	17 (3%)[g]	0.836
Male & Female Reproductive System	72 (2%)	56 (3%)[g]	16 (2%)[g]	0.064	55 (2%)[g]	17 (3%)[g]	0.816
Eye, Ear-Nose-Throat, Mouth	42 (1%)	35 (2%)	6 (1%)	0.015	32 (1%)[g]	10 (2%)[g]	0.835
Blood & Blood-forming Organs	31 (1%)	19 (1%)[g]	12 (1%)[g]	0.443	25 (1%)[g]	5 (1%)[g]	0.443
Partition (Admission type) (n (%))[e]							
Surgical	1270 (43%)	847 (43%)[g]	403 (43%)[g]	0.953	886 (39%)	369 (56%)	0.000
Medical	1547 (52%)	1044 (53%)[g]	482 (51%)[g]	0.390	1279 (56%)	255 (39%)	0.000
Other	158 (5%)	94 (5%)	62 (7%)	0.041	118 (5%)[g]	38 (6%)[g]	0.563

Patient Clinical Complexity Level Scores (PCCL) (n (%))[e]							
Not severe	1145 (39%)	887 (45%)	244 (26%)	0.000	933 (41%)	200 (30%)	0.000
Severe/Catastrophic	1821 (61%)	1096 (55%)	696 (74%)		1344 (59%)	459 (70%)	
Discharge Status (n (%))[e]							
Usual Residence	2129 (74%)	1521 (79%)	576 (65%)	0.000	1667 (75%)	440 (71%)	0.024
Other Hospital	303 (11%)	177 (9%)	123 (14%)	0.000	224 (10%)[g]	74 (11%)[g]	0.198
Other Facility[i]	423 (14.5%)	231 (12%)	185 (21%)	0.000	317 (14%)[g]	103 (17%)[g]	0.161
Left Against Medical Advice	9 (0.5%)	5 (0.3%)[g]	4 (0.4%)[g]	0.401	5 (0.2%)[g]	4 (0.6%)[g]	0.102
$EQ\text{-}5D_{profile}$ (n (%))[e]: Some/Major Problem with:							
Mobility	1870 (64%)	1181 (60%)	667 (72%)	0.000	1422 (63%)	432 (68%)	0.014
Pain	1846 (63%)	1189 (61%)	634 (68%)	0.000	1376 (61%)	451 (71%)	0.000
Self-Care	1296 (45%)	772 (40%)	510 (55%)	0.000	934 (42%)	349 (55%)	0.000
Anxiety/Depression	1246 (43%)	727 (38%)	507 (55%)	0.000	919 (41%)	316 (51%)	0.000
Activity	1893 (65%)	1171 (60%)	699 (75%)	0.000	1412 (63%)	460 (73%)	0.000
$EQ\text{-}5D_{vas}$ (median (range))[f]	51 (0 – 100)	60 (0 – 100)	50 (0 – 100)	0.000	58 (0 – 100)	50 (0–100)	0.000
Pre-survey Length of Stay (median (range))[f]	6 (0 – 449)	5 (0 – 364)	9 (0 – 449)	0.000	6 (0 – 449)	6 (0 – 364)	0.459

[a] Well-nourished participants [1]: included those not at risk of malnutrition (MST[28]) and SGA-A[26]

[b] Malnourished participants [1]: included moderately (SGA-B)[26] and severely (SGA-C)[26] malnourished participants, and patients with BMI < 18.5 kg/m2 [27]

[c] ≥ 50% intake includes 50%, 75% and 100% food intake

[d] ≤ 25% intake includes nil-by-mouth, 0%, and 25% intake

[e] Categorical variables represented as n (%)

[f] Continuous Variable presented as Median (Range) for data that is not normally distributed

[g] non-significant (*p*-value >0.05)

[h] includes waitlists and non-assigned

[i] includes residential aged care facility, rehabilitation, episode change within same hospital, other health facility

NOTE: Admission status data were missing for 3 participants; MDC data were missing for 9 participants; Partition data were missing for 7 participants; PCCL data were missing for 16 participants; Discharge Status data were missing for 78 participants; EQ-5Dprofile: Mobility data were missing for 62 participants, Pain data were missing for 64 participants, Self-care data were missing for 69 participants, Anxiety/Depression data were missing for 83 participants, Activity data were missing for 82 participants, $EQ\text{-}5D_{vas}$ data were missing for 249 participants, Pre-survey Length of Stay data were missing for 17 participants.

