Final Report

Title:

Reducing hospital acquired malnutrition – early identification of deteriorating nutritional status and application of a decision tool for action: a proof of concept study.

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Abstract / Executive Summary

Title: Reducing hospital acquired malnutrition – early identification of deteriorating nutritional status and application of a decision tool for action: a proof of concept study.

Background: Malnutrition is a common, but often overlooked condition in hospitalised patients, contributing to higher hospital costs and morbidity and mortality. Further deterioration of nutritional status occurs in almost 70% of inpatient adults, due to catabolic effects of acute inflammation along with iatrogenic starvation and insufficient nutritional intake. Results of an ever increasing number of studies have shown that optimal nutrition care can improve patient outcomes and cut healthcare costs. Nevertheless, adherence to evidence-based nutrition care processes remains suboptimal in clinical settings in Australia, as is the case worldwide.

Aim: This study aimed to develop and evaluate a multidisciplinary decision support tool (DST) to enhance existing hospital nutrition care practices and increase early treatment for patients at risk of nutritional decline. Secondary outcomes include reduction in length of stay and reduction in mortality or hospital readmissions at 30 days.

Methods: This proof of concept study was conducted in four acute inpatient wards located at two Melbourne hospitals. A novel DST was developed in a stepwise approach, underpinned by an integrated literature review, project team workshops, and informed by feedback from an expert steering group and end-users. The feasibility of the DST was evaluated via an anonymous staff survey. A before-after study design was utilised to audit the effectiveness of the DST. A case report form was designed to collect baseline and intervention data including cohort characteristics, nutrition care processes and clinical outcomes for n=200 eligible patients on the study wards.

Results: The finalised DST comprised 'traffic-light' colours to stratify patient risk and provide stepwise actions for guiding nurse-led, dietitian-led and team-based nutrition care. Responses from n=40 multidisciplinary staff measured perceived presentation, content, efficacy and usefulness of the DST using a 5-point Likert scale ranging from 1 (strongly agree) to 5 (strongly disagree). Mean item scores identified positive and negative aspects of the DST, with an average score of 2.1 (standard error 0.8) across items, indicating a favourable response. Analysis of audit/case report data to date has identified significantly more patients at risk of malnutrition were referred to a Dietitian ($p = 0.02$) and this occurred earlier in the hospital episode of care ($p=0.014$) in the intervention group (n=52) compared to baseline (n=63), suggesting improved adherence to evidence based guidelines. The sample size included in this analysis failed to detect a significant difference in patient outcomes. Further analysis of nutrition care and outcome data is underway.

Conclusion: The trial of the DST was positively received by staff as the end users and assisted earlier identification of deteriorating nutritional status and earlier Dietitian referral for patients at nutrition risk than baseline care. Optimising the design of a bedside DST to support timely treatment for patient malnutrition warrants further study in larger-scale trials.

Key words: Malnutrition; iatrogenic disease; hospitals; hospitalization; length of stay; clinical coding.

Glossary of Terms and Abbreviations

ACQSHC	Australian Commission for Quality and Safety in Healthcare
CALD	Culturally and linguistically diverse
COF	Condition onset flag
ICD-10-AM	International Classification of Diseases, 10th Revision, Australian Modification
IHPA	Independent Hospital Pricing Authority
HAC	Hospital-acquired complication
HEN	Home Enteral Nutrition
HAMN	Hospital acquired malnutrition
MST	Malnutrition Screening Tool
PN	Parental Nutrition
SGA	Subjective Global Assessment

Additional diagnosis
A diagnosis other than the principal diagnosis that affected the care of the patient while in hospital.

Avoidable hospital readmission
Avoidable hospital readmission means readmission to hospital for a condition or conditions arising from complications of the management of the condition for which the patient was originally admitted.

Clinical coder
A trained person whose primary role is to analyse clinical documentation (medical records) and assign standard codes using a classification system(s).

Complication or adverse event
An injury caused by clinical management rather than the underlying disease or condition

Condition onset flag (COF)
The condition onset flag is a means of differentiating between those conditions which arise during, and those arising before, an admitted patient episode of care. The permissible values are:
COF=1: A condition which arises during the episode of admitted patient care and would not have been present or suspected on admission.
COF=2: A condition previously existing or suspected on admission such as the presenting problem, a comorbidity or chronic disease (Australian Consortium for Classification Development (2015). Australian Coding Standards, Ninth Edition: ACS)

Episode
The period of admitted patient care delivered in hospital, between a formal or statistical admission and a formal or statistical discharge.

Hospital acquired complications (HACs)
According to IHPA, hospital-acquired complication means a hospital-acquired patient complication, as defined by the national list developed, and amended from time to time, by ACQSHC, for which clinical risk mitigation strategies may reduce (but not necessarily eliminate) the risk of that complication occurring. A HAC is identified from information in the patient's medical record by both an additional diagnosis code that is on the HAC list, and a COF=1.

Hospital acquired malnutrition (HAMN)
Lacks a common definition in the literature and is referred to as a hospital complication, adverse event or nosocomial malnutrition. In this study, HAMN is a hospital-acquired patient complication, as defined by the national list developed, and amended from time to time, by ACQSHC, for which clinical risk mitigation strategies may reduce (but not necessarily eliminate) the risk of that complication occurring. HAMN is identified and operationalized from information in the patient's medical record by both an additional diagnosis code that is on the HAC list, and a COF=1 from in-house activity data.

In-house hospital activity data
Also referred to in literature as casemix, morbidity, activity or administrative data, is existing data, routinely generated from the patient medical record through the assignment of codes by professional clinical coders. Diagnoses, procedures and external causes of injury are coded using the *International Classification of Diseases* (ICD) and the *Australian Classification of Health Interventions* (ACHI). Victorian Health Services refer to this activity data as VAED.

ICD-10-AM Protein-Energy Malnutrition definitions:
E43 Unspecified severe protein-energy malnutrition
In adults, BMI < 18.5 kg/m2 or unintentional loss of weight (> 10%) with evidence of suboptimal intake resulting in severe loss of subcutaneous fat and/or severe muscle wasting.

E44 Protein-energy malnutrition of moderate and mild degree
E44.0 Moderate protein-energy malnutrition
In adults, BMI < 18.5 kg/m2 or unintentional loss of weight (5–9%) with evidence of suboptimal intake resulting in moderate loss of subcutaneous fat and/or moderate muscle wasting.

E44.1 Mild protein-energy malnutrition
In adults, BMI < 18.5 kg/m2 or unintentional loss of weight (5–9%) with evidence of suboptimal intake resulting in mild loss of subcutaneous fat and/or mild muscle wasting.

E46 Unspecified protein-energy malnutrition
Malnutrition 'not otherwise specified' (NOS)
Protein-energy imbalance NOS/deficiency

Background

Malnutrition is a state in which a deficiency of energy, protein, and other nutrients causes measurable adverse effects on the body and negatively impacts clinical outcome (Kirkland 2017). Malnutrition in a broad sense incorporates protein-energy malnutrition, under-nutrition, depletion, wasting and deficiencies of macro and micro-nutrients. Despite malnutrition being prevalent in approximately 30% of Australian hospitalized patients (Agarwal 2013), it is a condition often undetected by busy clinical staff (Adams 2008), it is seldom documented in medical records (Tobert 2018) and is therefore under-diagnosed. This leads to only a low proportion of malnourished or 'at risk' patients receiving appropriate nutrition treatment, including commencement of a preventative management plan (Henriksen 2017).

In addition to patients admitted with pre-existing malnutrition there is a sub group of patients who can present to hospital on a spectrum from 'well nourished' to 'nutritionally at risk' and develop malnutrition during their inpatient stay. Thus, malnutrition may also be a condition acquired in hospital during the patient's episode of care. It has been reported that deterioration in nutritional status occurs in almost 70% of inpatients, caused by catabolic effects of acute inflammation along with iatrogenic starvation and insufficient nutritional intake. This leads to increased morbidity, and a culminative effect on a range of adverse patient consequences such as infection, delayed wound healing and delirium (Kirkland 2017).

Results from the 2010 Australasian Hospital Nutrition Care Day Survey showed that of 3122 participants, 32% were malnourished and malnourished patients had a greater length of stay of median 5 days and higher readmission rates than well-nourished patients (Agarwal 2013). Consequently, in addition to the negative patient consequences, for the health system this leads to increased costs, increased hospital complications, greater antibiotic use, increased clinical intervention and increased staff time per patient (ACI 2012).

In 2014, malnutrition was identified as a national patient safety priority by the Australian Commission for Safety and Quality in Healthcare (ACQSHC) (ACQSHC 2017). Malnutrition is listed as one of sixteen hospital-acquired complications (HACs) due to its prevalence, high volume, impact on cost and because it is potentially preventable (ACQSHC 2017). In this study, a HAC refers to a hospital-acquired patient complication, as defined by the national list developed, and amended from time to time by ACQSHC, for which clinical risk mitigation strategies may reduce (but not necessarily eliminate) the risk of that complication occurring (ACQSHC 2017).

Results from recent studies of hospitalized patients show that nutrition screening, with follow-up nutritional assessment and care when indicated, can improve patients' clinical outcomes and reduce healthcare costs (Sriram 2017). Investment in food and nutrition care in hospitals can lead to benefits for both the patient and the health system. However, while there have been improvements in utilisation of malnutrition screening tools in Australian hospitals over time (Ferguson 2010), the adherence to evidence-based nutrition care processes remains suboptimal in clinical settings, as is the case worldwide (Correia 2014).

Measurement

Hospital-acquired malnutrition (HAMN) in Australian public health services can be definitively measured based upon patient-level medical records of the episode of care, and their clinical coding retrospectively following discharge. HAMN can be determined when an International Classification of Disease ICD-10-AM code for protein-energy malnutrition (E43, E44.0, E44.1, E46) is assigned as an additional diagnosis and the condition onset flag (COF=1) (METeOR identifier: 354816) is applied to indicate that the diagnosis occurred during the episode of admitted patient care (ACQSHC 2018).

Based on these definitions and specifications, patient outcomes of hospital-acquired malnutrition were operationalised for this study.

According to available data, the rate of HAMN in Australian hospitals was 12 per 10,000 hospitalisations in 2015–16. This translates to over 5,400 patient episodes of HAMN in Australian hospitals each year. Patients experiencing hospital-acquired malnutrition remained in hospital for 21.3 days longer on average than those without this hospital-acquired complication (IHPA 2018).

Costs

The costs of HACs to the healthcare budget in Australia have been estimated. Available data (Health Policy Analysis 2013) indicate that the mean incremental impact of any hospital-acquired complication was estimated to be $9,244 and 5.3 days in 2013 and the mean cost of hospital-acquired nutritional deficiency is $2,113 per episode and increases length of stay by 1.5 days.

More recent data from 2015-16 suggests each hospitalisation with HAMN may be associated with approximately $44,176 in extra costs (IHPA 2018).

It should be noted that clinical documentation and clinical coding practices can vary between hospitals and states, as does the quality of COF coding. This does lead to variation in measurement and reporting of HACs between jurisdictions, and this may under-estimate the impact of HACs (Health Policy Analysis 2013).

Aetiology

The aetiology of HAMN has been under researched and as such the risks of HAMN development remains ambiguous and not well understood by clinicians. What is clear is that patients hospitalised for longer stays on acute care wards will experience deterioration in nutritional status unless action is taken to prevent it (Bauer 2012). Results from a Canadian, multi-site, prospective cohort study (Allard 2015) showed that factors associated with nutritional decline in hospital are different for medical and surgical patients: lower admission BMI, presence of cancer, two or more diagnostic categories, new in-hospital infection diagnosis, reduced food intake, dissatisfaction with food quality and illness affecting food intake were significant in the medical group, whereas for the surgical group only male sex was significant.

Reduced food intake during hospitalisation is common; results from the 2010 Australasian Nutrition Day Survey showed 23% of the study population consumed ≤ 25% of the food offered (Agarwal 2013). Contributing factors to reduced food intake in hospitals include poor appetite, reduced availability of culturally acceptable or nourishing food, and iatrogenic starvation (Kirkland 2017).

Iatrogenic (caused in the context of medical investigations or treatment) causes may stem from a lack of knowledge of how quickly hospital-acquired malnutrition can develop, low priority placed on nutrition as a treatment modality, ambiguity about evidence-based treatment options, and lack of hospital policies, evidence based guidelines and support tools to guide best practice. For example, patients commonly suffer from delays to the recommencement of oral diet due after surgery to out-dated post-operative practices and undergo extended fasting for diagnostic tests and treatments where not medically indicated (Thomas 2017).

Staff practices and perceptions

Numerous studies have explored nursing perceptions of their role in providing evidence-based nutrition care and describe a range of barriers that can influence practice. In a recent study involving Danish nurses (O'Connell 2018), nursing staff expressed nutritional care was important, however described barriers including struggling with existing resources, lacking a common understanding of

how nutrition care tasks are valued and prioritised, and failing to initiate treatment to protect patient autonomy. The researchers describe a requirement for an increased level of education, knowledge and training in the field of nutrition care to bridge the practice gap between nursing treatment based on 'experience' and 'patient values' and treatments that also integrate evidence-based care. They conclude this could be achieved through improved collaboration between doctors and nurses to increase the focus of nutrition care during daily ward rounds, and nutrition prescriptions from medical staff with clear instructions for faster initiation of evidence-based treatment.

Similarly, in an exploratory study conducted in Canada with nutrition care personnel (dietitians, dietetic interns, diet technicians and menu clerks), a number of enablers were identified to provide quality nutrition care in acute hospitals. These included a culture where teams worked together to achieve nutrition goals, delineation of roles and tasks, use of effective tools such as screening and evidence based protocols, and the creation of flexible hospital and food service systems to support delivery of care (Keller 2013).

