BMJ Open Quality

Sustainability and impact of the implementation of a frailty checklist for the acute medical unit: experience from a tertiary public hospital in Singapore

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To cite: Kasunuran-Cruz MT, Tan DKY, Yeo CY, *et al*. Sustainability and impact of the implementation of a frailty checklist for the acute medical unit: experience from a tertiary public hospital in Singapore. *BMJ Open Quality* 2023;**12**:e002203. doi:10.1136/bmjoq-2022-002203

► Additional supplemental material is published online only. To view, please visit the journal online (http://dx.doi.org/10.1136/bmjoq-2022-002203).

Received 24 November 2022
Accepted 7 July 2023

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ABSTRACT

Background Accelerated population ageing is associated with an increasing prevalence of frailty. International guidelines call for systematic assessment and timely interventions for older persons requiring acute care. Checklists have been applied successfully in healthcare settings.

Objective This study describes the implementation of a safety checklist for frailty in the acute medical unit (AMU) of a tertiary public hospital in Singapore. We explored the sustainability of processes up to 6 months after initial implementation. Additionally, we investigated process and system outcome benefits following the implementation of the checklist.

Methods This retrospective observational study used case notes review of patients admitted to the AMU of a tertiary public hospital in Singapore from February to August 2019. Process outcomes measured to include compliance with AMU frailty checklist assessments and interventions at 24 hours of hospital admission. System and patient outcomes studied to include the length of hospital stay; 30-day emergency department reattendance rate; 30-day hospital readmission rate and inpatient mortality. Propensity scores were used to create balanced cohorts for comparison between those with complete and incomplete compliance with the checklist. Logistic regression was used to adjust for known confounders.

Results Average weekly (all-or-nothing) compliance with the frailty checklist (14.7%) was sustained for 6 months. Where assessments detected high risk, appropriate interventions were appropriately triggered (44%–97.4%). While trends to benefit systems and patient outcomes were present, these were not statistically significant. Contextual patterns are discussed.

Conclusion A safety checklist for frailty was feasibly implemented in the AMU. The checklist was a complex intervention. Full compliance with the checklist was challenging to achieve. Further research assessing optimal patient selection criteria and how checklists may shift team behaviour is a priority.

WHAT IS ALREADY KNOWN ON THIS TOPIC

⇒ Accelerated population ageing is associated with increased acute care utilisation and expanding prevalence of frailty. International guidelines call for systematic assessment and timely interventions for older persons requiring acute care. Checklists have been applied successfully in other healthcare settings.

WHAT THIS STUDY ADDS

⇒ This study finds a checklist for early assessment, and timely intervention of frailty was feasibly implemented in the acute medical setting of a tertiary public hospital in Singapore. The checklist was sustained for up to 6 months and led to appropriate triggers of interventions within 24 hours of hospital admission. Full compliance was challenging to achieve (overall 15.1%), and the intervention's effect size did not produce statistically significant differences in system and patient outcomes at 6 months.

HOW THIS STUDY MIGHT AFFECT RESEARCH, PRACTICE OR POLICY

⇒ Low-cost technologies such as checklists may be feasibly and sustainably implemented in the acute care setting. There is evidence for improved processes after checklist implementation. However, checklists are complex interventions. Optimal patient selection, evaluation of how checklists may change team behaviour or culture, and integration of checklists into longitudinal pathway creation are areas for further study.

INTRODUCTION

Accelerated population ageing is associated with an increasing prevalence of a clinical phenomenon known as frailty. Though not fully elucidated, the mechanism of frailty is thought to derive from accumulated deficits over multiple physiological systems. This results in increased host vulnerability to external stressors.[1] Consequently, the clinical syndrome of frailty is associated with significant adverse outcomes: increased mortality, functional decline and poor quality of life.[2]

In the acute care setting, frailty is particularly prevalent: emergency department (ED) (6.9%–78.0%), general medicine (23.0%–77.9%) and intensive care (13.7%–100.0%).[3]