Table 2: Comparison of outcomes by participants' nutritional status and 24-hour % food intake bivariate level

Variables	Overall Results	As per Nutritional Status			As per % food intake		
		Well-nourished[a]	Malnourished[b]	*p*-value	≥50% intake[c]	≤ 25% intake[d]	*p*-value
Length of Stay (LOS) (days)[e]	11 (2 – 158)	10 (2 – 158)	15 (2 – 119)	0.000	11 (2 – 119)	13 (2 – 158)	0.000
Readmissions [f] (n (%)):							
1 readmission (n (%))	564 (19%)	349 (18%)	206 (23%)	0.000	435	122	0.378[g]
2 readmissions (n (%))	198 (7%)	127 (6%)	66 (7%)		161	35	
≥ 3 readmissions (n (%))	120 (4%)	68 (3%)	49 (5%)		88	31	
Mortality [f]:							
90 day in-hospital mortality (n (%))[h]	72 (2.4%)	28 (1%)	43 (5%)	0.000	40 (2%)	32 (5%)	0.000
30-day in-hospital mortality (n (%))	46 (1.5%)	22 (1%)	23 (2.5%)	0.010	25 (1%)	21 (3%)	0.001

[a] Well-nourished participants [1]: included those not at risk of malnutrition (MST[28]) and SGA-A[26]

[b] Malnourished participants [1]: included moderately (SGA-B)[26] and severely (SGA-C)[26] malnourished participants, and patients with BMI < 18.5 kg/m2 [27]

[c] ≥ 50% intake includes 50%, 75% and 100% food intake

[d] ≤ 25% intake includes nil-by-mouth, 0%, and 25% intake

[e] Continuous Variable presented as Median (Range) for data that is not normally distributed

[f] Categorical variables represented as n (%)

[g] non-significant (*p*-value >0.05)

[h] Includes 30-day in-hospital mortality results

Table 3: Bivariate and Ordinal Regression results for readmissions within 90-days of index hospitalisation (N= 3017)

Risk Factors	Bivariate Analyses			Ordinal Regression Analyses	
	Readmissions n (%)	No readmissions n (%)	*p*- value	Odds Ratio	CI (*p*- value)
MDC: Neoplastic	35 (43%)	47 (57%)	0.032	1.55	1.20 – 1.99 (0.001)
Discharge to Other Facility[a]	210 (50%)	209 (50%)	<0.001	1.43	1.16 – 1.51 (0.000)
Discharge to Usual Residence	633 (30%)	1465 (70%)	<0.001	1.33	1.16 – 1.51 (0.000)
Severe/Catastrophic PCCL score	650 (36%)	1171 (64%)	<0.001	1.30	1.18 – 1.43 (0.000)
Medical Partition	571 (37%)	976 (63%)	<0.001	1.22	1.00 – 1.48 (0.049)
MDC: Respiratory	145 (39%)	227 (61%)	0.005	1.15	1.00 – 1.31 (0.048)
Age ≥ 65 years	587 (36%)	1063 (64%)	<0.001	1.11	1.02 – 1.22 (0.021)
EQ_{vas} score[b]	50 (0 – 100)	55 (0 – 100)	<0.001	1.00	1.00 – 1.004 (0.044)
Malnutrition[c]	346 (36%)	605 (64%)	0.001	1.06[d]	1.04 – 1.17 (0.235)[d]

CI: Confidence Intervals; MDC: Major Diagnostic Category; PCCL: Patient Clinical Complexity Level

[a] includes residential aged care facility, rehabilitation, episode change within same hospital, other health facility

[b] Represented as median (range)

[c]Malnutrition[1]: included moderately (SGA-B)[26] and severely (SGA-C)[26] malnourished participants, and patients with BMI < 18.5 kg/m2 [27]

[d] non-significant (*p*-value >0.05)

Table 4a: Bivariate and Logistic Regression results for 30-day in-hospital mortality (N=3017)