Targeting preventability

Despite the highly prevalent nature of patient malnutrition and the likelihood nutritional status will decline during hospitalisation, practice gaps in the delivery of evidence based nutrition care remain evident in Australia and internationally (Correia 2014).

Preventing malnutrition in hospitals is a complex problem to overcome; as the contributing factors are multi-factorial and clinical risk mitigation strategies and interventions must address patient factors, staff practices and hospital systems to be effective.

A greater focus on staff education to increase nutrition knowledge of healthcare providers (Silver 2018) and development and use of nutrition care tools or protocols to promote a multidisciplinary team approach and enable easy and quick decision making to support care delivery (Bounoure 2016) is warranted in order to address key barriers and enablers for the provision of evidence based nutrition care in hospital settings.

Building on the promising results of research groups across the globe working to implement evidence based nutrition protocols and care pathways into routine hospital care (Bounoure 2016, Correia 2014, Keller 2015), our key premise is that prevention and treatment of malnutrition can be improved with the use of a bedside decision support tool to increase the focus on nutrition care, guide multidisciplinary teamwork and enhance adherence to evidence-based nutrition care.

Aims

Building on the rising recognition and importance of nutrition care in hospitals, this study aimed to:

- develop and evaluate a novel multidisciplinary decision support tool to be located at the patient bedside,
- assess usability and feasibility of the decision support tool via a staff survey
- assess effectiveness of the tool to enhance existing hospital nutrition care practices and increase early treatment for patients at risk of nutritional decline.

The primary study outcome of interest was increased completion of malnutrition risk screening within 24 hours of admission and increased referrals to a dietitian for patients at risk of nutritional decline.

Secondary outcomes include reduction in length of stay and reduction in mortality or hospital readmissions at 30 days.

Research Team

An interdisciplinary research collaboration was formed between two Melbourne tertiary referral health services; St Vincent's Hospital Melbourne (SVHM) and Western Health (WH), and Victoria University, comprising subject expert, clinician and researcher expertise. An external project expert steering group was also convened to provide oversight and guidance to the project, with member expertise including clinical nutrition and dietetics, health information management, research and medicine. The project had a 24-month time line (refer to Appendix 1 for detail of each stage of the design).

Literature Review

An integrated literature review was undertaken to support the study. National and international research relating to identifying patients at risk of nutritional decline and management of adult malnutrition in acute hospital settings were identified and used to inform the development of the chosen intervention, a bedside decision support tool.

The following research questions were applied to available peer-reviewed literature;

- How is hospital-acquired malnutrition currently defined in adult populations in hospital settings?
- How is hospital-acquired malnutrition currently identified in adult populations in hospital settings?
- How is hospital-acquired malnutrition currently reported in adult populations in hospital settings?
- How is hospital-acquired malnutrition currently treated in adult populations in hospital settings?
- What clinical support tools are currently available to identify, diagnose and treat deteriorating adult inpatient nutritional status and how can they be adapted for different patient cohorts and clinical situations?

Specifically, the integrated review aimed to explore how hospital-acquired malnutrition was defined, identified, reported and treated, as well as identify the availability of evidence based decision support tools, care pathways, algorithms or protocols to assist frontline healthcare providers identify, prevent and treat malnutrition in hospitals.

Defining, identifying and reporting malnutrition

Although malnutrition is a global concern, there has been a fundamental lack of consensus on diagnostic criteria for application in clinical settings (Cederholm 2018). A recent review by Elia (2017) cited upward of 15 definitions of malnutrition found in the literature, ranging from dictionary definitions to those provided by national and international health organisations.

At the patient level, this leads to variation in diagnostic approaches and clinical documentation practices by healthcare providers, and this translates to inconsistencies in malnutrition diagnosis coding and reporting at the hospital level.

Elia (2017) highlights this ambiguity causes a gross underestimation (as much as 100-fold) in national statistics of malnutrition prevalence in hospitals, a conclusion confirmed in a large scale review of nearly 6 million hospital records across 105 academic medical centers in the U.S.A showing the

median report rate of all malnutrition was only 4.0% (Tobert 2018). This suggests an alarming lack of malnutrition diagnosis in clinical practice, in contrast to malnutrition rates closer to 30% reported in point-prevalence studies worldwide (Agarwal 2013).

The literature review undertaken for this study also confirmed a paucity of studies that specifically define 'hospital acquired malnutrition' as an outcome quality and safety dependent variable.

A Canadian multicenter prospective cohort study (Allard 2016) reported in-hospital decline in nutritional status, as assessed by Subjective Global Assessment (SGA) (SGA A to SGA B/C or SGA B to SGA C) and weight loss ≥ 5%, was associated with prolonged length of stay, independent of patient or disease severity factors. While in a single site study in the UK (Kingston 2017) the incidence of hospital acquired malnutrition was measured by evaluating changes in the nutritional screening scores of patients throughout hospital admission, as undertaken using a validated screening tool on day of admission to hospital and twice weekly thereafter.

In addition, and as noted earlier in this report, hospital clinical documentation standards and clinical coding practices vary, as does the quality of COF coding. This further contributes to variation in measurement and reporting of HACs and under-estimates the true impact of HACs, including HAMN. More research is needed to guide the practice of healthcare providers and professional clinical coders in this area.

It has been suggested that any reported increases in the prevalence or incidence of hospital malnutrition in the future may simply reflect an increase in awareness of standards of care for malnutrition identification and documentation and improved coding and reporting systems, especially as this is a goal of many health-care organisations in response to hospital safety and quality initiatives and activity based funding incentives (Elia 2017). Of particular interest, Tobert (2018) showed that hospitals with higher volume, ranking and patient satisfaction scores reported diagnosis of malnutrition more frequently, indicating higher quality of reporting not poorer quality of care.

Treatment of malnutrition

This ambiguity around malnutrition reporting also leads to difficulties in interpreting and translating published research results of successful malnutrition prevention and treatment strategies in the clinical setting.

Treatment of malnutrition in hospitals is a complex problem to overcome; as the contributing factors are multi-factorial and interventions must address patient factors, staff practices and hospital systems to be effective.

The success of addressing malnutrition in hospitalised patients depends not just on the nutritional therapy selected but also on the timely and appropriate application of guidelines and standardized protocols by frontline healthcare staff (Hamilton 2013). Results from recent studies of hospitalized patients show that nutrition screening, with follow-up nutritional assessment and care when indicated, can improve patients' clinical outcomes and reduce healthcare costs (Sriram 2017).

First line treatments of oral feeding through diet enrichment or oral nutrition supplements have consistently been shown to provide nutrition, clinical, functional and economic benefits (Hamilton 2013). Oral nutrition is the preferred method of nourishment; however, specialised nutrition support is considered for patients unable to meet their nutrient requirements adequately. Enteral nutrition support is recommended as second line treatment, and parenteral nutrition support as third line treatment is indicated when the gastrointestinal tract cannot be safely used.

Use of clinical support tools in nutrition care delivery
The development of the novel decision support tool for this study was underpinned by the integrated literature review, which supported broad nutrition intervention strategies that are targeted to defined patient cohorts, address common barriers and enablers for providing optimal care, promote a multidisciplinary approach, and improve staff knowledge and awareness (Bell 2014). In particular, we have chosen nutrition care pathways and protocols developed internationally (Bounoure 2016, Correia 2014, Keller 2015) and adapted these to our study in Australian acute hospital settings.

Study setting

The feasibility and effectiveness of the decision support tool to assist in the prevention and treatment of malnutrition in acute hospital settings was explored by conducting a proof of concept study across four acute inpatient wards (two study wards at SVHM and two study wards at WH).

Study ward selection
We used a process of clinical utilization review, working with internal hospital performance unit experts to review retrospective coded malnutrition activity data to ascertain study ward selections. This data analysis identified wards with higher prevalence of malnutrition to enable our intervention to be tested in a patient population at higher exposure to the risk. The four study wards ultimately selected comprised mixed patient cohorts admitted under Gastroenterology, Urology, Colorectal Surgery and General Medicine units at SVHM, and Gastroenterology, Respiratory, Infectious Disease and General Medicine units at WH. These patient cohorts typically present to hospital with medical diagnoses such as inflammatory bowel disease and cancers, liver disease, heart and/or pulmonary disease and multi co-morbidities of older age, lending to higher expected rates of malnutrition as an additional diagnosis.

Study Design

To evaluate the decision support tool's feasibility and effectiveness on the study wards, a staff survey was undertaken and an observational patient cohort audit comprising a quasi-experimental pre-post intervention methodology was performed.

A number of survey instruments were developed by the researchers for this study.

Clinician survey
To evaluate the decision support tool's feasibility, a cross sectional survey was undertaken with n=40 doctors, nurses and dietitians working on the study wards during the intervention period (May-July 2018).

The survey (see Appendix 2) sought clinician responses to the presentation, content, efficacy and usefulness of the decision support tool using a 5-point Likert scale ranging from 1 (strongly agree) to 5 (strongly disagree). Participants were also able to provide extended text responses within the survey to help elaborate issues reported.

Audit/case report form
To evaluate the decision support tool's effectiveness on the study wards, an observational audit comprising a pre-post intervention methodology was undertaken. A case report form was designed

to collect patient-level data from paper-based medical histories, including demographic and clinical characteristics, nutrition care processes and clinical outcomes of interest (see Appendix 3).

The audit of standard (baseline) care comprised eligible patients sequentially admitted to the study wards during May-June 2017. The audit of decision support tool (intervention) care comprised eligible patients sequentially admitted to the study wards during May-July 2018.

Ethical approval

Ethical approval for the study was granted by the St Vincent's Hospital Melbourne Human Research Ethics Committee (ethics approval number SVHMLRR 032/18). Consent for staff participation was implied when completed surveys were returned. A waiver of informed consent for the collection of patient-level data was obtained for eligible patient participants.

Defining standard (Baseline) Nutrition Care

Both Western Health and St Vincent's Hospital Melbourne hold full accreditation under the Australian Health Service Safety and Quality Accreditation Scheme, and as such have established robust local nutrition governance processes, evidenced by overarching hospital nutrition committees, local nutrition care policies and regular audits of nutrition practice.

To assess the quality of baseline nutrition care processes at the study sites, existing nutrition care practices were mapped against the Patient Nutrition Care Journey framework (NSW Agency for Clinical Innovation (ACI) 2012). This framework, underpinned by the NSW Health Nutrition Care Policy (NSW Health 2017), local health district Nutrition and Food Governance committees, and ACI Diet Specifications for Adult Inpatients (ACI 2015), outlines key processes and tasks required to ensure patients receive appropriate nutritional care throughout their admission to hospital.

Development of the decision support tool

The literature search identified evidence-based malnutrition screening tools, decision support tools, care pathways, algorithms or protocols (Bounoure 2016, Braden 1998, Correia 2014, Keller 2015, Roller 2016). These were reviewed by the project team for applicability to the mixed patient cohorts in Australian acute hospitals.

The decision support tool was designed to:

- increase the focus of the importance of nutrition care in hospitals
- delineate roles and tasks of healthcare providers in the nutrition care process
- enhance existing hospital nutrition care practices of malnutrition risk screening and referral to a dietitian or nutrition support team
- identify and stratify patient risk factors for declining nutritional status during the episode of care such as presence of nutrition impact symptoms and reduced food intake
- build better interdisciplinary communication between nurses, dietitians and doctors
- support evidence based clinical decision making to guide escalation of treatment from standard to specialised interventions

The format and content of the decision support tool was developed over a six-month period in a stepwise, iterative approach and refined via three project team workshops, and email input and feedback from the project's expert steering group. Individual and small group meetings with end-users (front line hospital nurses, dietitians and medical staff) were also undertaken by researchers at both participating study sites for further refinement.

A novel feature of the decision support tool (see Appendix 4) that has not been previously reported in the literature was the development of 'traffic-light' colours that indicate to end-users the level of

patient risk (red=high risk, amber=moderate risk, green=low risk). This feature was designed as a guide to prompt stepwise and escalating clinician processes. This tool included actions for guiding standard nurse-led care, triggers for referral to a dietitian to implement comprehensive care, and parameters for timely escalation to the medical team for initiation of more specialised treatment involving enteral tube feeding or parenteral nutrition support. Prompts for clinical handover or discharge planning were also included so nutrition care could be continued after the acute hospital stay if needed.

Decision Support Tool (Intervention) Care
A colour printed copy of the decision support tool was laminated as an A4 form and placed in the bedside chart of all patients on the study wards for the duration of the intervention period. During a two-week run-in period prior to the intervention commencing, the researchers provided brief staff education sessions to clinicians working on the study wards. These were scheduled during nursing handover or existing ward meetings times to maximize attendance.

With the intention of promoting the project and enhancing uptake of the intervention, a comprehensive accompanying written user guide was made available. The user guide described the research project and provided instructions for using the decision support tool, with the intention of promoting the project and to enhance uptake of the intervention

During the intervention period, all patients on the study wards continued to receive nutrition care according to local hospital nutrition care policies, practices and procedures — irrespective of their eligibility for inclusion in the data collection for this study. The decision support tool intervention was designed as a prompt to facilitate and enhance adherence to existing evidence based hospital nutrition care policies and procedures. Patient consent for any nutrition treatment interventions by dietitians and clinicians was sought according to usual ward and professional care standards of practice.

Data Management

Clinician survey
The anonymous clinician paper-based surveys were transcribed onto a password protected Excel data base. As participants were also able to provide extended text responses within the survey, these were transcribed verbatim to allow for qualitative content analysis.

