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Implementation of a nutrition screening tool to improve nutritional status of children with cancer in Singapore's largest paediatric hospital

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ABSTRACT

Poor nutritional status in children with cancer can impact treatment outcomes and mortality. Nutrition screening is a simple yet effective approach to identify malnutrition risk for early intervention. We aim to improve the identification of children with cancer at high risk of malnutrition, so that nutritional intervention and rehabilitation can commence early for these children. Our multidisciplinary team conducted a root cause analysis and concluded that the generic screening tool did not differentiate malnutrition risk for different cancer types, stage and intensity of treatment. Hence, a screening tool that considered the identified factors was tested for reliability and validity first. Subsequently, we used the Plan, Do, Study, Act model with two improvement cycles to put in place a systematic process to facilitate the implementation. The interventions included (1) instituting the tool in the electronic medical records and (2) direct referral to dietitian based on screening score.

We compared pre- and post-implementation cohorts and demonstrated better identification of nutritionally at-risk patients (36.4%–85.7%, p<0.001) with the new tool as well as improved timeliness of nutritional intervention (3 days to 1 day from admission, p=0.010). A lower malnutrition rate (17.4%–6.5%, p<0.001) in the postimplementation cohort was also demonstrated. Nutritional intervention within 48 hours of admission led to an overall positive weight change at 3 months (+2.68%, IQR: −1.14 to 9.09 vs −0.43%, −6.60 to 2.29; p=0.036) in the malnourished patients from both cohorts. Further studies will be conducted to evaluate the scale of the effectiveness of early intervention and close nutritional monitoring, in improving the nutritional status of children with cancer. The collaborative partnership among the doctors, nurses and dietitians has helped to streamline and simplify nutrition screening, making it an efficient and sustainable system in our hospital.

INTRODUCTION

Problem

The KK Women's and Children's Hospital Cancer Centre is among the largest paediatric children's cancer centres in Southeast Asia and treats 70% of childhood cancers in Singapore. Being a Joint Commission International accredited hospital, universal nutrition screening by nurses within 24 hours of admission using a generic paediatric nutrition screening tool has been implemented since 2011. However, this generic tool may not be suitably designed for children with cancer.

Our baseline audit from December 2017 to May 2018 showed that 11 of 274 (4%) admissions were screened to be at high risk of malnutrition, of which 4 of 11 were successfully referred to the dietitian (36.4% referral rate). Of this baseline cohort, 16 patients did not have previous weight history in the records. Malnutrition, defined as ≥5% wt loss in patients aged 2–20 or any weight loss in children <2 years,[1] was assessed in the remainder 258 records, in the month prior to admission. Baseline malnutrition was present in 45 of 258 (17%) records audited. This suggests that the generic screening tool was unable to accurately identify the malnutrition risk of our patients. In addition, median time to a dietitian referral was 3 days (IQR 1–14). There is currently no consensus on the optimal time to intervene for nutritional care. Nevertheless, it is established that malnutrition in the initial phase of therapy is associated with worse survival in childhood cancer patients.[2] Therefore, nutritional intervention should start as early as possible to mitigate this risk.

Our understanding of the effects of cancer and disease-related treatment on nutritional status in children prompted this quality improvement (QI) project to implement a disease-specific nutrition screening tool. The primary aim of this QI project is to improve the identification of children with cancer who are at risk of malnutrition and to facilitate timely referral to the dietetic service for early nutritional intervention within 48 hours of admission. A secondary aim is to explore the impact of timely dietitian intervention on nutritional status. This was achieved first by

the identification of a reliable screening tool and subsequently by ensuring that a systematic process is in place to facilitate the implementation. This interprofessional collaborative work and the details of how the team implemented the screening process is described in this report.