Risk Factors	Bivariate Analyses			Logistic Regression Analyses	
	In-hospital mortality n (%)	No in-hospital mortality n (%)	*p*- value	Odds Ratio	CI (*p*- value)
Severe/Catastrophic PCCL score	44 (3%)	1745 (97%)	<0.001	8.18	1.93 – 34.73 (0.004)
MDC: Respiratory	13 (4%)	348 (96%)	0.03	1.78	0.81 – 3.93 (0.151)[a]
≤ 25% Food Intake	21 (3%)	629 (97%)	0.001	2.69	1.31 – 5.52 (0.007)
Malnutrition[b]	23 (3%)	906 (97%)	0.01	1.27	0.63 – 2.59 (0.504) [a]
Age ≥ 65 years	40 (3%)	1573 (97%)	<0.001	2.74	1.11 – 6.79 (0.03)
EQ_{vas} score[c]	50 (0 – 85)	51 (0 – 100)	0.03	0.99	0.98 – 1.01 (0.215) [a]

CI: Confidence Intervals; PCCL: Patient Clinical Complexity Level; MDC: Major Diagnostic Category

[a] non-significant (*p*-value >0.05)

[b] Malnutrition [1]: included moderately (SGA-B) [26] and severely (SGA-C) [26] malnourished participants, and participants with BMI < 18.5 kg/m^2[27].

[c] Represented as median (range)

Table 4b: Bivariate and Logistic Regression results for 90-day in-hospital mortality (N=3017)

Risk Factors	Bivariate Analyses			Logistic Regression Analyses	
	In-hospital mortality n (%)	No in-hospital mortality n (%)	*p*- value	Odds Ratio	CI (*p*- value)
Severe/Catastrophic PCCL score	68 (4%)	1721 (96%)	<0.001	6.01	2.14 – 16.89 (0.001)
MDC: Respiratory	19 (5%)	342 (95%)	0.001	1.91	1.01 – 3.61 (0.047)
≤ 25% Food Intake	32 (5%)	618 (95%)	<0.001	1.99	1.13 – 3.51 (0.017)
Malnutrition[b]	43 (5%)	886 (95%)	<0.001	1.91	1.09 – 3.34 (0.023)
Age ≥ 65 years	58 (4%)	1555 (96%)	<0.001	2.23	1.15 – 4.34 (0.018)
EQ_{vas} score[c]	43 (0 – 99)	51 (0 – 100)	<0.001	0.98	0.97 – 0.99 (0.015)

CI: Confidence Intervals; PCCL: Patient Clinical Complexity Level; MDC: Major Diagnostic Category

[a] non-significant (*p*-value >0.05)

[b] Malnutrition [1]: included moderately (SGA-B) [26] and severely (SGA-C) [26] malnourished participants, and participants with BMI < 18.5 kg/m^2[27].

[c] Represented as median (range)

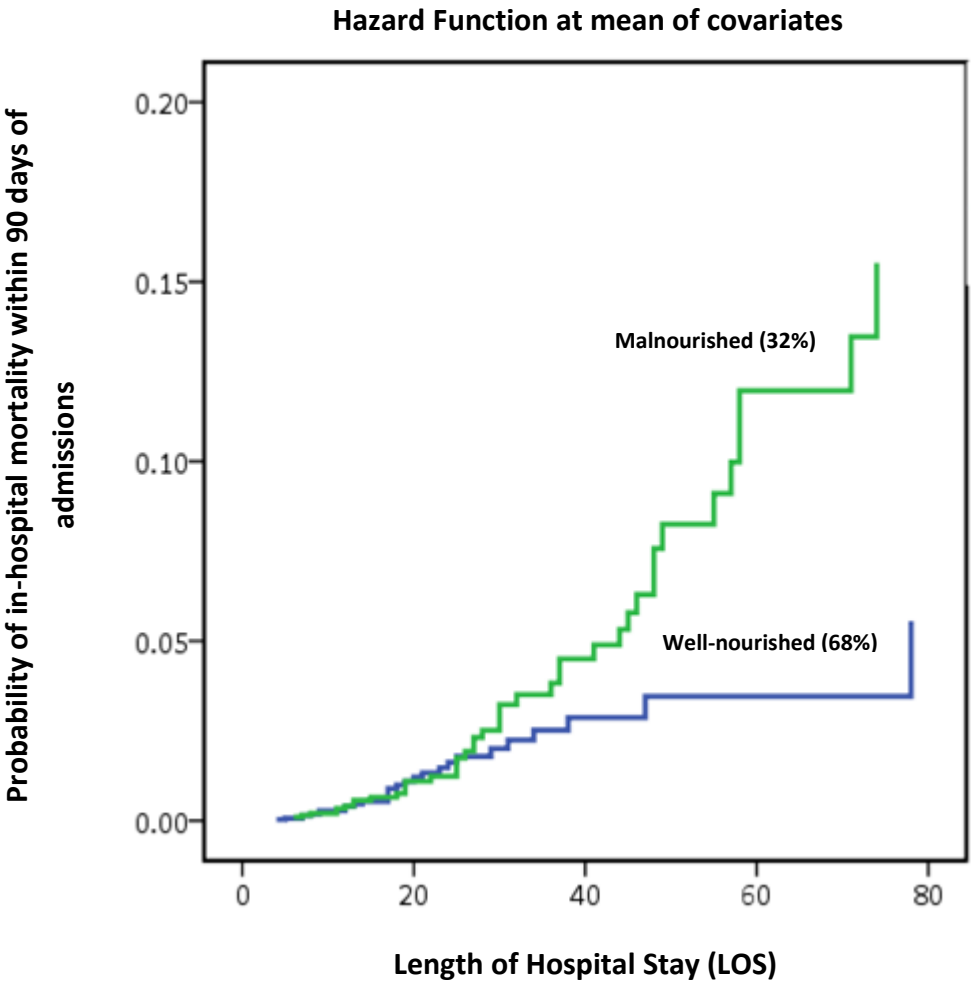
Table 5: Hazard Analysis of risk factors and 90-day in-hospital mortality (N= 3017)