Patient audit data
The baseline and intervention medical history audits of patient demographic, clinical and nutrition care data were completed by members of the research team and transcribed onto paper case report forms. Patient-level identifying information was collected in a numerical, re-identifiable format in order to collect coded activity data and 30-day outcome information. Paper audit forms were transcribed to a password protected Excel data base.

Sample size and statistical power

Clinician Survey
A convenience, cross sectional sample of doctors, nurses and dietitians working on the study wards during the intervention period were recruited to complete the clinician survey. Staff were invited to participate by email and face to face at staff meetings. The researchers aimed to collect 10 staff surveys per study ward (total n=40).

Sample size and statistical power
As the primary purpose of this proof of concept study was to design a novel decision support tool prototype and explore its feasibility and uptake in the hospital ward setting, less emphasis was placed on a sample size calculation to achieve statistical significance for primary and secondary outcomes, and as such one was not performed.

Patient audit data
Baseline patient audit: Based on the expected number of patient admissions, as well as meeting inclusion criteria and pragmatic considerations of data collection burden with available resources, researchers conducted a retrospective audit of 100 consecutive eligible patient admissions for an eight week period in May – June 2017; that is 25 patient audits per study ward.

Intervention patient audit: In addition, 100 consecutive eligible patient admissions meeting the inclusion criteria during the eight week intervention period, May – July 2018, underwent medical history audit; that is 25 patient audits per study ward.

This report has incorporated analysis from 40 staff, and 63 baseline and 52 intervention patients due to delays in data collection and analysis. Further analysis of nutrition care and outcome data is underway.

Data/statistical analysis

Clinician survey:
Survey data was exported to SPSS Version 20 for analysis. In order to handle potential non-response bias, data will be weighted back to the overall clinical population of WH and SVHM using a weighting statistical analysis, raking adjustment process.

Descriptive statistics were employed to present the demographic characteristics of the participants. Frequency distribution, summary statistics, cross-tabulation and filters will be used to describe all demographic data.

Responses to individual questions (items) were tabulated. An exploratory factor analysis was undertaken, starting with a single factor solution, in an attempt to derive a factor score. Subsequently, factor scores were calculated by averaging over the items. Difference in scores between sites was tested for using a two sample t-test.

Content analysis was undertaken of qualitative responses to guide future decision support tool iterations, promote sustainability of the tool as well as plans for wider implementation and larger scale trials.

Patient audit data:
Patient data was analysed using R 3.4.2 and the survival package. Descriptive statistics for baseline data were tabulated. Differences between sites and between pre- and post-intervention extractions were assessed using fisher's exact test for categorical variables and t-tests for continuous variables. Differences in binary/categorical outcome variables were assessed with the Mantel-Haenszel tests (which extends the chi-square test to allow for stratification by site). Time to event data was visualised using the (non-parametric) Kaplan-Meier estimator wherein patients were censored at discharge from hospital. Differences between curves were assessed using the stratified log-rank test which adjusts for differences in baseline performance between the two sites. Due to the small sample size, further adjustment for covariates was not attempted.

Results

Standard nutrition care processes (baseline practice)

To support best practice in malnutrition prevention and management both WH and SVHM have a number of department and organisation wide policies and procedures in place that govern the nutrition care processes for patients. WH and SVHM undertook a traffic light self-assessment to assess quality of baseline nutrition care. Differences and similarities in hospital systems and practices can be seen across study sites, which may affect applicability of the study findings to other healthcare settings.

Table 1: Summary of standard nutrition care processes (baseline practice)

Adaption of Patient Nutrition Care Journey framework (ACI 2012)	**Task** *(responsibility)*	**WH**	**SVHM**
On admission - medical / nursing assessment including information relating to food and nutrition	Complete admission medical / nursing assessment *(medical / nursing staff)*	IP	IP
Initial diet order	Prescribe and/or authorise the diet and place the diet order *(medical officer, nurse, dietitian, allied health assistant, dietitian assistant, speech pathologist or clerical staff)*	I	I
Nutrition Risk Screening	Use a validated nutrition risk screening tool and document *(clinical staff trained in nutrition risk screening)*	I	I
Referral to Dietitian and other services	Refer any patient identified at risk of malnutrition to a clinical dietitian for nutrition assessment *(clinical staff who completes the nutrition risk screening)*	I	I
Patient Menu Selection	Assist the patient/carer to make adequate selections from menu (*assistants with appropriate training (e.g. food service, dietetic or allied health assistants)*	IP	I
Meal Assembly	Assemble the meal according to patients meal selections; therapeutic diet specifications; standardised portions; attractive presentation; food safety standards *(food service staff)*	I	I
Meal Delivery	Deliver the correct meal to the correct patient and position the meal/tray safely *(food service or support staff)*	I	IP
Mealtime Environment	Prepare patient for meals. Minimise disruptions; ensure sufficient staff on ward at mealtimes; identify patients who require assistance/supervision; allocate help *(coordinated by nursing staff)*	IP	IP
Supervision and Assistance to Eat and Drink	Provide supervision and assistance with eating and drinking *(nurses, appropriately trained clinical staff, e.g. under the guidance of a speech pathologist for dysphagic patients)*	I	IP
Mealtime Observation	Observe and actively participate in mealtime environment to recognise changes to the patient's needs/capacity *(responsibility of all staff, relatives, carers and volunteers involved in the mealtime environment)*.	IP	IP
	Ensure current nutrition care plan is implemented, document observations and intake accurately *(responsibility of nursing staff, may be completed by assistants with appropriate training)*	IP	IP

Key: red = not developed, amber = in progress, green = implemented

Acceptability and feasibility of the decision support tool - staff survey feedback

Most respondents were registered nurses (70%) followed by dietitians (25%) and medical staff (5%). The majority of respondents (52.5%) had 6-15 years of clinical experience and most worked in a part time capacity (57.5%). Refer to Table 2 for demographic information of clinical staff completing the survey.

Table 2: Staff survey Demographic Information

	SVHM (n)	*WH (n)*	*Total (n(%))*
Total survey respondents	20	20	40
How have you been working as a health professional?			
<1 year	1	2	3 (7.5%)
1-5 years	5	6	11 (27.5%)
6-15 years	12	9	121 (52.5%)
16-25 years	2	1	3 (7.5%)
26 years or more	0	2	2 (5%)
Respondents' employment status			
Full time	6	8	14 (35%)
Part time	12	11	23 (57.5%)
Casual	1	0	1 (2.5%)
Bank	0	0	0 (0%)
Graduate nurse program	1	1	2 (5%)
Agency	0	0	0 (0%)
Other	0	0	0 (0%)
Respondents' employment category			
Registered Nurse	11	17	28 (70%)
Dietitian	7	3	10 (25%)
Medical staff	2	0	2 (5%)
Clinical manager	0	0	0 (0%)
Other	0	0	0 (0%)
Self-rated previous knowledge of decision support tools			
Very good	5	4	9 (22.5%)
Moderate	12	14	26 (65%)
Basic	2	2	4 (10%)
Minimal/none	0	0	0 (0%)

Previous experience with using decision support tools			
Yes	11	12	23 (57.7%)
No	7	7	14 (35%)

Experience with decision support tools

Twenty-three respondents (57.5%) had experience with using clinical decision-support tools in the clinical setting and nine respondents had experience with tools for nutrition care and management, such as an ICU feeding protocol, TPN guidelines, and upper gastrointestinal surgery decision support tool for patients requiring enteral feeding.

Usefulness and feasibility of the tool

Thirty-three respondents (82.5%) strongly agreed or agreed the tool was easy to follow with eight respondents (20%) specifically commenting the tool was easy to follow. Traffic light colours were helpful (85% (n=34) strongly agree or agree) and the flow chart was logical (80% (n=32) strongly agree or agree). Refer to Table 3 for details.

Exploratory factor analysis revealed that answers to questions were related to one another (all factor loadings >0.7) except for one item. With the removal of the one negative question in the survey "I found the tool to be onerous in terms of workload" and one respondent that didn't complete all the questions, the majority of respondents scored 3 (neutral) or lower (2 = agree, 1 = strongly agree) to questions relating to the presentation, logic, and ability to use the tool. The average score over all positive items and including all respondents with complete answers was 2.1, with a standard error 0.8, suggesting a favourable opinion of the tool. There was a statistically significant higher average score for St Vincent's respondents compared to Western Health (SVHM (n=20) 1.8 ± 0.5, WH (n=19) 2.4 ± 1.0, p=0.021).

Table 3: Staff responses to questions about decision support tool

Was the tool well presented?			
Strongly agree	7	2	9 (22.5%)
Agree	12	11	23 (57.5%)
Neither agree or disagree	1	5	6 (15%)
Disagree	0	0	0 (0%)
Strongly disagree	0	2	2 (5%)
Did the tool present information in a logical manner?			
Strongly agree	7	2	9 (22.5%)
Agree	12	11	23 (57.5%)
Neither agree or disagree	1	6	7 (17.5%)
Disagree	0	0	0 (0%)
Strongly disagree	0	1	1 (2.5%)
Did the tool include relevant information for describing optimal nutrition management*?*			
Strongly agree	8	5	13 (32.5%)

Agree	10	10	20 (50%)
Neither agree or disagree	2	4	6 (15%)
Disagree	0	0	0 (0%)
Strongly disagree	0	1	1 (2.5%)
Was the tool clear in terms of giving specific advice for action?			
Strongly agree	9	4	13 (32.5%)
Agree	11	12	23 (57.5%)
Neither agree or disagree	0	3	3 (7.5%)
Disagree	0	0	0 (0%)
Strongly disagree	0	1	1 (2.5%)
Was the tool easy to follow*?*			
Strongly agree	8	3	11 (27.5%)
Agree	11	11	22 (55%)
Neither agree or disagree	1	5	6 (15%)
Disagree	0	0	0 (0%)
Strongly disagree	0	1	1 (2.5%)
Were you able to access information for clinical decision-making within the information and workflow of the tool*?*			
Strongly agree	8	5	13 (32.5%)
Agree	9	9	18 (45%)
Neither agree or disagree	3	3	6 (15%)
Disagree	0	1	1 (2.5%)
Strongly disagree	0	2	2 (5%)
Do you think the tool helps with identifying patients at risk of malnutrition?			
Strongly agree	9	4	13 (32.5%)
Agree	10	11	21 (52.5%)
Neither agree or disagree	1	3	4 (10%)
Disagree	0	1	1 (2.5%)
Strongly disagree	0	1	1 (2.5%)
I found the tool enhanced communication between nurses, dietitians and doctors			
Strongly agree	5	0	5 (12.5%)
Agree	8	10	18 (45%)
Neither agree or disagree	5	5	10 (25%)

Disagree	2	3	5 (12.5%)
Strongly disagree	0	2	2 (5%)
The tool supported timely care options/treatment for patients at risk of malnutrition			
Strongly agree	5	1	6 (15%)
Agree	11	12	23 (57.5%)
Neither agree or disagree	4	4	8 (20%)
Disagree	0	1	1 (2.5%)
Strongly disagree	0	2	2 (5%)
I found the tool to be onerous in terms of additional workload			
Strongly agree	1	0	1 (2.5%)
Agree	4	7	11 (27.5%)
Neither agree or disagree	8	10	18 (45%)
Disagree	5	2	7 (17.5%)
Strongly disagree	2	1	3 (7.5%)
The tool was adequately incorporated into clinical workflow			
Strongly agree	1	1	2 (5%)
Agree	9	11	20 (50%)
Neither agree or disagree	6	4	10 (25%)
Disagree	4	2	6 (15%)
Strongly disagree	0	2	2 (5%)
I knew how to get further information about the tool if I had queries			
Strongly agree	11	3	14 (35%)
Agree	8	10	18 (45%)
Neither agree or disagree	0	2	2 (5%)
Disagree	1	2	3 (7.5%)
Strongly disagree	0	2	2 (5%)
I feel confident using the tool			
Strongly agree	7	3	10 (25%)
Agree	12	10	22 (55%)
Neither agree or disagree	1	4	5 (12.5%)
Disagree	0	1	1 (2.5%)
Strongly disagree	0	2	2 (5%)

The tool was user centred			
Strongly agree	4	2	6 (15%)
Agree	11	9	20 (50%)
Neither agree or disagree	5	5	10 (25%)
Disagree	0	2	2 (5%)
Strongly disagree	0	2	2 (5%)
I would support the implementation of the tool in the future			
Strongly agree	6	2	8 (20%)
Agree	7	10	17 (42.5%)
Neither agree or disagree	7	5	12 (30%)
Disagree	0	1	1 (2.5%)
Strongly disagree	0	2	2 (5%)

Strengths of the tool

Examples of descriptive responses to the tool's strengths are summarized in Table 4:

Table 4 Usefulness and feasibility of the tool: participant comments

Clear guidelines to dieticians on when to escalate care Information for nursing staff on what is considered inadequate intake Information for nursing staff on identifying nutrition (needs) on admission
Started conversation between staff sooner; rather than later Provides clear guidance to support earlier initiation of enteral nutrition
Clear guidelines, very thorough, very beneficial for preventing and recognizing malnutrition and for promoting positive clinical patient outcomes
Encouraged nursing led care. Parameters (set) for nursing to assess adequacy of oral intake Provided guidance for documentation e.g. documenting barriers to food intake. Can assist with communicating nutrition issues to medical staff (such as) 'patient not meeting nutrition target'
Easy to follow traffic light system. Improved referrals – more prompting for nurses and able to identify with risk patients. Good to help with advocating for nutrition support
Clear indicators for escalation in nutrition support and increased conversations with medial team regarding nutrition support and care
Assisting nurses in deciding whether a patient is at risk of malnutrition. Gives nurses a tool to work with and to know when to refer to the dietitian. If implemented, it would give more evidence for the commencement of enteral feeding with reluctant doctor
Easy to follow, clear pathway regarding patient management, encourage increased communication between health professionals

Improvements needed to the tool

Five key areas were identified as needing improvement and these are summarized below. Text in italics represents a participant response.