Background

Poor nutritional status is associated with a significant reduction in 2-year survival and an increase in treatment failure; remediation of poor nutritional status is reported to mitigate the negative association with survival.[3] A combination of limited nutrient reserves and high nutritional needs for growth makes children vulnerable to the impact of cancer and its therapy,[4] which can lead to nutrition-related morbidities. Malnutrition in children with cancer is related to decreased treatment tolerance, increased risk of infections and reduced survival.[5] Children with certain malignant solid tumours, brain tumours and nonlymphocytic leukaemia are at particular risk of malnutrition due to the intensity of their treatment.[6] Facilitation of early nutrition intervention to optimise the nutritional status of children undergoing treatment is paramount to the success of cancer therapy.

Nutrition screening at diagnosis and at regular follow-up throughout the course of cancer treatment is an effective strategy to identify risk factors and develop early interventions.[7] There are few studies that investigated the effectiveness of nutrition screening in children with cancer. A retrospective study showed that nutrition screening identified 62% of children, adolescents and young adults with cancer at risk of malnutrition during the first 6 months of their treatment; out of which, 45% of them lost more than 10% of their baseline weight and were thus classified as malnourished.[5] An international survey of institutions reported 70 of 125 institutions have a screening tool that triggers a nutrition consult.[8] Cancer type, treatment stages and nutrition-related clinical symptoms that may occur throughout treatment are essential considerations to reliably triage children with cancer, as these factors can impact food intake, and in turn nutritional status.[9] The development and validation of a uniform nutritional screening tool and nutrition protocol are necessary to optimise the nutritional status in children with cancer during and after treatment. Leveraging on this modifiable factor can improve the quality of life and survival for patients and survivors of paediatric cancers.[5] Previous studies have not shown superiority of any screening tool in hospitalised children. A screening tool should be tailored for each hospital and diagnosis and should have excellent reproducibility regardless of performers; failing which the screening tool should be identified based on the appropriateness and suitability of the hospital setting.[10]

METHODOLOGY

Design

We established that there was a problem with missed or late referral of patients who were at high malnutrition risk. We formed a multidisciplinary QI team, comprising of a physician, nurse champions and dietitians. As this was a QI project, where participants were not subjected to additional risks or burden beyond usual clinical practice, it did not require ethics review by our institutional review board. The project was conducted in compliance with all applicable institutional policies, regulations and guidelines.

The team conducted a root cause analysis using the five Why Analysis technique. The existing tool was a generic nutrition screening tool with no differentiation of malnutrition risk for different cancer types, stage and intensity of treatment. We found it inaccurate to classify all patients with a cancer diagnosis as one group. Different cancer types have different disease trajectories; the type of treatment protocols, treatment stages and nutrition-related clinical symptoms that may occur through the treatment will also impact the nutritional status.[9] The nutrition screening tool for childhood cancer (SCAN), published in 2015, is the only validated cancer-specific tool for children. The strength of the SCAN is that the development took into account all these factors, and it was intended to be a quick and simple process to identify children with cancer who are at risk of developing malnutrition.[9] The SCAN was based on six questions specific to identify nutritional needs of children with cancer, and the scoring was determined by clinical evaluation of each question's contributing to nutrition risk.[9] They included: (1) type of cancer and presence of comorbidities, (2) intensity of treatment, (3) presence of symptoms related to gastrointestinal tract, (4) reported oral intake over the recent past week, (5) any weight loss, (6) physical examination of signs of undernutrition.[9] To ensure the relevance of the SCAN for our institution, one of our paediatric oncologists assisted to verify the medical terminology and treatment protocols in the tool.

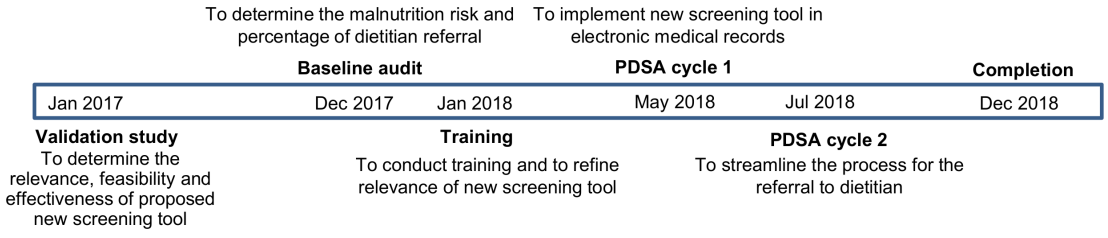

Figure 1 Timeline of the implementation. PDSA, Plan, Do, Study, Act

Figure 1 summarises the timelines of the different stages in the implementation of the screening tool.