Risk Factor	Hazard Ratio	CI (*p*- Value)
Surgical Partition	3.03	1.06 – 8.69 (0.039)
Medical Partition	3.71	2.01 – 6.85 (0.000)
Age ≥ 65 years	2.84	1.53 – 5.29 (0.001)
Severe/Catastrophic PCCL	3.55	1.27 – 9.92 (0.016)
≤ 25% Food Intake	2.29	1.39 – 3.76 (0.001)

CI: Confidence Interval; PCCL: Patient Clinical Complexity Level

Note: Other risk factors such as Main Diagnostic Categories, Admission Status, and gender were not significant

Figure 1: Cumulative incidence of 90-day in-hospital mortality in well-nourished and malnourished patients (N= 3017)



Appendix 1: Data collected for each participant:

Admission-related:	Admission Status	Whether it was an emergency, elective or other admission
	Australian Refined Diagnosis Related Group (AR-DRG)	Refers to Australia's national diagnosis related care (DRG) classification scheme that provides a clinically meaningful way for relating the number and types of patients treated in hospitals to the resources required by the hospitals [29]. AR-DRGs are assigned based on Principal Diagnosis [29]. While New Zealand used version 5.0 of the AR-DRGs, hospitals in Australia used a range of versions (4.2, 5, 5.1, 5.2, and 6). Since the study cohort represented a large number of AR-DRGs (n= 685) it was necessary to simplify the categorisation of participants by disease type**.** **Major Diagnostic Categories (MDCs),** which are based on a single body system or aetiology that is associated with a medical speciality and therefore include AR-DRGs and principal diagnoses [29], were used for this purpose. Since MDCs are uniform across various AR-DRG versions, categorising the type of disease into MDCs maintained consistency across the AR-DRG versions.
	Partition	MDCs are sub-divided into a maximum of three separate partitions or type of admissions: surgical, medical, and other. The presence or absence of operating room and non-operating room procedures is generally responsible for the assignment of the episode of admission to one or other of these partitions [29].
	Patient Clinical Complexity Level (PCCL) scores	refers to the cumulative effect of a patient's complications and comorbidities [29]. The calculation of these scores is a complex process and is designed to prevent similar conditions from being counted more than once [29]. PCCL scores are calculated for each episode of admission and range from 0 – 4 (for surgical episodes) and from 0 – 3 (for medical episodes) and are defined as follows [29]: 0 = not a complication or comorbidity 1 = a minor complication or comorbidity 2 = a moderate complication or comorbidity 3 = a severe complication or comorbidity 4 = a catastrophic complication or comorbidity.
	Discharge Status	refers to the discharge destinations of the participants after index hospitalisation. The following categories were used: ▪ Home/Usual residence ▪ Other hospital