1. Presentation and format

Several points were raised about the tool's format and updates based on this feedback will be made as follows: Some areas needed to be clearer with less words and the title bigger; other areas were too cluttered and arrows at certain points in pathway, needs to be simplified.

2. Need for ongoing education

Seven participants emphasized the need for further education as expressed in the following quotes: *More information re making sure people know about it; Tool good, but feel like need more education to new staff and to prompting to look at the tool; More education re support tool as some staff not familiar; Provide more talks about it, using case studies; It would need a lot of education and ongoing support for nurses to actually use it in their day to day routine, especially given everything else they need to do.*

These points do show the need for ongoing education across units to ensure the sustainability of the tool.

3. Enhancements needed

Four participants provided explicit advice about enhancements needed to the tool:
Make sure doesn't get lost in back of bed chart. Further information on tool around dot points in Dietitian Led Action section, e.g., it says resolving delirium/agitation' but would be good to highlight if good or bad to consider feeds in this situation; Tool to be in front of folders – people often forget they are there. Slightly unrealistic tool i.e. after 3 days of not meeting 75% requirements (this is most people in hospital; 50% may be more realistic – Less information altogether – people more likely to use; Consider instead of detailing what each level of care indicated adding in the malnutrition screening tool to the document (color coded as above); Tool should be part of admission pack. Tool does not allow for family/patient understanding. Tie into Sunday weigh time for all patients. Part of food description chart including weight on chart

4. Process improvement matters

Two participants provided advice on process matters: *I think it would be better utilized in the dietitian who commenced intervention continued the intervention I personally found it difficult to come in when intervention had already commenced*; *75% target is not realistic. Despite staff nurses being educated on tool, there were inconsistencies (miscommunication regarding understanding tool) and time consuming (tracking which patients were exposed to the tool)*

5. Leadership

One comment had been made about leadership: *Required large "buy in" from dietitians, nursing and medical. I felt this wasn't always present. A larger push from Nursing Leadership on the ward may help*

Examples of how tool was used

Key points from respondents showing examples of tool use are provided in Table 5:

Table 5: Respondent examples of how tool used

I had a patient not meeting 75% percent requirements and the tool promoted me to consider escalation of care earlier that I usually would and have appropriate discussion with medical staff; It also prompted me to document discussions (more the 'user guide' than actual tool)
Patient on free fluid diet post op many days, but not clinically malnourished. Used tool. Definitely need dietitian input – prompting is great
Patient not eating much. Referred to dietitian, especially during breakfast. Was given special menu and patient was happy and more cooperative
Post-op patient with (problems). Able to recognize patient at risk of malnutrition and base with dietician
For a patient who has been on clear/free fluids for >24 hours, to show medical team patient may be at risk of hospital acquired malnutrition. Also great for graduate nurses to know importance of timely dietician referral and when to refer
Patient that had <75% requirements due to small bowel obstruction; used tool to advocate for TPN
The tool promoted discussion with medical team earlier than usual regarding escalating of nutrition support
I have used the tool on ~2 occasions where MST was low (1 or 2) to refer patient for nutrition assessment.
It prompted early referrals for dietetic intervention
This tool assisted with a clinical situation whereby a patient discharged from ICU pulled out his nasogastric tube and there was a question if it should be reinserted. The tool prompted me to have a discussion with the medical team if the nasogastric tube should be inserted earlier than I otherwise would have

Effectiveness of the Tool – pilot study utilising before-after design

Ward characteristics and demographics of participants

Refer to Table 6 and 7 for details of included patient demographics. Weight, % weight change, height, BMI, and details of principal diagnosis and comorbidities were not included in this report. Patients were predominantly elderly (mean age >65 years), multi-morbid, community dwelling and admitted to a general medicine unit. Of note, 27.0% of WH patients in the intervention group were admitted to the intensive care during their hospital stay compared to 3.8 % of SVHM patients, which may indicate higher disease severity in the WH group.

Table 6: Unit and ward characteristics

	SVHM		WH		Total		
	Baseline	**Intervention**	**Baseline**	**Intervention**	**Baseline**	**Intervention**	**P Value**
Total admitted patients in study	26	26	37	26	63	52	
Admissions per ward							0.828
7W	13 (50%)	13 (50%)	N/A	N/A	13 (20.6%)	13 (25%)	

8W	13 (50%)	13 (50%)	N/A	N/A	13 (20.6%)	13 (25%)	
2D	N/A	N/A	18 (48.6%)	13 (50%)	18 (28.6%)	13 (25%)	
2C	N/A	N/A	19 (51.4%)	13 (50%)	19 (30.2%)	13 (25%)	
Admissions per unit							0.05
Gastroenterology	2 (7.7%)	8 (30.8%)	4 (10.8%)	5 (19.2%)	6 (9.5%)	13 (25%)	
General medicine	13 (50%)	12 (46.2%)	21 (56.8%)	11 (42.3%)	34 (53.9%)	23 (44.3%)	
Urology	1 (3.8%)	4 (15.4%)	N/A	N/A	1 (1.6%)	4 (7.7%)	
Colorectal	10 (38.5%)	2 (7.7%)	N/A	N/A	10 (15.9%)	2 (3.8%)	
Respiratory	N/A	N/A	9 (24.3%)	9 (34.6%)	9 (14.3%)	9 (17.3%)	
Infectious diseases	N/A	N/A	3 (8.1%)	1 (3.8%)	3 (4.8%)	1 (1.9%)	

Table 7: Participant demographics and characteristics

	SVHM		**WH**		**Total**		
	Baseline	**Intervention**	**Baseline**	**Intervention**	**Baseline**	**Intervention**	**P Value**
Number of patients in study							0.141
Number of female patients	12 (46.2%)	14 (53.8%)	11 (29.7%)	13 (50%)	23(36.5%)	27 (51.9%)	
Number of male patients	14 (53.8%)	12 (46.2%)	26 (70.3%)	13 (50%)	40 (63.5%)	25 (48.1%)	
Living Situation							0.306
Alone	10 (38.5%)	12 (46.2%)	10 (27%)	10 (38.5%)	20 (31.7%)	22 (42.3%)	
With Family, carers, other	13 (50%)	12 (46.2%)	22 (59.5%)	15 (57.7%)	35 (55.6%)	27 (51.9%)	
Residential Care	3 (11.5%)	2 (7.7%)	5 (13.5%)	1 (3.8%)	8 (12.7%)	3 (5.8%)	
CALD	17 (65.45%)	4 (16%)	8 (22.2%)	8 (34.8%)	25 (40.3%)	12 (25%)	0.138
Interpreter Required	9 (34.6%)	3 (11.5%)	5 (14.3%)	2 (9.1%)	14 (23%)	5 (10.4%)	0.145
Mean MST score ± SD	1.0 ± 1.6	1.2±1.7	1.1±1.1	1.9±1.9	1.1 ± 1.2	1.6 ± 1.8	0.159
Mean Age ± SD	76.7 ± 12.6	65.7 ± 19	67.1 ± 17.8	64.4 ± 19.4	71.0 ± 16.4	65 ± 19	0.076
Count of Comorbidities ± SD	7 ± 2.9	5.2 ± 3.2	4.8 ± 2.5	5.0 ± 2.6	5.7 ± 2.9	5.1 ± 2.9	0.265
Average LOS in ICU for patients that went to ICU +/- SD	1±0 (n=1)	3±0 (n=1)	7.2±9.9 (n=4)	5.4±5.5 (n=7)	6.0 ± 9.0 (n=5)	5.1 ± 5.1 5.2 (n=8)	0.85

Abbreviations: SD = Standard Deviation (95% CI), MST = Malnutrition Screening Tool

Study outcomes

The primary study outcome of interest was increased completion of malnutrition risk screening within 24 hours of admission and increased hazard rate of referral to dietitians, leading to more and /or sooner referrals. Multiple testing was controlled for by using Bonferonni correction, essentially alpha = 0.025.

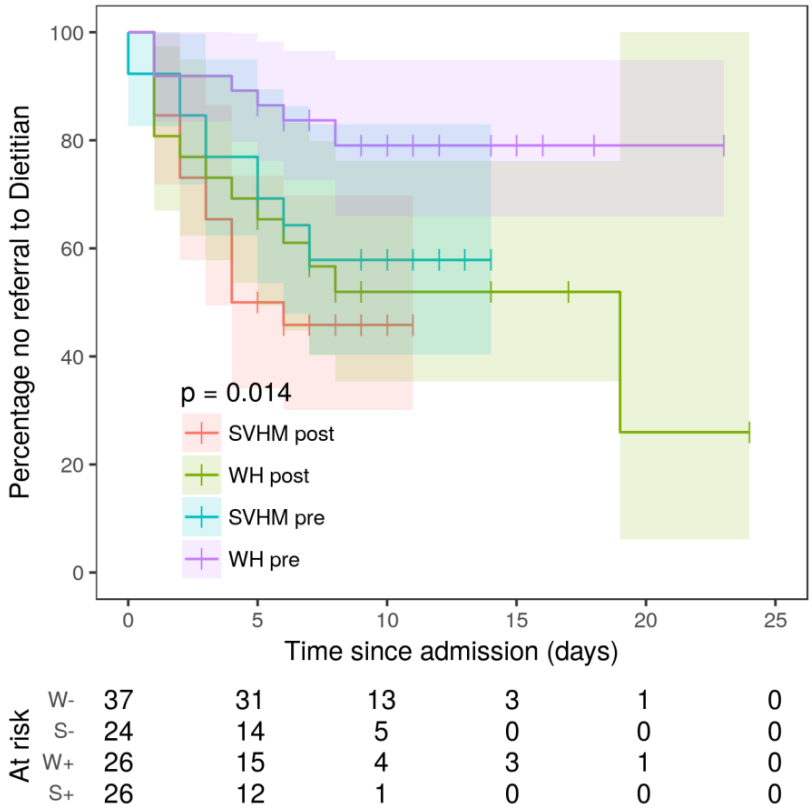
As shown in Table 8, there was no significant difference in malnutrition screening tool (MST) completion rates within 24 hours of admission between baseline and intervention groups. A common odds ratio of MST completion was 1.2 (0.5; 2.9). Average malnutrition risk scores (MST ≥2) between baseline and intervention groups were not statistically different (refer to Table 7).

Table 8: Comparison of nutrition care practices (screening and referral) at baseline, intervention and study sites

	SVHM		**WH**			**Total**		
	Baseline	Intervention	Baseline	Intervention	*P* Value	*Baseline*	*Intervention*	*P Value*
MST completed within 24 hrs (%)	12 (46.2%)	17 (65.4%)	27 (73%)	17 (65.4%)	0.695 (Stratified Test)	39 (61.9%)	34 (65.4%)	0.924
MST Score ≥ 2	5 (35.7%)	7 (35%)	13 (46.4%)	10 (52.6%)	NA	18 (42.9%)	17 (43.6%)	1.0
Pts referred to dietitian if MST ≥2	2 (40%)	6 (86%)	2 (15%)	8 (80%)	*0.002 (Common Odds Ratio 13)	NA	NA	NA
Patient received Dietitian Care	10 (38.5%)	14 (53.8%)	7 (18.9%)	13 (50%)	NA	17 (27%)	27 (9%)	*0.011

Significantly more patients with higher malnutrition risk (MST ≥2) were referred to a dietitian in the intervention group with a common odds ratio of 13 (2; 111) p=0.0014 (exact test), and significantly more patients received dietitian care in the intervention group with a common odds ratio of 2.8 (1.2; 6.6). As Figure 1 shows, the Kaplan-Meier curve is consistent with referrals occurring at a higher intensity during the first week, demonstrating earlier referrals to dietitians with decision support tool care compared to standard care.

Figure 1: Time to Dietitian Referral



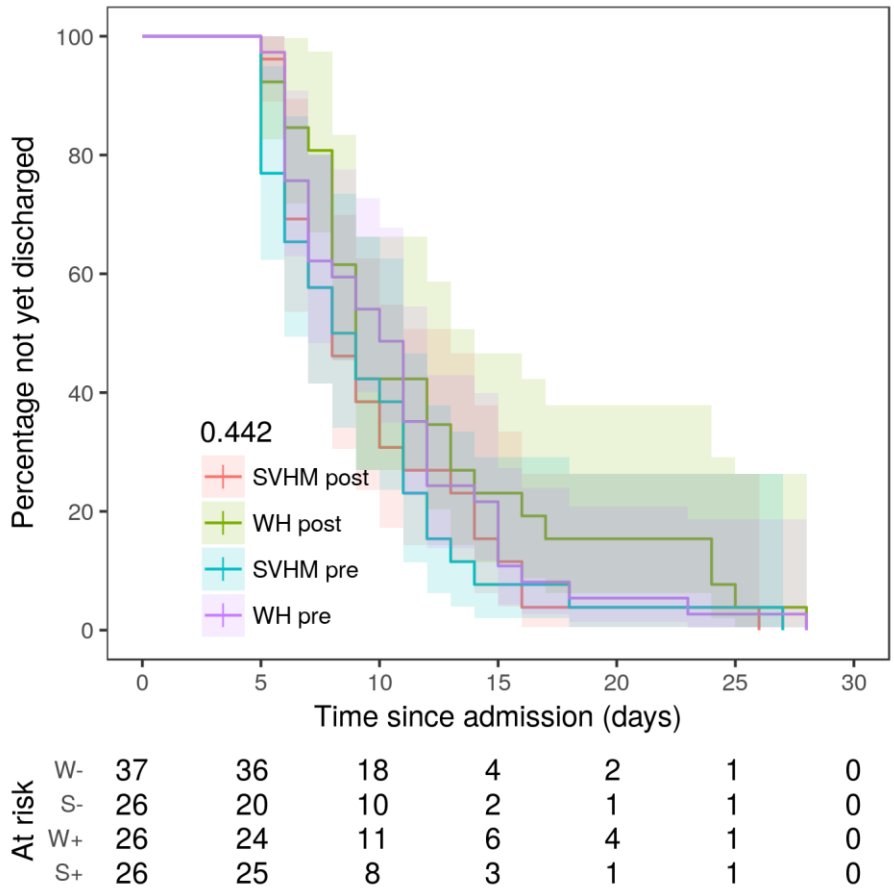
Secondary outcomes included reduced length of stay and reduction in combined endpoint of unplanned readmission to hospital or death within 30 days post discharge. As secondary outcomes are a 'downstream' effect from primary outcomes, multiple testing is controlled for with the gatekeeper method; secondary outcomes were assessed only if the test statistic for at least one of the primary outcomes was significant.