Validation study (January 2017)

In order to determine an appropriate screening tool to use, we first conducted a validation study. The SCAN is the only validated childhood cancer-specific nutrition screening tool, which is developed after an extensive review of currently available tools and published screening recommendations.[9] A validation study in our local population was deemed necessary to ensure its relevance as well as feasibility and effectiveness. Validation was conducted in a convenience sample over a 3-week period in January 2017. We compared the existing generic screening tool, with three other tools: (1) modified version of the existing tool, (2) original SCAN and (3) modified version of the SCAN without the physical signs, as an assessment of physical signs was perceived as challenging and time-consuming for the nursing staff to perform. The screening was performed by a single-trained dietitian, and malnutrition risk identified by the SCAN was compared against the gold-standard nutrition assessment using the Paediatric Subjective Global Nutrition Assessment (SGNA) scoring of malnutrition status.[11] Malnutrition was defined as moderately or severely malnourished according to the SGNA, while a score of 3 or more on the SCAN indicated malnutrition risk. Sensitivity and specificity were calculated for the four aforementioned tools.

The validation study involved 31 patients and the malnutrition risk classification using each tool was compared. The SCAN was found to be the most sensitive tool in identifying malnutrition risk, but it was less specific than the existing tool (table 1).

Modifying the SCAN to exclude physical sign assessment reduced the sensitivity of the tool to 69.2%. Although the sensitivity can be increased by adjusting the cut-off to score from 3 to 2, we decided to implement the original SCAN. The original SCAN has a higher specificity; therefore, those who were not picked up by the screening tool will have a lower probability of being at malnutrition risk and will not require active nutritional intervention.

Training programme to use the SCAN (January 2018)

While the baseline data were collected and analysed, training in the use of the new tool was initiated. A group of six nursing champions from the ward was invited to collaborate with the dietitians, so as to facilitate the improvement processes and increase engagement of all stakeholders involved.

The training programme was conducted using standardised materials including visual images and case studies of possible scenarios to be part of the training to create simulations of real situations. The nursing champions attended one training session with the dietitian. Thereafter, the inter-rater reliability assessment showed moderate agreement in the ratings given by the nursing champions and dietitian (kappa=0.757). Subsequently, the nursing champions trained all the ward nurses and any new nurses who joined the ward thereafter.

Strategy

Plan, Do, Study, Act (PDSA) cycle 1 (May 2018): The aim of the first improvement cycle was to facilitate the process of nurses performing the nutritional screening by integrating into routine practice. Incorporating the tool into our electronic medical record (EMR) system will improve efficiency and provide accurate and up-to-date information at the point of care. After the readability and clarity of the questions in the tool was established, our nursing informatics team created a mandatory screening template using 'yes/no' radio-button triggers and incorporated the details of the criteria of the tool in our EMR system. The SCAN was implemented in the EMR from May 2018. The admitting nurse had to select the SCAN to do the screening for all patients admitted into the ward.

The weight field was set to be auto-populated from the clinical records to assist in the retrieval of weight history. There were errors in the calculation of weight changes due to variations in the time points the weight data were referenced to. Further refinement of the backend logic in the auto-population of the weights had to be done. The fine-tuning of the weight calculation not only minimised errors in transcription but also helped to reduce the nurses' time spent in searching through the previous records.

Data collected included the percentage of correct screening forms used, percentage of patients screened to be at high risk referred to a dietitian and number of days from admission to receive dietetic interventions. However, despite the high completion rate of nutritional screening of 94.4%, the percentage of high-risk patients referred for nutritional intervention remained low (62.7%).