In this setting, frailty is associated with excess mortality, high-resource utilisation (extended hospital stay and hospital readmission) and institutionalisation.[3] In the acute care setting, early interventions for frailty are beneficial. At 3–12 months follow-up, comprehensive geriatric assessment both increases the likelihood that patients will be alive in their own homes and decreases the likelihood of institutionalisation.[4] A redesign of hospital systems to allow for both earlier multidisciplinary assessment and timely intervention was associated with reduced mortality and hospital bed occupancy. These outcomes were achieved without increased hospital readmission rates.[5] Accordingly, international guidelines call for systematic assessment and timely interventions for older persons requiring acute care.[6–8]

Checklists have been applied successfully in the healthcare setting. An example of a successful checklist implementation is one to reduce catheter-related bloodstream infections.[9] In a multicentre study, checklists during central venous line insertion resulted in a sustained (at 18 months) 66% reduction in catheter-related bloodstream infection rates. The theory underpinning this success is that checklists allow a collaborative team to focus on the task, promote the flattening of hierarchy and improve human factors.[10] Using checklists in the healthcare setting continues to diversify and spread internationally. A multinational study finds the surgical safety checklist is associated with reduced mortality and inpatient complications.[11]

Frailsafe implements a checklist for systematic assessment and timely intervention of older persons in the secondary care setting.[12] Frailsafe is a checklist designed to improve the safety and reliability of care for frail older people admitted urgently to the hospital. For older patients requiring acute care, the Frailsafe checklist aims to ensure that a 'small set of evidence-based interventions have been completed as soon as possible after admission'.[12 13] The checklist comprises a screening section, specific assessments and paired interventions. The screening questions aim to identify patients that may be frail. There were seven specific assessment domains: dementia and delirium, mobility, risk of falls, risk of pressure ulcers, resuscitation and escalation status, equipment needed (eg, pressure mattress), and polypharmacy. These are then paired with specific interventions to reduce patient harm.

This study aims to describe the implementation of a safety checklist based on Frailsafe in the acute medical unit (AMU) of a tertiary public hospital in Singapore. We aim to explore the sustainability of processes up to 6 months after initial implementation. Additionally, we investigate process and system outcome benefits following the implementation of the checklist.

METHODS

Data and measurements

This retrospective observational study used case notes review with the following three inclusion criteria: patients aged 65 years and older; admitted to the AMU at a tertiary public hospital in Singapore between 28 February 2019 and 7 August 2019 (6 months); and length of hospital stay of at least 24 hours. A case report form (CRF) was created on the REDCap platform. Data abstraction from case notes were entered directly into the electronic platform. Data abstracted included baseline patient characteristics, patient demographics, frailty status, admission early warning score and the Charlson Comorbidity Index. Process outcomes measured included compliance with AMU frailty checklist assessments and interventions.

Additionally, four system and patient outcomes were studied: length of hospital stay; 30-day ED reattendance rate, 30-day hospital readmission rate and inpatient mortality. A copy of the CRF is shown in online supplemental table 1.

Statistical analysis

The summary tables show descriptive data on patient characteristics, process outcomes and system outcomes. The χ^2 or Fisher's exact test was used to assess proportions, while paired t-test or Mann-Whitney U test was used to assess means. The AMU Frailty Checklist had two components: one for assessment and one for intervention. The checklist consisted of six individual assessment domains: cognitive impairment; falls and mobility; pressure ulcers and nutrition; bowels and bladder; limits of care; and medicines management. These assessments are paired with specific evidence-based interventions. Compliance with assessment was measured in an 'all-or-nothing' manner to complete all frailty domain assessments covered by the AMU frailty checklist. To construct statistical process control charts, percentage compliance overall and to each frailty assessment domain was aggregated weekly into run charts with three sigma control limits, spanning the 6 months.