As outlined in Table 9 there was no statistical difference in acute hospital length of stay between baseline and intervention groups or mortality or unplanned hospital admission within 30 days. Refer to Figure 2 for further analysis on time to discharge which did not reach statistical significance.

Table 9: Comparison of Secondary Outcomes between baseline, intervention and study sites

	SVHM		WH		Total		
	Baseline	Intervention	Baseline	Intervention	*Baseline*	Intervention	*P-Value*
Average length of stay (days)	9.5 ± 4.9	9.8 ±4.8	10.7±5.0	12.0±6.6	10.2±5.0	10.9±5.8	0.486
Mortality or unplanned hospital admission within 30 days	11 (42%)	5 (20%)	10 (27.8%)	6 (23.1%)	21 (33%)	11 (21%)	0.15

Figure 2: Time to Discharge between sites and pre-post intervention



Other outcomes of interest

Clinical documentation of a malnutrition diagnosis (either presence or absence) was found to be significantly higher in the intervention group, and this may relate to higher numbers of dietitians assessing the nutritional status of patients due to higher referrals (Refer to Table 8). While the diagnosis of malnutrition doubled in the intervention group, this did not meet statistical significance. There were only 2 cases of a documented hospital acquired malnutrition diagnosis, both at WH in the baseline group. Figure 2 describes % of patients assigned coding for malnutrition at different sites. At SVHM, in the baseline group one patient with malnutrition was not coded. In the intervention group one patient was coded with hospital acquired malnutrition (COF=1) but not documented as such, and 3 cases of malnutrition documented were not coded, highlighting gaps in clinical documentation and coding practice.

Table 10: Comparison of malnutrition between baseline, intervention and study sites

	SVHM		**WH**			**Total**	
	Baseline	Intervention	Baseline	Intervention	*P* Value	*Baseline*	*Intervention*
Malnutrition documentation (presence or absence)	6(23.1%)	11 (42.3%)	6(16.2%)	13 (50%)	*0.004 (Stratified Test)	12(39.3%)	24(55.3%)

Malnutrition diagnosis (present on admission) documented	2 (7.7%)	8 (30.8%)	4 (10.8%)	3 (11.5%)	0.854 (Stratified Test)	6 (9.5%)	11 (21.2%)
Malnutrition coding assigned at discharge	1 (3.8%)	4 (15.4%)	5 (13.9%)	4 (15.4%)	Not Significant	6 (9.7%)	8 (15.4%)
HAMN diagnosis during admission	0 (0%)	0 (0%)	2 (5.4%)	0 (0%)	Not Significant	2 (5.4%)	0 (0%)
HAMN reporting by coding COF=1	0 (0%)	1 (3.8%)	0 (0%)	1 (3.8%)	Not Significant	0 (0%)	2 (3.8%)

Figure 3: Total malnutrition episodes coded during hospital admission (no. of patients) between sites and pre-post intervention

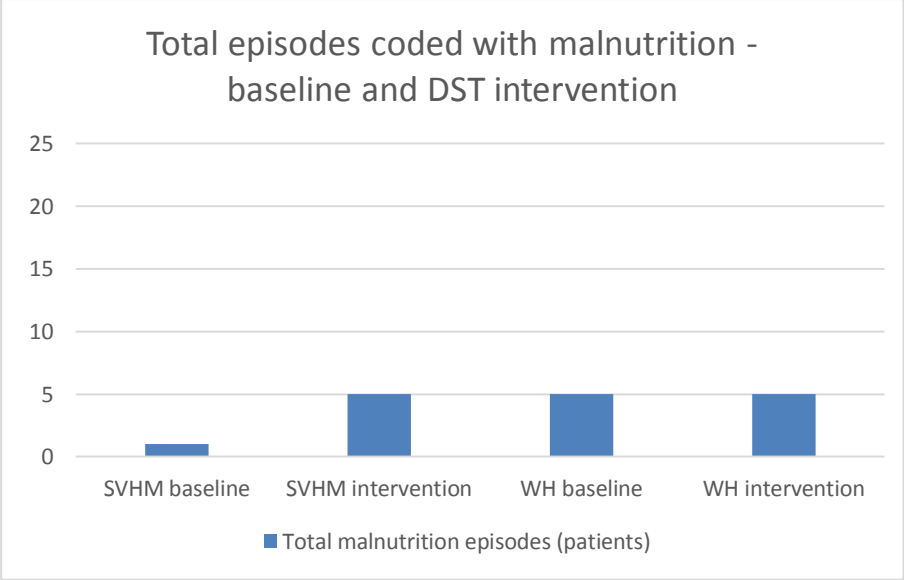


Table 11 shows that the quantification of dietary intake is not well documented in patient hospital records by nurses or dietitians in general, and findings did not demonstrate that the DST intervention had an impact on changing practice in this area. Interpretation of results is limited by missing data on the days assessed, however it was observed that daily entries recorded by nurses relating to dietary intake seldom contained terms to describe nutritional adequacy, and conversely identify risk of nutritional decline.

Similarly, limited data was encountered when evaluating whether patients were meeting nutrition targets (>75% nutritional requirements) on day 5 of admission. This data was from patient's dietary intake at day 5 and documenting the percentage of nutrition requirements met. Of the 10 patients seen by the Dietitian at baseline at SVHM, one had nutrition requirements documented at day 5 and it met >75%. Of the 14 patients seen by the Dietitian during the intervention phase at SVHM, only two patients had nutrition requirements met documented at day 5 and neither of these met >75%. Of the 6 patients seen by the Dietitian at baseline at WH, one had nutrition requirements

documented at day 5 however did not meet >75%. Of the 13 patients seen by the Dietitian during the intervention phase at WH, 5 patients had nutrition requirements documented at day 5 of which three patients met >75% and 2 met <75%.

Table 11: Clinical documentation of dietary intake and nutritional adequacy by nurses and dietitians

	SVHM			WH		
	Baseline	Intervention	*P* Value	Baseline	Intervention	*P* Value
Nursing documentation – adequate/inadequate/poor *oral intake? (n (% days of data collection)*	6 (4.6%) (125 not documented)	22 (16.2%) (114 not documented)	Not Significant	24 (12.8%) (164 not documented)	9 (6.4%) (132 not documented)	Not Significant
Patients meeting daily >75% nutrition targets	1	0	Not Significant	0	3	Not Signficant

Discussion

Decision Support Tool feasibility

Positive feedback received from end users experiences' of the DST to support bedside decision making as received from the clinician survey (qualitative and Likert scale responses) shows that it was received favorably and was effective for prompting communication between staff around nutrition care processes. In particular, clinicians found the DST useful for prompting assessments of nutrition risk and dietetic referrals, as well as helping to escalate care in a timely manner. Such actions by clinical staff in nutritional care processes are critical for preventing deteriorating nutritional status leading to a preventable complication - hospital-acquired malnutrition. Constructive feedback concerning improvements needed to the tool's format, and location in bed charts will be adopted to enhance future iterations of the DST. An important gap was identified concerning levels of clinician knowledge about hospital acquired malnutrition and nutritional care processes. It would be imperative to escalate education processes across all clinician groups in future iterations of the tool.

With implementation of electronic medical record systems currently underway at the study sites, the opportunity presents for integrating decision aids to facilitate targeted interventions. Developing an electronic version of the decision support tool with built in algorithms for daily nutrition care recommendations is a future possibility.

Decision Support Tool effectiveness

Although similar numbers of patients were recruited to the study from each trial ward, the sample size was small and there was variation in hospital unit, CALD background and interpreter needs which may impact on the findings between baseline and intervention groups. In addition, baseline anthropometric data was not included as height, %weight change and BMI was generally only recorded by Dietitians, and they completed a nutrition care plan for only 27% of baseline and 52% of the intervention group. It is possible therefore that individual patient factors such as different clinical conditions, cultural background and baseline anthropometric parameters may have influenced nutrition risk, limiting the impact of the use of the DST on clinical outcomes. Owing to missing anthropometric data in routine records, the authors note the low priority placed on obtaining repeated patient weight measures over time in the clinical setting, and missed opportunity to better identify trajectories of decline, maintenance, and improvement.

There was no significant difference seen in malnutrition screening tool (MST) completion rates within 24 hours of admission. However, significantly more patients were referred to the Dietitian, and earlier in their hospital stay in the intervention period and this relationship was even stronger for patients with a higher level of malnutrition risk. A limitation of this study is that we are unable to identify if it is the tool itself or the staff education that accompanied the implementation of the tool that has resulted in this outcome. Pleasingly the staff survey responses seem to support the tool and highlighted its impact in prompting more referrals.

No impact on reduced length of stay was seen despite earlier and more frequent dietetic intervention, and a trend was seen for a reduction in adverse (hospital readmission or mortality) 30 day outcomes between baseline and intervention groups, which warrants further investigation with a larger sample size as this study was not explicitly powered for its secondary outcomes. Multiple factors can affect length of stay, moreover, reductions in length of stay are an endpoint downstream; increased dietitian referral may lead to better nutrition care and this in turn may lead to reduced length of stay. As such, the magnitude of the downstream effect is lower and the expected noise is higher.

There was no difference in malnutrition risk according to average MST score between baseline and intervention groups. However there appeared to be higher prevalence of malnutrition in the intervention group, although this may have been the result of improved referrals to Dietitians and therefore increased identification, diagnosis and documentation.

No significant differences were found in the documented cases of hospital acquired malnutrition related to the small sample size. This was expected given the literature has reported only 12 cases per 10,000 hospitalizations in 2015-2016 (IHPA 2018) and our sample size was only 115. Interestingly only 2 cases were diagnosed and documented, and these were in the baseline group. A difference between reported HAMN and actual HAMN was observed even in the small sample size in this study and highlights the need for collaboration between clinicians and hospital coders to continually improve clinical documentation and coding practices to enable accurate reporting.

Hospital acquired malnutrition may be identified in various ways. For this study the following method has been synthesised within this research for the accurate identification and measurement of HAMN;

Dietitians:

1. prospective measurement of nutritional status at two time points
2. diagnosis of malnutrition (and severity) with validated tool (SGA) or ICD-10-AM criteria
3. clear clinical documentation of malnutrition diagnosis in the patient's medical record, with evidence that nutritional status has declined during the hospital stay (malnutrition absent to present, or malnutrition progresses from mild to moderate to severe, and weight loss ≥5%)
4. stardardise assessment with the use of validated tool or template and use coloured sticker in paper records to highlight nutrition care plan for clinical coders
5. add malnutrition term to additional diagnosis list or discharge summary

Clinical coders:

6. assign alphanumeric ICD-10-AM malnutrition code as additional diagnosis upon review of clinical documentation and discharge summary
7. apply condition onset flag (COF=1) to indicate that malnutrition onset (or decline) occurred during the episode of admitted patient care

Researchers:

8. receive hospital report on episodes of coded malnutrition from hospital data analytics unit

Data on whether the DST use is associated with an increase in meeting daily nutrition targets was limited due to our small sample size and by the limitation of the study design being heavily reliant on documented nutrition care. It is possible the number of patients meeting 75% of energy and protein requirements at day 5 was higher, however this was only documented in a very small number of cases. As with the paucity of patient weight data, of additional concern is that documentation of daily nutritional intake and adequacy was often lacking. Despite a high self assessment of baseline nutrition care processes, basic daily nutrition care tasks such as malnutrition risk screening, weighing patients and monitoring nutritional adequacy are not embedded in routine care. This requires ongoing focus in busy hospital and attention to staff training to improve awareness is required.

Strengths

A strength of this proof of concept has been an inter-disciplinary, inter-organisational collaborative research approach with team members committed over a four-year period to investigate hospital-acquired malnutrition. The outcome of this collaboration has been the development of a novel decision support tool designed to overcome barriers to optimal nutritional care. This has enabled clinicians to identify, in a more timely manner than baseline care, those patients at risk of nutritional decline and provided further decision support at various points in the episode of care. Our proof of concept has shown that the tool can be effective to raise the importance of continued focus on nutrition care. It has brought to the attention of the two hospitals involved that HAMN is a pressing quality and safety matter; it has alerted clinicians in the ward settings that diagnosing nutrition problems, intervening to resolve those problems, and monitoring and evaluating patient nutritional progress will help ensure nutritional decline is not overlooked; additionally, unwarranted variation in current nutritional care practice is known to lead to harmful consequences and this tool will help ensure common standards to practice .

A further strength of this proof of concept study has shown that clinicians say the tool is practical to use and the tool can be effectivity used within routine ward practices. This suggests implementation of the concept of a bedside decision support tool would be accepted in this setting and more work to further refine the tool is warranted.