Table 1 Statistical evaluation of nutrition screening tools compared with SGNA

	Existing generic tool	SCAN (cut-off ≥3)	Modified generic tool	Modified SCAN (cut-off ≥3)	Modified SCAN (cut-off ≥2)
Sensitivity (%)	69.2	92.3	84.5	69.2	92.3
Specificity (%)	94.4	66.7	61.1	66.7	61.1
Positive predictive value (%)	90	66.7	61.1	60	63.2
Negative predictive value (%)	81.0	92.3	84.6	75	91.7

SCAN, nutrition screening tool for childhood cancer; SGNA, Subjective Global Nutrition Assessment.

PDSA cycle 2 (July 2018): in the second improvement cycle, we aimed to improve the timeliness for nutritional intervention. Although the screening was embedded in the admission process, the nurses were faced with multiple checklists and admission forms to complete within the first 24 hours. The screening required verification and action by a doctor to trigger a referral to the dietitian. Since the communication may be delayed or overlooked in some circumstances, it could result in missed or late referrals. With the team's agreement, a manual direct referral workflow was piloted in the ward. Once the screening was completed by the nurse, she will flag up patients on our work board if the patient was deemed as a high malnutrition risk. The dietitian will then do a daily check to pick up all the high-risk patients and initiate a self-referral to start the nutritional intervention.

Measurement

Ongoing audits were conducted between May and December 2018. The audit involved both the nurse admitting the patient and the nurse champion who would complete the screening separately. Their screening results were compared and discrepancies in scoring and screening outcomes were collated. Inter-rater reliability was established between nursing champions and ward nurses (kappa value=0.773).

The primary measure of improvement in our study was the percentage of patients who were screened to be at high malnutrition risk and received dietetic intervention in a timely manner, measured by the number of days to dietitian referral and dietitian referral rates. Secondary measures to evaluate the impact of nutrition screening on malnutrition rates were also collected preimplementation (December 2017–May 2018) and postimplementation (July–December 2018) of the SCAN. They included the weight status at admission (known as baseline weight), 1 and 3 months after discharge. The percent weight change was calculated as percentage weight change from baseline.

Summary univariate analysis was used to describe the demographics data and compare between the preimplementation and postimplementation groups. Categorical variables were summarised using frequencies and percentages and comparison of dietitian referral rates between groups was analysed using χ^2 statistics. Median with IQR was reported for the non-normally distributed weight changes, and the equivalent nonparametric test was used for comparisons. Statistical significance was set at p<0.05. IBM SPSS Statistics V.19 was used for all analyses.

RESULTS

The referral rate to dietitian in both PDSA cycles is shown in figure 2. The median percentage of patients with high malnutrition risk referred to the dietitian increased from baseline of 33% to postimplementation of 83% after the second PDSA cycle. A total of 267 records were audited between July and December 2018 after the implementation of SCAN. There were no significant differences in median age at admission (9.0 years, IQR: 4.5–13.0 vs 8 years, IQR: 4.8–13.6; p=0.42) and gender (48.5% vs 55.4% men; p=0.11) between preimplementation and postimplementation groups. Table 2 shows a comparison of the results preimplementation and postimplementation of SCAN. For children identified as high malnutrition risk, dietitian's referral rate improved significantly from