Two methods were used to assess if full compliance with the checklist assessments was associated with positive systems and patient outcomes. First, propensity score matching with the 'nearest neighbour' method was used with a 1:1 ratio to create a matched cohort between two groups: patients who had full compliance to the assessment checklist compared with those who did not. The four covariates for matching include: age, Charlson Comorbidity Score, Clinical Frailty Score and admission National Early Warning Score. The system and patient outcomes were then compared. Second, adjusted ORs (AORs) and 95% CIs for full compliance with the checklist assessments were produced using logistic regression. The five variables for adjustment include: age, ethnicity, Charlson Comorbidity Score, Clinical Frailty Score and admission National Early Warning Score. As the length of hospital stay had a gamma distribution, a generalised linear model with Gamma family and log link were used to adjust for the five variables above. Analysis was undertaken using Microsoft Excel and R V.4.2.1 software.

Patient and public involvement statement

It was not appropriate or possible to involve patients or the public in the design, conduct, reporting or dissemination plans of our research.

RESULTS

Implementation of the AMU frailty checklist

An initial audit was undertaken of all patients aged 75 years and older admitted to the AMU over 7 days in August 2018. The prevalence of frailty by clinical frailty scale[14] was high (n=41/61; 67.2%), and the prevalence of frailty syndromes was high: cognitive impairment (36.1%), pressure ulcers (6.6%), falls (24.6%), social issues (19.7%), weight loss/nutritional concerns (27.9%), basic activities of daily living (ADLs): assisted (45.9%) or wholly dependent (4.9%), instrumental ADL: assisted (34.4%) or wholly dependent (32.8%). Process mapping was used to understand the journey of an older person admitted to the AMU. Three main problems were highlighted: (1) different assessments were done by different health professionals; (2) the assessments were not consistently done and (3) no health professional oversaw the global picture. Physicians, nursing, therapists and pharmacy representatives formed a quality improvement team. Using an affinity diagram, the team explored barriers to comprehensive assessment for older persons on the AMU. An Ishikawa chart was constructed to explore root causes. Finally, a Pareto chart was used to prioritise problems to solve that would yield the most benefit. The top four problems, which cumulatively received 80% of the teams' votes, include: (1) not sure what assessment to use, (2) not sure what frailty i, (3) no established process to measure frailty on the AMU and (4) perception from juniors that frailty was not an essential issue in the acute setting. The Affinity diagram, Ishikawa chart and Pareto chart are displayed in online supplemental figures 1–3.

The team iteratively designed a frailty checklist to be completed within 24 hours of the patient's admission to the AMU in patients 75 years and older. The final checklist, given in online supplemental table 2, represents the eighth iteration. Physicians, nurse and therapist champions trained their peers in the importance of early interventions and how to practically carry out the assessments. Posters were placed in clinical areas as reminders to the AMU clinical teams. Junior doctors were empowered to adopt a 'check-and-challenge' approach using the checklist on consultant ward rounds. Implementation of the checklist took place with weekly plan-do-study-act cycles over 1 month. Clinical staff were approached regularly (weekly over a month) to get feedback on problems and successes. Changes were instituted in response, and the team tracked overall compliance to completing the frailty checklist with a run-chart. Average daily compliance increased from 8% to 52% over the month. These changes are shown on the project timeline in online supplemental figure 4. Following this month, the checklist was extended to apply to patients 65 years and older to match other elder-care initiatives within the hospital system.

Patient characteristics

Over the 6 months, 1724 consecutive patient episodes were included in the analysis. The mean age was 78 years, with n=896 (52%) of patients characterised as frail by Clinical Frailty Score. Where assessments were complete, there was a significant prevalence of frailty syndromes: n=286 (16.6%) had a history of dementia and 335 (19.4%) were assessed as confused on admission; n=321 (18.6%) had existing decubitus ulcers; n=47 (2.7%) had a high risk of developing ulcers by Braden score; 211 (12.2%) were at increased risk of poor nutrition; n=962 (88.2%) had an increased risk of falls; n=313 (18.2%) were constipated and 186 (10.8%) were in urinary retention. Patients were comorbid with a mean Charlson Comorbidity Index of 2.7. The mean admission National Early Warning Score (a physiology-based score reflecting disease acuity) was 1.4, in keeping with the acute inpatient setting. Acute health resource utilisation was high: mean length of hospital stay was 7.25 days; 30-day ED reattendance was 15%; and 30-day hospital readmission was 13.7%. Patient characteristics for those over 65 years admitted to AMU are shown in table 1.