Limitations

An uneven distribution of staff survey responses across disciplines and between sites, together with a small sample size, mean it is difficult to determine if responses collected are representative of staff viewpoints. In addition, surveys were voluntary, and staff were approached by researchers to complete so there is risk of bias with more engaged clinicians responding, and responses being more positive to support colleagues in their work. However it is noted that over 50% of clinicians that completed the survey had 6-15 years' experience and the positive responses is an opportunity for these clinicians to assist with championing the tool if further implementation or study of the tool is completed.

Overall, the decision support tool was supported by clinical staff, though several modifications to the tool need to be addressed before wider implementation. Formatting of some areas of the tool are required to clarify and simplify information. Additionally, some of the key steps in the algorithm may require modification. Ongoing education about the tool and hospital-acquired malnutrition was highlighted in feedback as was the need for leadership support particularly from the nursing division.

As this research was conducted within routine ward practice, one of the limitations identified was reliable recording of prompting/use of the decision support tool by staff on a daily basis, complicated by regular nursing shift changes and junior medical staff ward rotations. It was noted that the presence of nursing bank and part time staff also reflected a range of awareness of the tool.

Efforts were made on a regular basis during the intervention to inform and update nursing staff and new staff on the study wards. Strategies to overcome these workforce matters included regular briefing of the tool during ward meetings and at nurse handover.

Although an integrated literature review was completed to inform the tool development, the team instigated a systematic review approach (PROSPERO registration number CRD42018081967) to value add to the design of the project. We have not completed this full review at the time of this report.

Implications (recommendations) for practice and translational opportunities
This proof of concept has shown that a tool can be effectively used within routine practice, but much more needs to be done to roll out the tool beyond the wards selected in this study and to ensure clinical staff consistently implement nutritional care practices over time. First, the tool does need further refinement and then testing; secondly, the tool has relevance to the aged care setting and in the next iteration of development, we will harness interest from that sector and develop opportunities in 2019. Thirdly, as nutritional practices have considerable unwarranted variation leading to harmful consequence (for example, diagnosis of deteriorating nutritional status may be delayed), this user-friendly tool is likely to offer a practical solution for timely decision making concerning nutritional management. Finally, the study shows that a group of clinicians has endorsed use of the tool, but more efforts are required to enhance education, and validate the tool so that changes to nutritional care and management practices occur across the health sector. Of note is that wider health service and policy issues must be addressed to enhance overall nutritional care practices in hospital settings that are beyond the scope of our proposed future and enhanced study design. These relate to the need for improved standards for the documentation and reporting of nutrition care and adherence to standardized care.

Key outputs from this study have been:

- a determination from the literature regarding defining and operationalizing hospital-acquired malnutrition to enable consistent reporting
- development and implementation of a novel decision-support tool with evidence-based clinical criteria to identify deteriorating nutritional status, prompts for referral to a dietitian for individualised care, and prompts to further escalate care for specialised nutrition support
- institutional approval within internal clinical governance committees for use of the tool
- a determination from clinicians that the tool has of the feasibility and utility for enhancing baseline nutrition care practices
- identification that despite a high self assessment of baseline nutrition care processes, basic daily nutrition care tasks such as malnutrition risk screening, weighing patients and monitoring nutritional adequacy are not embedded in routine care
- recommendations on future change to the tool to optimise adherence of clinician engagement and provision of evidence based nutrition practices
- policy recommendations for clinical coding and documentation

Conclusion

This proof of concept study has implemented a systematic approach for providing high quality nutrition care. It demonstrated post-intervention enhancements to nutrition care processes in comparison to baseline practice and positive outcomes. Results from this DST implementation study do show, nevertheless, that future work is necessary to refine and further test the DST on a broader scale to achieve translation. Funding from various grant bodies and government will be sought to undertake a large scale multi-institutional study for several objectives: to validate diagnostic criteria

within the decision support tool; to confirm results across wider patient cohorts; to obtain cost-effectiveness data for policy support and upscaling; and for developing an electronic prototype.

It may be possible to enhance uptake of the DST during bedside decision making through integration with the electronic medical record. Developing an electronic version of the decision support tool with built in algorithms for daily nutrition care recommendations is a future possibility and an area of opportunity given implementation of electronic medical record systems currently underway at the study sites.

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Appendices

Appendix 1: Master Plan/Logic model of overall study design

RESEARCH STAGES	DESIGN AND OVERVIEW	DATA COLLECTION	DATA ANALYSIS	TIMELINE
Stage 1	**Systemic literature review** Undertake to direct the development of criteria to identify deteriorating nutritional status based on patient physical/ medical characteristics/ observations and changes over time. Expert opinion will be sought from the expert steering group where there are gaps in the literature. The literature will also be reviewed to investigate the current use of clinical support tools and international nutrition care pathways in the clinical setting and how they could be adapted to the provision of nutrition treatment for different patient cohorts and clinical situations in the Australian Hospital setting.	Overall strategy developed according to PRISMA guidelines and registered with PROSPERO	Write up	May 2017 – May 2018
Stage 2	**Data collection A:** Baseline utilisation review will be conducted based on in-house hospital activity data on the hospital-acquired and malnutrition population at participating hospitals. Analysis of this data will be the basis for the ward selection at SVHM and WH. Wards will be selected where improvements will have maximum impact.	Retrospective analysis of participating hospital activity data using data mining techniques	Data presented using statistics	Prepare 1- 3 year calendar data set

Stage 3	Develop a decision support and treatment initiation tool prototype, incorporating evidence-based nutrition treatment options and an algorithm directing clinicians to select and initiate timely standardized nutrition interventions.	Draws from literature review Input from experts	No analysis	August 2017 – February 2018 Implement on wards April 2018
Stage 4	Develop patient audit data collection tool, incorporating demographic, clinical and nutritional care process data	Excel spreadsheet with data elements for research team.	Statistics	November 2017 – March 2018
Stage 5	**Data collection B**: Baseline retrospective audit of patient medical records using pre-determined audit collection tool. Retrospective baseline audit of n=100 eligible patients admitted May-June 2017	Audit tool: Excel spreadsheet with data elements for data collection by ward dietitians. **<u>Inclusion Criteria:</u>** Hospitalized patients with any diagnosis (except as specified in exclusion criteria) consecutively admitted to the four participating acute wards; Expected hospital stay >120 hours (>5 days); Patients admitted Monday - Friday between 08:00 – 16:00 (due to funding limitations to provide research assistant for data collection); Patients with an expected length of stay of 5 days or less will be excluded from the data collection. Local researchers will utilize the estimated date of discharge and treating team opinion for this determination within 48 hours of admission. **<u>Exclusion Criteria:</u>** Pediatric patients (less than 18 years of age);	Statistics	Baseline: May - June 2017.

		Unfeasible screening for whatever reason; Pregnancy or lactating; Patient with poor short-term prognosis as determined by treating team.		
Stage 6	Implementation phase of tool. A 2-week 'run in' period, whereby the decision support and treatment initiation tool will be introduced to clinical staff and the ward settings, training completed and troubleshooting by the research team addressed.	Targeted educational sessions, ward posters or flyers, information sheets.		2-13 April 2018
Stage 7	**Data collection C**: Intervention audit of patient medical records using pre-determined audit collection tool. Intervention audit of n=100 eligible patients admitted May-July 2018	Same eligibility (inclusion/exclusion criteria as above for data collection B)		May - July 2018
Stage 8	**Data collection D:** Determine if clinicians find the decision-support tool usable, feasible and effective. Anonymous staff surveys will be undertaken to gain feedback on usefulness of the tool and will explore usability and feasibility.	Paper-based survey to maximize response rates and to maintain confidentiality. Rationale is that clinician access to email is unreliable.	Excel for Statistics	May- July 2018 (whilst staff are using the tool and have active engagement with it during intervention period)
Stage 9	**Data collection E:** Review of impact of tool on hospital-acquired malnutrition. Similar to data collection process as for data collection A.	Retrospective analysis of in-house hospital activity data using data mining techniques	Statistics on hospital-acquired malnutrition.	September - October 2018

Appendix 2: Staff Survey

Participant Information Sheet/Consent Form

Health/Social Science Research - *Adult providing own consent*

Title: Reducing hospital-acquired malnutrition through early identification of deteriorating nutritional status and application of a decision support tool: a proof of concept study

Principal Investigator: Natalie Simmance

Location: St Vincent's Hospital Melbourne and Western Health

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1 What is the purpose of this research?

A novel nutrition care decision support tool has been developed by our project team for use by health professionals (nurses, dietitians, doctors) at the bedside to aid in the identification of deteriorating nutritional status and to support clinical care decisions for escalating nutrition care interventions. The decision support tool development was guided by literature review as well as expert opinion sought from clinicians and research personnel.

This research aims to evaluate the tool's useability and feasibility and to inform future work to improve nutrition care processes for hospitalised patients to prevent hospital acquired malnutrition.

You have been invited to complete a short survey as you have been involved in using the tool. Your feedback on this survey will help contribute to the learnings and outcomes of the hospital-acquired malnutrition project both within your health network and more broadly.

This research has been initiated by the researcher, Natalie Simmance and co-researchers at Western Health and Victoria University. Funding has been received for this project by the HCF Research Foundation. It is anticipated that the results will be written into the project's final report, a paper for publication in a peer reviewed journal and presented at a professional conference.

2 What does participation in this research involve?

Participation in this project will involve about 15 minutes of your time to complete the attached survey. You will be asked to provide information about work experience and familiarity with decision support tools, and to make an assessment about the feasibility and usability of this decision support tool.

3 Do I have to take part in this research project?

Completion of the survey is voluntary. If you do not wish to take part you are not obliged to. If you do decide to take part, you will be given this Participant Information and Consent Form

to read and you will be given a copy to keep. Completion and return of the questionnaire to the research team implies consent to participate in the study.

There are no costs associated with participating in this research project, nor will you be paid.

4 What are the possible benefits of taking part?

The contribution from clinical staff involved in this pilot project at each of the health services involved will be invaluable for informing future projects to improve nutrition care in hospitals for patients who are at risk of nutrition decline and malnutrition.

5 What are the possible risks or disadvantages of taking part?

There are no known risks or disadvantages associated with your participation in this survey. The survey is entirely voluntary; you are free to discontinue participation in the survey at any time. In addition, the survey is entirely confidential; your name will not appear in any reports or publications. Only the members of research team have access to the survey data via a specific username and password. The data only will be used in the research work of hospital-acquired malnutrition.

Your participation in the survey will not affect your relationship with your employer in any way. The survey information you submit will not be identifiable as only group aggregate data will be published.

Data will be entered into an electronic database and stored securely on a password protected computer in a locked office at St Vincent's Hospital Melbourne for a period of five years.

6 What if I withdraw from this research project?

Once you have completed and returned your survey, it will not be possible to withdraw the information you have provided as your information will not be identifiable.

7 Could this research project be stopped unexpectedly?

It is unlikely that this research will be stopped unexpectedly.

8 What happens when the research project ends?

Once the final date for contribution of data is reached, the principal and associate researchers will conduct an analysis of the data and this will contribute to the final project report and publication preparation. In 2018, results of this survey will be made available to you in a poster format located in the wards under study and a presentation will be conducted at participating sites. Results will be written into the project's final report, a paper for publication in a peer reviewed journal and presented at a professional conference.

9 Who has reviewed the research project?

The ethical aspects of this research project have been approved by the HREC of St Vincent's Hospital Melbourne and Western Health. This project will be carried out according to the National Statement on Ethical Conduct in Human Research (2007).

10 Further information and who to contact

The person you may need to contact will depend on the nature of your query:

Research contact person

Name	*Natalie Simmance*
Position	*Chief Dietitian, St Vincent's Hospital Melbourne*
Telephone	*03 9231 3756*
Email	*natalie.simmance@svha.org.au*

Details of the local HREC are:

Name	*Executive Officer of Research*
Position	*St Vincent's Hospital Melbourne Human Research Ethics Committee*
Telephone	*03 9231 2394*
Email	*research.ethics@svha.org.au*

Reducing hospital-acquired malnutrition through early identification of deteriorating nutritional status and application of a decision support tool: a proof of concept study

We are seeking your feedback to help inform this and future projects directed to improve nutrition care in hospitals for patients who are at risk of nutrition decline and malnutrition. Therefore, we encourage you to provide us with detailed responses in order to gather valuable data around your experience and opinions.

Q1 How long have you been working as a health professional?

- ❍ Less than 1 year
- ❍ 1~5 years
- ❍ 6~15 Years
- ❍ 16~25 years
- ❍ 26 years or more

Q2 How long have you been employed at Western Health or SVHM?

- ❍ Less than 1 year
- ❍ 1~5 years
- ❍ 6~15 Years
- ❍ 16~25 years
- ❍ 26 years or more

Q3 What is your employment status?

- ❍ Full Time
- ❍ Part Time
- ❍ Casual
- ❍ Bank
- ❍ Graduate nurse program
- ❍ Agency
- ❍ Other, please specify _____

Q4 Are you a(n)?

- ❍ Enrolled nurse
- ❍ Registered nurse
- ❍ Dietitian
- ❍ Medical staff
- ❍ Clinical manager
- ❍ Other, please specify _____

Q5 How would you rate your knowledge and experience of clinical decision-support tools used for contemporary clinical practice?