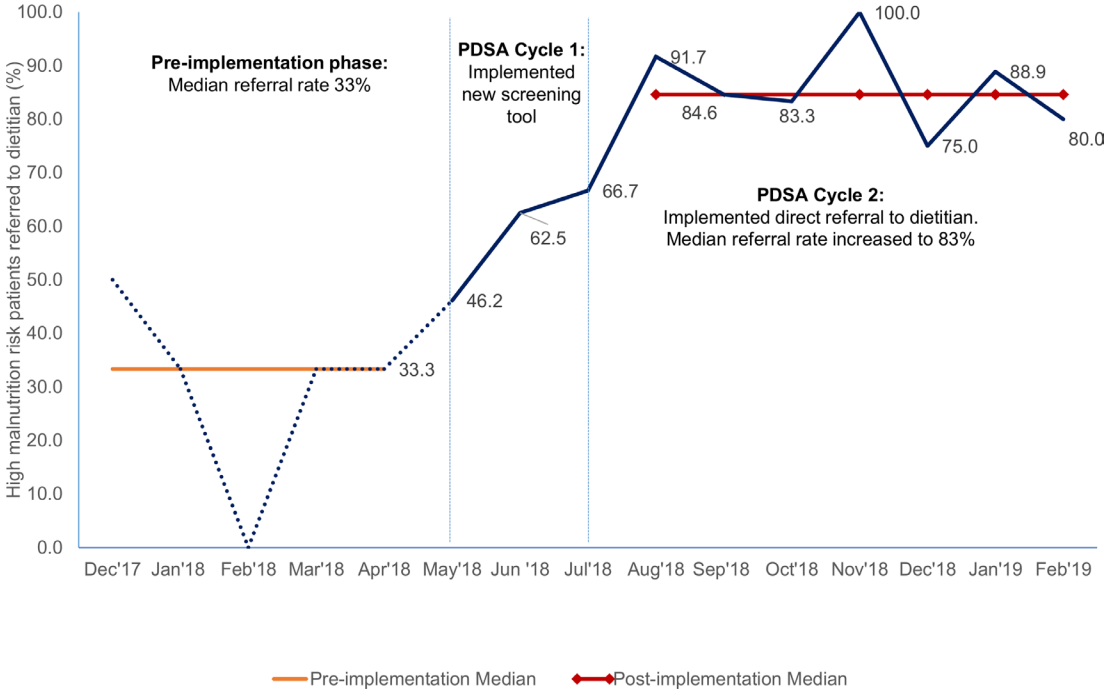

Figure 2 Monthly run chart showing the percentage of high nutrition risk patients referred to dietitian. PDSA, Plan, Do, Study, Act.

Table 2 Comparison of nutrition screening results preimplementation and postimplementation of SCAN

Variable	N	Preimplementation, N=274	N	Post implementation, N=267	P value
Malnutrition rate at admission, n (%)	258	45 (17.4)	260	17 (6.5)	<0.001
Screened to be high risk and seen dietitian, n (%)	11	4 (36.4)	49	42 (85.7)	0.005
Seen by dietitian within 48 hours of admission, n (%)	30	16 (53.3)	41	40 (97.6)	<0.001
Time to dietitian intervention (days)	28	3 (IQR:1 to 14)	13	1 (IQR: 1 to 1)	0.010
Weight change at 1 month (%)	254	0 (IQR:−4.15 to 5.35)	256	2.50 (IQR: −1.33 to 6.22)	0.001
Weight change at 3 months (%)	240	2.02 (IQR: −4.46 to 7.36)	243	4.47 (IQR: 0.20 to 10.06)	<0.001

SCAN, nutrition screening tool for childhood cancer.

4 of 11 high risk (36.4%) to 42 of 49 (85.7%), p<0.001. Timeliness of dietitian referral improved from a median of 3 days (IQR: 1–14) to 1 day (IQR: 1–1) from admission (p=0.010).

To explore the impact of timely dietitian intervention on nutritional status, both cohorts of malnourished patients who received dietitian intervention were combined for the analysis (n=42). Early dietitian intervention (within 48 hours, n=27) was associated with significant improvement in percentage weight change over 3 months in malnourished (+2.68; IQR: −1.14 to 9.09 vs −0.43; IQR: −6.60 to 2.29, p=0.036) as shown in figure 3.

DISCUSSION

Using our existing resources, we transformed a general nutrition screening process to one that focuses on children with cancer, who are known to be at high risk for malnutrition at diagnosis and during treatment.[3]

To date, no published study on the external validity and generalisability of the SCAN is available in the literature.[12] A systematic review of the screening and assessment tools for early detection of malnourished hospitalised children was unable to show superiority of any tool due to the heterogeneity of the tools and the validation study designs.[12] Only the SCAN was tested among children with cancer.[12] Validated against the SGNA, the SCAN showed 'excellent' accuracy (0.90, 95% CI 0.78 to 1.00; p<0.001), 100% sensitivity, 39% specificity, 56% positive predictive value and 100% negative predictive value.[9] This means that the tool was 100% effective that patients would not be malnourished if the tool classified them as 'not at risk of malnutrition'.[9] In comparison to our validation study, the specificity was higher in our population. We can, thus, conclude that for specific conditions, specific tools may be more sensitive than generic tools, as was what we observed in our population.