		▪ Other healthcare facility- included residential aged care facility, rehabilitation, episode change within same hospital, other health facility ▪ Left against medical advice ▪ Death
Outcomes-related	Pre-survey LOS	Was computed as the difference between the date of the survey and date of admission. This was done to evaluate if length of hospital stay impacts food intake.
	Index LOS	Refers to the LOS for the index hospital admission (i.e. hospital admission during which participants were enrolled in Phase 1 of the study). It was computed as the difference between date of discharge and date of index hospital admission.
	Date of Death	Was used to compute the number of days between date of admission and date of in-hospital death.
	Readmissions	Were recorded, along with the frequency of readmissions, for up to 90 days from the date of index hospitalisation.
Quality of life	In Phase I of the survey, participants' self-perceived quality of life was assessed using EQ-5D, a non-disease specific two part questionnaire [14]. The first part of the questionnaire, $EQ\text{-}5D_{profile}$, comprises five dimensions: mobility, self-care, usual activities, pain, and anxiety or depression [14]. Each dimension is divided into three categories of severity (no, moderate, or extreme problem) [14]. The second part of the questionnaire includes a visual analogue scale, $EQ\text{-}5D_{vas}$, ranging from 0 (worst possible health) to 100 (perfect health) [14]. Although the EQ-5D was primarily designed for self-completion, it does allow for proxies to rate how they would rate the subject's health [14]. In the ANCDS, when appropriate, an authorised carer or next of kin was permitted to complete the questionnaire [14].	

Appendix 2: Steps undertaken to clean the dataset for outcomes variables:

Outcome	Steps undertaken to clean the dataset
Length of Stay (LOS)	Since LOS was positively skewed and varied across the Major Diagnostic Categories (MDC); trimming (deleting) LOS methodology was used to prevent outliers from having a significant and unrepresentative impact on the average LOS. The following steps were followed to trim the LOS data [30]: ***Step 1:*** Patients were excluded based on the following criteria [30]: • Death during index hospitalisation; • Missing data values for: LOS, age, discharge status, MDC, admission source, admission status, PCCL; • Discharge against medical advice. ***Step 2:*** Upper and lower trim points were calculated for each MDC as per the following equations [30]: Lower Trim Point= Q1 – (3*IQR); Upper Trim Point= Q3 + (3*IQR) where: • Q1: the first quartile of all patients records from the LOS dataset • Q3: the third quartile of all patients records from the LOS dataset • IQR: Q3 – Q1 ***Step 3:*** Since the lower trim points for MDCs were in negative values, participants with LOS > upper trim points for each MDC were excluded [30]. Participants with LOS= 1 day were also excluded as their admissions were more likely to be associated with clinical investigations or tests.
Readmissions	Participants who died during index hospitalisation were excluded from the analyses related to readmissions data.
In-hospital mortality	Participants who were not discharged within 90 days of index hospital admission were included in the analyses.

Appendix 3: Regression Models used for evaluating the association between confounding and outcome variables

Outcome variables	Regression Model used	Confounding variables[a]	Evaluable confounding variables[b]
LOS (square root)	Linear regression model	Partition, MDCs[31], age group[31], admission status, disease severity[31] (dichotomised PCCL score), nutritional status[31]	Dichotomised EQ-$5D_{profile}$, $EQ\text{-}5D_{vas}$ score, dichotomised percentage food intake (i.e. ≤25% and ≥50%)
Readmission	Ordinal regression model	LOS [21], surgical admission, medical admission, MDCs (respiratory, neoplastic), age group[31], disease severity [31](dichotomised PCCL score), discharge status (home/usual residence, other healthcare facility)	Nutritional status, dichotomised $EQ\text{-}5D_{profile}$ (excluding pain), $EQ\text{-}5D_{vas}$ score
Mortality	Logistic regression model	Emergency admissions, surgical admissions, respiratory disease, disease severity[31] (dichotomised PCCL score), age group[31]	Nutritional status, dichotomised % food intake, dichotomised $EQ\text{-}5D_{profile}$ (mobility, self-care), $EQ\text{-}5D_{vas}$ scores.
Hazard Analysis	Cox Regression model	Surgical and medical admission, MDCs, age group[31], gender[31], admission status, disease severity [31] (dichotomised PCCL score)	Nutritional status, dichotomised % food intake

EQ-5Dvas: EQ-5D visual analogue scale; LOS: length of hospital stay, MDC: major diagnostic category; PCCL: Patient Clinical Complexity Level

[a] Confounding variables: Variables that are considered risk factors as per the literature.

[b] Evaluable Confounding variables: Variables that demonstrated a significant association with the outcomes variable at a bivariate level requiring an evaluation of their significance at a multivariate level.