- ❍ Very Good knowledge
- ❍ Moderate knowledge
- ❍ Basic knowledge
- ❍ Minimal to no knowledge

Q6. Do you have any experience with using any other clinical decision-support tools?
Circle: Yes / No

If yes, please provide further information

Q7. Please complete the following questions about this nutrition care decision support tool:

	1=strongly agree	2= agree	3= neither agree nor disagree	4= disagree	5 = strongly disagree
PRESENTATION					
Was the tool well-presented?					
Are the traffic light colours helpful?					
CONTENT					
Did the tool present information in a logical manner?					
Did the tool include relevant information for describing optimal nutrition management?					
The tool was clear in terms of giving specific advice for action					
EFFICACY / USEFULNESS AS A DECISION SUPPORT TOOL					
Was the tool easy to follow?					
Were you able to access information for clinical decision-making within the information and workflow of the tool?					

	1=strongly agree	2= agree	3= neither agree nor disagree	4= disagree	5 = strongly disagree
Do you think the tool helps with identifying patients at risk of malnutrition?					
I found the tool enhanced communication between nurses, dietitians and doctors.					
The tool supported timely care options / treatment for patients at risk of malnutrition.					
I found the tool to be onerous in terms of additional workload					
The tool was adequately incorporated into clinical workflow					
I knew how to get further information about the tool if I had queries.					
I feel confident using the tool					
The tool was user-centred					
I would support the implementation of the tool in the future.					

Q8. What were the tool's strengths?

Q9. Please provide feedback on areas for the tool's improvement.

Q10. Could you elaborate on a clinical scenario you encountered where this tool's usability was very effective? What actions did you take both on your own and with the tool's assistance?

Thank you for completing this survey. Please return in the self-addressed envelope to your local researcher or via internal mail.

Appendix 3: Audit tool - Patient data elements - data collection B and C

Patient Study ID:	

Bradma

(W1 . . . .100 for Western Health)
(S1. .. . . .100 for St Vincent's Hospital)

Does patient meet inclusion criteria?
Inclusion criteria: Hospitalized patients with any diagnosis (except as specified in exclusion criteria) consecutively admitted to the four participating acute wards; Expected hospital stay >120 hours (>5 days); Patients admitted Monday - Friday between 08:00 – 16:00.

☐ Yes ☐ No

If no, why?
☐ Patient < 18 years old
☐ Pregnant/Lactating
☐ Patient has short term prognosis – where death is expected in 1 month
☐ Patient admitted outside study hours (Monday - Friday between 08:00 – 16:00)
☐ Expected LOS <5 days

If removed during the study/study not completed, why?
☐ Actual LOS <5 days
☐ Died
☐ Transferred to another ward
☐ Other:

Outcomes (d/c):	
☐ Length of stay	☐ Malnutrition present on admission
☐ Wt change _____%	☐ Hospital Acquired Malnutrition
☐ Died	☐ Nutrition Diagnosis resolved

Outcomes (at 30 days):	
☐ Unplanned readmission	☐ Malnutrition as coded
☐ Discharge diagnosis as coded	☐ Died
☐ Co morbidities as coded	

ASSESSMENT ON ADMISSION

Patient Location		
Ward:	SVHM: ☐ 7W ☐ 8W	WH: ☐ 2D ☐ 2C
Unit: SVHM	☐ Gastro ☐ Urology ☐ Colorectal ☐ General medicine	
WH	☐ Gastro ☐ Respiratory ☐ ID ☐ General medicine	

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Patient Demographics		
Living situation	☐ Lives alone ☐ Lives with family or carer ☐ Lives in residential care	
Identify as:	☐ From a CALD background Interpreter required? ☐ Yes ☐ No ☐ Aboriginal/TSI	
Admission Information		
Admission date:	dd/mm/yy	
Primary medical reason for admission:	**Respiratory:** ☐ Pneumonia ☐ COPD ☐ Asthma ☐ Influenza w pneumonia/other respiratory manifestations ☐ Pulmonary embolism ☐ Respiratory arrest **Gen med:** ☐ Cardiac failure ☐ Pneumonia ☐ Influenza with pneumonia/other resp manifestations ☐ COPD ☐ Sepsis ☐ Functional decline **Urology:** ☐ Nephrectomy/Cancer ☐ Nephrostomy tube/Stent for calculus of ureter/renal w or w/o hydronephrosis Resection of prostate/BPH/prostate cancer ☐ Ileocystoplasty ☐ Haematuria	**Gastroenterology:** ☐ HCC for embolization ☐ Alcoholic cirrhosis/hepatitis/failure ☐ Crohn's ☐ Oesophagus varices/reflux/ulcer/Barrett's ☐ PR bleeding/melenae ☐ Liver disease ☐ IBD ☐ GI bleeding ☐ Pancreatitis **Colorectal:** ☐ GI/colorectal neoplasm ☐ Appendicitis ☐ Diverticulitis/Diverticulosis ☐ Small bowel obstruction ☐ Anal abscess/fistulae ☐ GI obstruction ☐ GI neoplasm ☐ PR bleeding ☐ IBD **Infectious Diseases:** ☐ Syphilis ☐ Otitis externa ☐ Sepsis ☐ Infective Endocarditis

Final Report

Co-morbidities:	**Respiratory:** ☐ COPD ☐ Asthma ☐ TB ☐ Pneumonia ☐ Respiratory arrest **Cancer/ Immune:** ☐ Active malignancy **Renal:** ☐ Moderate or severe renal disease **Vascular:** ☐ Cerebrovascular disease (Stroke or TIA) ☐ Hypertension ☐ Peripheral vascular disease **Susbstance Abuse:** ☐ Heavy alcohol use or binge drinking history ☐ Current smoker ☐ Drug abuse history **Musculoskeletal:** ☐ Dementia ☐ Neurologic illnesses (such Multiple sclerosis or Parkinson's **Neurological:** ☐ Dementia	**Gastroenterology:** ☐ Liver disease ☐ Inflammatory Bowel Disease ☐ Gastrointestinal Disease (hernia or reflux) ☐ GI Bleeding ☐ Diarrhoea, Nausea, Vomiting for Ix **Endocrine:** ☐ Diabetes Type I or II ☐ Diabetes with end organ damage ☐Obesity and / or BMI > 30 **Myocardial:** ☐ Angina ☐ Arrhythmia ☐ Congestive heart failure ☐ Myocardial infarction ☐ Valvular ☐ Neurologic illnesses (such Multiple sclerosis or Parkinson's) **Psychological:** ☐ Anxiety ☐ Depression ☐ Other mental health issue **Miscellaneous:** ☐ Visual impairment (cataracts, glaucoma, macular degeneration)

ICU admission		
ICU admission:	☐ Yes ☐ No	LOS in ICU:
Nutrition support received:	☐ Yes ☐ No If yes:	☐ Oral nutrition ☐ Enteral nutrition ☐ Total ☐ Supplementary ☐ Parenteral nutrition ☐Total ☐ Supplementary

Nurse Led Assessment on admission		
Nurse Assessment using Decision Support Tool	☐ Yes ☐ No If No, why? ☐ Not aware of tool ☐ Tool unclear ☐ Other:	
Oral intake Assessment:	☐ Adequate ☐ Inadequate ☐ Very Poor ☐ Info unavailable/not completed	
Did researcher prompt nurse-led assessment?:	☐ Yes ☐ No	
Dietitian referral completed:	☐ Yes ☐ No ☐ Not available	Referral date:

Final Report

Nutrition assessment completed:	☐ Yes ☐ No	Assessment date:

Comprehensive Nutrition Care – Initial Nutrition Assessment:		
Height:	_____ cms	☐ Actual/measured ☐ Pt reported ☐ Estimated
Current weight:	_____ kgs	☐ Actual/measured ☐ Pt reported ☐ Estimated
Fluid accumulation?	☐ No ☐ Yes	If yes, estimated dry body weight: _____ kgs
BMI:	_____ kg/m^2	RR: ☐ 18.5-25kg/m^2 ☐ 22-27kg/m^2
MST on admission:	In the last 6 months, have you lost weight without trying?	
	☐ Yes ☐ No ☐ Unsure ②	If Yes, specify amount: ☐ 1-5kg ① ☐ 10kg ② ☐ 11-15kg ④ ☐ 15kg+ ③ ☐ Unsure ②
	Have you had a reduced appetite lately (felt less hungry)? ☐ Yes ① ☐ No	
	MST Score:	

Estimated Requirements:	Equation used for calculations:	
	Weight used for calculations:	_____ kgs
	Goal Energy Requirement:	_____ kJ/d_____ (kcal/kg)
	Goal Protein Requirement:	_____ g/d _____ (g/kg)

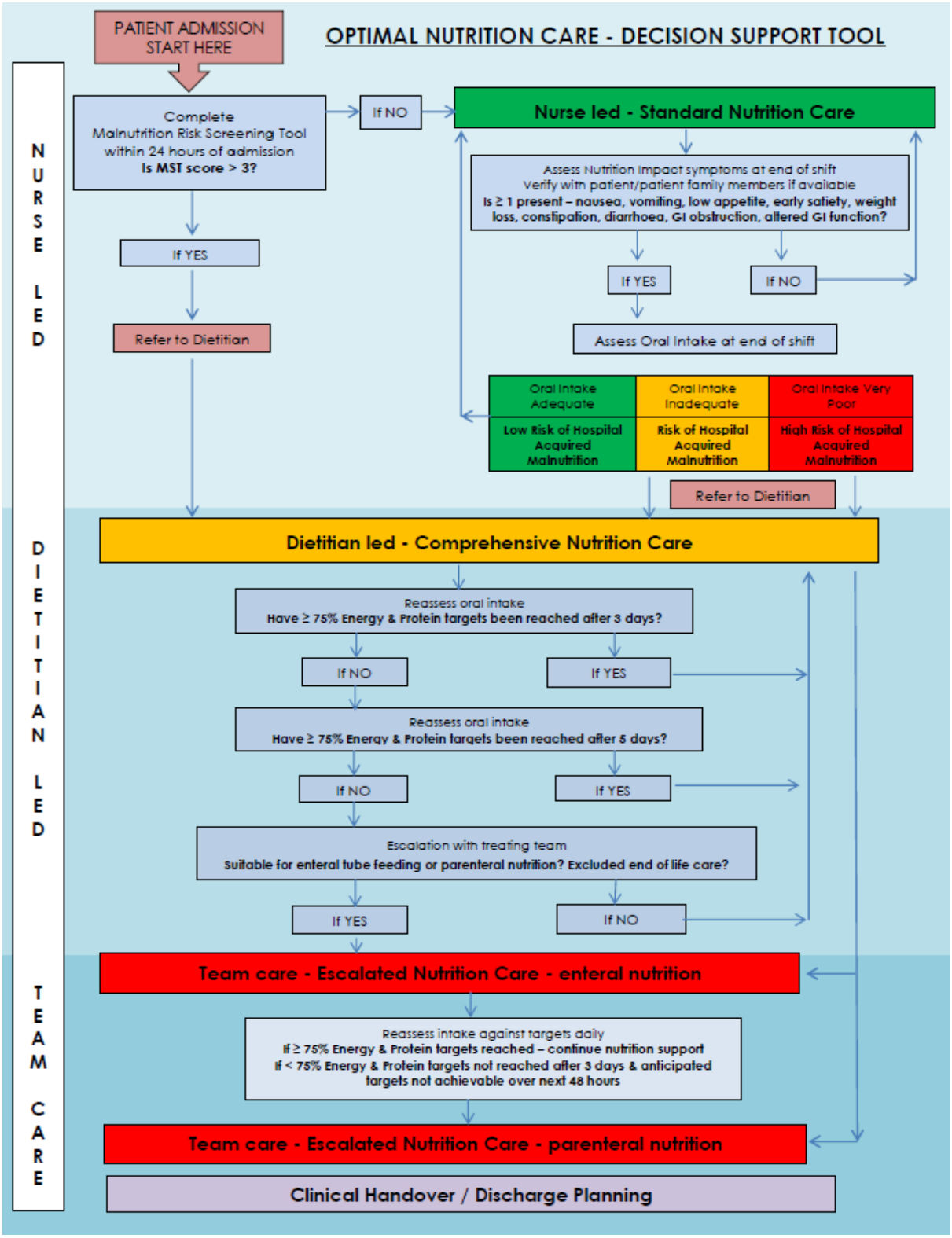
Nutrition Diagnosis (PESS Statement)	Diagnosis:	☐ Malnutrition ☐ Inadequate oral intake ☐ Inadequate energy intake ☐ Altered GI function	☐ Inadequate protein and energy intake ☐ Imbalance of electrolytes ☐ Other:
	Related to:	☐ Increased requirements ☐ Loss of appetite ☐ Nausea ☐ GI obstruction ☐ Lowered cognitive function ☐ Physical impairment (vision, dexterity, dentition)	☐ Taste changes ☐ Dislike food texture ☐ Dislike hospital food ☐ Altered absorption ☐ Meals out of reach ☐ Poor motivation ☐ Other:
	Evidence:	☐ Loss of weight ☐ SGA ___ ☐ Electrolytes outside of reference range	☐ Consuming <100% meals ☐ Signs of muscle wasting and subcutaneous fat loss