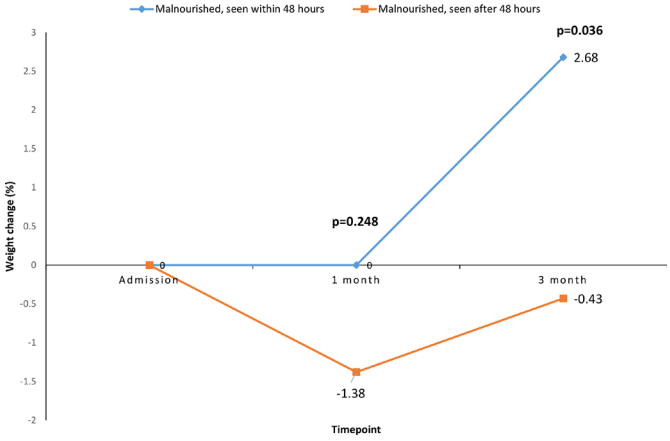

Figure 3 Relationship between timely dietitian intervention (within 48 hours, n=27 vs after 48 hours, n=15) and percentage weight change among the malnourished patients at 1 month and 3 months.

Nutrition screening has been strongly recommended for children with cancer, yet the assessment of nutritional status does not routinely occur in institutions that provide treatment to children and adolescents with cancer.[8] Moreover, different indices are used to indicate the nutrition status of a patient.[8] A retrospective analysis reported 62% of all patients diagnosed were at malnutrition risk during the first 6 months of their treatment regimen; of these, 78% received timely nutrition referrals within 24 hours.[6] It was not possible to conclude the direct association of early nutrition screening and improvement in malnutrition rates.[6] However, it was found that 45% of the patients who were screened to be at malnutrition risk lost more than 10% from their baseline weight during the 6-month period.[6] This finding suggested that screening may be reliable in picking up these patients for early nutritional intervention. In our QI project, we did not assess whether the patients received nutritional intervention previously and could not definitively conclude that the improvement was directly related to the screening tool. We postulated that there was a potential benefit of early intervention, which may possibly have an impact on reversing the risk of malnutrition. However, this was not designed as a research study to test this outcome. Further studies should be conducted to evaluate the cost-effectiveness of nutrition screening tool in early and/or preventive nutritional intervention in optimising the nutritional status of children with cancer. While we do not have any patient reported outcomes or feedback from caregivers about this enhanced nutrition surveillance, this could be another aspect to study the impact and value of nutrition screening in the future.

A nutrition screening tool is a simple, yet effective method to identify malnutrition and this can be implemented hospitalwide or selectively in high-risk areas.[1] The completion rate of screening during our study was 100%. The tool is straightforward and can be performed by any staff on receiving adequate training and, notably, is integrated into the standard nursing admission procedure. The systematic nutrition screening and referral workflow facilitated prompt dietetic intervention, which helped to reduce weight loss in malnourished children and prevented deterioration in nutritional status. This study demonstrated the importance of an interdisciplinary collaboration involving nurses, dietitians and physicians to identify malnutrition and provide appropriate dietetic intervention.

An important aspect of sustainability in QI projects is the integration and assimilation of new initiatives into routine care. In one example, an outpatient centre implemented the tool as an additional SCAN note in the EMR, separately documented by the front desk staff after completing three prescreening questions.[13] Embedding the tool into the clinic note template with a forced entry field instead of a separate note as well as provider completion of screening instead of another front desk staff in order to eliminate the notification step can further improve sustainability.[13] In our project, we overcame both these issues by incorporating the tool and the notification into the same electronic system. Another possible strategy to maintain sustainability of this QI initiative is to integrate nutritional screening into a clinical pathway, so that there is accountability, active communication and consistency of practices at specific timepoints. A clinical pathway is a plan of care for a particular patient population, which takes into account sequencing and timing of interventions by different healthcare professionals. It represents the minimum standard of care and ensures that the essentials are not forgotten and are performed on time.[14] By integrating the medical treatment protocols, nursing care plans, nutrition care plans and activities of other allied health professionals into a single care plan, the expected progress and outcomes of the patient through the hospital system can be defined clearly.[14] This strategy not only adds a visual reminder to the team but also defines common goals for all involved in the entire care process. Such integration can potentially lead to improved outcome and value for patients. This will, in turn, help to streamline and standardise the care of children with cancer required to ensure optimal nutrition care. Further conversations to plan and discuss with the multidisciplinary team will need to continue to develop a clinical pathway for children with cancer.

One of the general limitations for QI project is reproducibility in other clinical context, as it is not a research study and has poor control of external variability. We were also unable to assess long-term sustainability of the tool utilisation and accuracy in screening for users when we had stopped the audit process. We tried to overcome this by doing random audit postproject completion (five per month) to ensure nurses are screening accurately and consistently and that has yielded positive findings so far. Our hospital has a Healthcare Quality & Safety Standards Committee, which conducts ongoing audit process to assess the hospital's quality of care as well as communicates through emailers and roadshows on each of the key standards. One of the key patient-centred standards includes the assessment of patients, and nutritional screening is one of the measurable elements in this standard. This will ensure the long-term sustainability of the tool utilisation to identify at-risk patients for timely nutritional intervention.

A limitation of nutrition screening is the possibility of inaccurate information collection, which is usually based on caregiver recall. We implemented SCAN within our EMR, enabling weight history to be auto-populated from medical records, which helped to circumvent recall bias to some extent. Second, as the nutrition screening was only conducted at admission, there may be changes in the patients' nutritional status during the hospitalisation, which can affect the interpretation of our results. One possible enhancement to this project could be to have rescreening at regular intervals and follow-up longitudinally to determine whether there are any advantages to conducting regular screening.

Nursing staff turnover and inadequate training can introduce biases on how to use the tool correctly. A rigorous training model, using standardised training materials and empowering the nursing champions, helped to ensure that every new nurse was properly inducted and trained to do the screening. Intensive audits on the ground during the initial months of implementation to iron out any discrepancies and misinterpretations were useful. These audits also helped to raise awareness of the importance of nutrition as well as the utility of screening to identify at-risk patients before they deteriorate. The nursing champions will continue to ensure new nurse training at the ward level with the incorporation of nutrition education into nursing orientation. Together with dietitian, they will continue to conduct quarterly audits to ensure long-term adherence and sustainability.

The other limitation was that individual encounters were counted instead of following each unique patient longitudinally. However, the primary intention of the study was to determine whether children with a positive screen for malnutrition received timely intervention and we counted every admission as one potential time point to pick up patients for nutritional intervention.

CONCLUSION

The partnership among the doctors, nurses and dietitians has helped to streamline and simplify the processes, which made nutrition screening an efficient as well as sustainable system approach to identify malnutrition risk for early intervention. Nurses were able to easily and quickly execute this nutrition screening tool and follow-through the workflow. This QI project was able to reaffirm

the principles of patient-centred care by providing coordinated, integrated and responsive care and tailored to the patients' clinical needs. All members of the team interacting with the patient and family at each visit can play a key role in helping to identify potential risks for malnutrition.

We will aim to make incremental improvement to our nutrition protocol for this patient population by first planning to enhance the EMR system by setting up an automatic prompt to the dietetic service a list of patients requiring dietetic intervention. Once the enhancement is completed, we hope to implement this across the hospital for all patients with a cancer diagnosis in both inpatient and outpatient areas. We will continue with regular audits to ensure consistency in the practice. Our long-term aim is to design, together with the multidisciplinary team, a clinical pathway for children with cancer.

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Competing interests None declared.

Patient and public involvement Patients and/or the public were not involved in the design, or conduct, or reporting, or dissemination plans of this research.

Patient consent for publication Not required.

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Data availability statement All data relevant to the study are included in the article.

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