Daily Nutrition Progress Form (1/3)				
Study Day: 1, 3, 5, 7 …	DAY no. ___ Day of week _____		DAY no. ___ Day of week _____	
Weight kg	_____ kg ☐ N/A ☐ Actual/measured ☐ Pt reported ☐ Estimated		_____ kg ☐ N/A ☐ Actual/measured ☐ Pt reported ☐ Estimated	
Fluid accumulation?	☐ Yes ☐ No **If yes, est dry weight:**		☐ Yes ☐ No **If yes, est dry weight:**	
Wt change kg				
Nutrition Impact Symptoms	☐ Nausea ☐ Low appetite ☐ Vomiting ☐ Diarrhoea ☐ Taste changes	☐ Constipation ☐ Altered GI function ☐ GI obstruction ☐ Early satiety ☐ Not documented	☐ Nausea ☐ Low appetite ☐ Vomiting ☐ Diarrhoea ☐ Taste changes	☐ Constipation ☐ Altered GI function ☐ GI obstruction ☐ Early satiety ☐ Not documented
Barriers to food intake	☐ Fasting If yes, fasting for: ☐ 1 day ☐ 2-3 days ☐ >3 days ☐ Missed Meals, number ___ ☐ Delirium ☐ Dysphagia	☐ Pain ☐ Poor dentition ☐ Poor vision/dexterity ☐ Meals out of reach ☐ Cognitive impairment ☐ Not documented ☐ Other:	☐ Fasting If yes, fasting for: ☐ 1 day ☐ 2-3 days ☐ >3 days ☐ Missed Meals, number ___ ☐ Delirium ☐ Dysphagia	☐ Pain ☐ Poor dentition ☐ Poor vision/dexterity ☐ Meals out of reach ☐ Cognitive impairment ☐ Not documented ☐ Other:
Did nurses document nutritional impact symptoms/ barriers to food intake?	☐ Nausea ☐ Low appetite ☐ Vomiting ☐ Diarrhoea ☐ Taste changes	☐ Constipation ☐ Altered GI function ☐ GI obstruction ☐ Early satiety ☐ Not documented	☐ Nausea ☐ Low appetite ☐ Vomiting ☐ Diarrhoea ☐ Taste changes	☐ Constipation ☐ Altered GI function ☐ GI obstruction ☐ Early satiety ☐ Not documented
	☐ Fasting If yes, fasting for: ☐ 1 day ☐ 2-3 days ☐ >3 days ☐ Missed Meals, number ___ ☐ Delirium ☐ Dysphagia	☐ Pain ☐ Poor dentition ☐ Poor vision/dexterity ☐ Meals out of reach ☐ Cognitive impairment ☐ Not documented ☐ Other:	☐ Fasting If yes, fasting for: ☐ 1 day ☐ 2-3 days ☐ >3 days ☐ Missed Meals, number ___ ☐ Delirium ☐ Dysphagia	☐ Pain ☐ Poor dentition ☐ Poor vision/dexterity ☐ Meals out of reach ☐ Cognitive impairment ☐ Not documented ☐ Other:
Did doctors document nutritional impact symptoms/ barriers to food intake?	☐ Nausea ☐ Low appetite ☐ Vomiting ☐ Diarrhoea ☐ Taste changes	☐ Constipation ☐ Altered GI function ☐ GI obstruction ☐ Early satiety ☐ Not documented	☐ Nausea ☐ Low appetite ☐ Vomiting ☐ Diarrhoea ☐ Taste changes	☐ Constipation ☐ Altered GI function ☐ GI obstruction ☐ Early satiety ☐ Not documented
	☐ Fasting If yes, fasting for: ☐ 1 day ☐ 2-3 days ☐ >3 days ☐ Missed Meals, number ___ ☐ Delirium ☐ Dysphagia	☐ Pain ☐ Poor dentition ☐ Poor vision/dexterity ☐ Meals out of reach ☐ Cognitive impairment ☐ Not documented ☐ Other	☐ Fasting If yes, fasting for: ☐ 1 day ☐ 2-3 days ☐ >3 days ☐ Missed Meals, number ___ ☐ Delirium ☐ Dysphagia	☐ Pain ☐ Poor dentition ☐ Poor vision/dexterity ☐ Meals out of reach ☐ Cognitive impairment ☐ Not documented ☐ Other

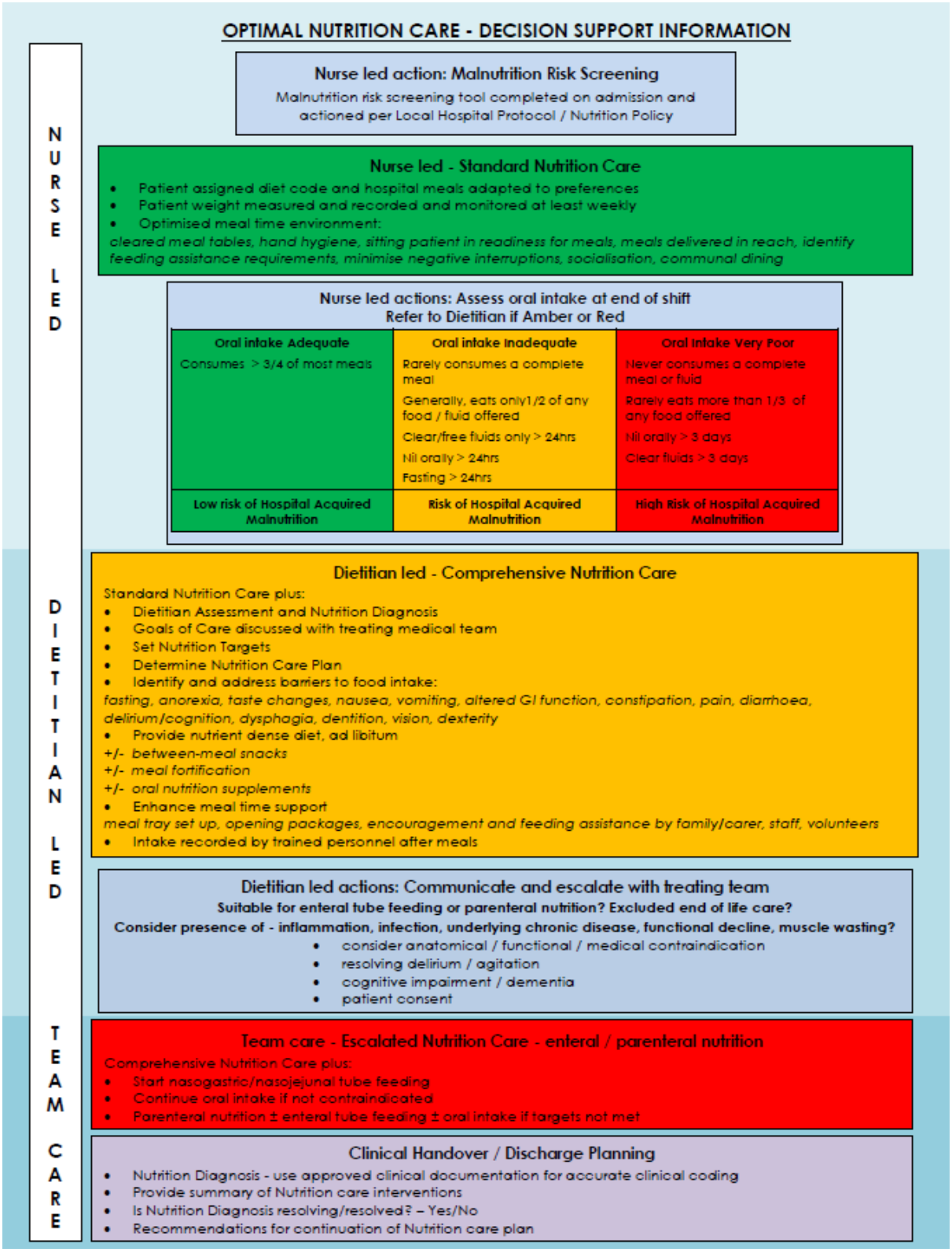
Study Day: 1, 3, 5, 7 …	DAY no. ___ Day of week _____		DAY no. ___ Day of week _____	
Diet Code	☐ Full Ward Diet ☐ HEHP ☐ SHEHP ☐ Low Salt ☐ Clear fluids ☐ Free Fluids ☐ DIAB	☐ DHEHP ☐ Texture modified ☐ Low Fibre ☐ NBM ☐ Fasting ☐ Other:_____ ☐ Not documented	☐ Full Ward Diet ☐ HEHP ☐ SHEHP ☐ Low Salt ☐ Clear fluids ☐ Free Fluids ☐ DIAB	☐ DHEHP ☐ Texture modified ☐ Low Fibre ☐ NBM ☐ Fasting ☐ Other:_____ ☐ Not documented
Meal time (MT) support required?	☐ Yes ☐ No If yes: ☐ Full feeding assistance ☐ Supervision/encouragement/set up ☐ Not documented		☐ Yes ☐ No If yes: ☐ Full feeding assistance ☐ Supervision/encouragement/set up ☐ Not documented	
MT support actioned?	☐ Yes ☐ No If Yes ☐ Volunteer ☐ Nurse ☐ Coloured dome ☐ Other:		☐ Yes ☐ No If Yes: ☐ VMAP ☐ Nurse ☐ Coloured dome ☐ Other:	
Nutrition Support	☐ None ☐ HP milkshake ☐ Oral nutrition supps (other than HPM) ☐ Between meal snacks ☐ Extra diet options ☐ Enteral nutrition ☐ Total/complete ☐ Supplementary ☐ TPN ☐ Total/complete ☐ Supplementary ☐ Not documented		☐ None ☐ HP milkshake ☐ Oral nutrition supps (other than HPM) ☐ Between meal snacks ☐ Extra diet options ☐ Enteral nutrition ☐ Total/complete ☐ Supplementary ☐ TPN ☐ Total/complete ☐ Supplementary ☐ Not documented	
Energy intake	☐ 0-25% ☐ 26-50% ☐ 51-75% ☐ 76-100%		☐ 0-25% ☐ 26-50% ☐ 51-75% ☐ 76-100%	
	☐ **< 75% met** ☐ Not documented		☐ **< 75% met** ☐ Not documented	
Protein intake	☐ 0-25% ☐ 26-50% ☐ 51-75% ☐ 76-100%		☐ 0-25% ☐ 26-50% ☐ 51- 75% ☐ 76-100%	
	☐ **< 75% met** ☐ Not documented		☐ **< 75% met** ☐ Not documented	
Escalated with Treating team	☐ Yes ☐ No		☐ Yes ☐ No	
Suitable for enteral tube or parenteral feeding?	☐ Yes ☐ No If No, why? ☐ Dementia ☐ Short term prognosis ☐ On artificial feeding ☐ Other:		☐ Yes ☐ No If No, why? ☐ Dementia ☐ Short term prognosis ☐ On artificial feeding ☐ Other:	

Daily Nutrition Progress Form (3/3)		
Study Day: 1, 3, 5, 7 …	DAY no. ___ Day of week _____	DAY no. ___ Day of week _____
Is ≥1 of the following present?	☐ Inflammation ☐ Functional decline ☐ Infection ☐ Muscle wasting ☐ Underlying chronic disease	☐ Inflammation ☐ Functional decline ☐ Infection ☐ Muscle wasting ☐ Underlying chronic disease
Escalated Nutrition Care actioned	☐ Yes If Yes, why? ☐ Enteral tube ☐ Parenteral ☐ No If No, why? ☐ Team declining based on medical issues ☐ Patient not consenting ☐ Other:	☐ Yes If Yes, why? ☐ Enteral tube ☐ Parenteral ☐ No If No, why? ☐ Team declining based on medical issues ☐ Patient not consenting ☐ Other:
Is Nutrition diagnosis resolving?	☐ Yes ☐ No If No, why? ☐ Underlying chronic disease ☐ Nutrition impact symptoms ☐ Ongoing intake below target ☐ Other:	☐ Yes ☐ No If No, why? ☐ Underlying chronic disease ☐ Nutrition impact symptoms ☐ Ongoing intake below target ☐ Other:

Appendix 4: Nutrition Care Decision Support Tool (page 1)



Appendix 4: Nutrition Care Decision Support Tool (page 2)



Final Report

Appendix 5: Project budget Spreadsheet

STAFF BUDGET				Year 1			
Staff position	**Total**	**Level**	**Salary overhead (%)**	**# positions**	**Salary**	**Per Position FTE**	**Total**
Project officer/coordinator	$44,283.20	4	13%	1	$110,708.00	0.4	$44,283.20
Site senior dietitian/research assistant - St Vincent's	$15,034.50	3	13%	1	$100,230.00	0.15	$15,034.50
Site senior dietitian/research assistant - Western Health	$15,034.50	3	13%	1	$100,230.00	0.15	$15,034.50
Project co-investigators time (in kind) - refer application	$0.00						$0.00
TOTAL	$74,352.20			**3**		**0.7**	**$74,352.20**
Salary overheads	$9,444.37						$9,444.37

Casual staff		**Level**	**Salary overhead (%)**	**# positions**	**Hourly rate**	**Per Position hours:**	**Total**
Biostatistician	$2,000.00			1			$0.00
Research governance lead (in kind)	$0.00						$0.00
Expert review panel (in kind)	$0.00						$0.00
Medical Librarian (in kind)	$0.00						$0.00
Allied Health research lead (in kind)	$0.00						$0.00
TOTAL	$0.00			**1**		**0**	**$0.00**
Salary overheads	$0.00						$0.00

Total Salary/wages	**$74,352.20**	**$74,352.20**
Total Overheads	**$9,444.37**	**$9,444.37**
STAFF TOTAL	**$83,796.57**	**$83,796.57**

OTHER EXPENSES

e.g. equipment, consumables, travel.

Expense	
human research ethics committee submission (self-initiated) - in kind	$0.00
office space and consumables (in kind)	$0.00
on line survey (in kind)	$0.00
equipment; PC, internet, etc. (in kind)	$0.00
OTHER TOTAL	**$0.00**

RESEARCH TRANSLATION EXPENSES

Description	
Peer review publications (in kind)	$0.00
Conference presentations	$2,000.00
RESEARCH TRANSLATION EXPENSES TOTAL	**$2,000.00**
RESEARCH TRANSLATION EXPENSES AS A PERCENTAGE OF TOTAL BUDGET	**2%**
TOTAL PROJECT BUDGET AMOUNT	**$85,796.57**