Process measures

Using our screening criteria of patients over 65 years admitted to AMU, more frail patients had frailty assessments completed compared with non-frail patients. Table 2 displays the compliance to AMU frailty assessments within 24 hours of admission in patients over 65 years by frailty status as defined by Clinical Frailty Score.

The overall (all-or-nothing) compliance to completion of the frailty checklist assessments using weekly aggregates was 14.7%. The performance for the six individual domain assessments exhibited variability: average weekly compliance was 62.9% for cognitive impairment; 62.7% for falls risk; 63.4% for pressure ulcers and nutrition; 42% for bowel and bladder; 20.6% for medicines assessment and 31.5% for limits of care. Online supplemental figure 5 shows the overall and individual domain assessments completed within 24 hours of AMU admission aggregated weekly.

Where checklist assessments were completed, appropriate interventions were initiated within 24 hours of admission to AMU. Table 3 describes the checklist assessment completion rates (as 'all-or-nothing') for each frailty domain and subsequent interventions within this period. The cohort, where assessment by the checklist was completed, appeared to have a high risk for consequences of frailty: 410/1085 (37.8%) of patients assessed had an increased risk of cognitive impairment; 952/1081 (88.1%) of patients assessed had high falls risk; 415/1090 (38.1%) of patients assessed had an increased risk for decubitus ulcers or malnutrition; and 388/727 (53.4%) patients assessed had constipation or urinary retention. Though assessed at high risk, compliance rates to interventions were variable at 24 hours of AMU admission: from documentation of Abbreviated Mental Tests (44%) to regular toileting (97.4%).

System and patient outcomes

There was no difference in the four outcomes measured in those with full compliance to the AMU Frailty bundle

Table 1 Patient characteristics for patients over 65 years admitted to AMU, National University Hospital(NUH) between 28 February 2019 and 7 August 2019

Patient characteristics	
n	1724
Age (mean (SD))	78.13 (8.15)
Race (%)	
Chinese	1302 (75.5)
Malay	185 (10.7)
Indian	125 (7.3)
Other	112 (6.5)
Charlson Comorbidity Index (mean (SD))	2.74 (2.02)
Clinical Frailty Score (%)	
1	3 (0.2)
3	222 (12.9)
4	603 (35.0)
5	273 (15.8)
6	280 (16.2)
7	222 (12.9)
8	104 (6.0)
9	17 (1.0)
National early warning score (mean (SD))	1.36 (1.98)
History of dementia (%)	286 (16.6)
Confused on admission (%)	335 (19.4)
Existing pressure ulcers (%)	321 (18.6)
Braden score<12 (%)	47 (2.7)
Nutrition score>2 (%)	211 (12.2)
Falls risk=high risk (%)	962 (88.2)
Faecal loading suspected (%)	157 (9.1)
Urinary retention (post-void residual urine >200 mL) (%)	183 (10.6)
Length of hospital stay (mean (SD))	7.25 (26.67)
30-day emergency department reattendance (%)	258 (15.0)
30-day hospital readmission (%)	237 (13.7)
Inpatient mortality (%)	38 (2.2)

AMU, acute medical unit.

assessments at 24 hours, compared with those that had incomplete or no compliance: mean length of hospital stay 5.8 vs 7.5 days (p=0.33); 30-day ED reattendance rate at 14.6% vs 15.0% (p=0.94); 30-day hospital readmission rate 14.2% vs 13.7% (p=0.882) and inpatient mortality rate of 0.3% vs 0.2% (p=0.99). However, the two groups had significant differences in patient characteristics. The patients with full compliance were older (mean age 83.7 vs 77.1; p<0.001), frailer (42.1% vs 9.9%; p<0.001), and exhibited a trend of being more acutely unwell (mean admission National Early Warning Scores of 1.58 vs 1.33; p=0.06). Online supplemental table 3 displays complete patient characteristics and outcomes for both groups.

Propensity score matching for age, Charlson Comorbidity Score, Clinical Frailty Score and admission national early warning score resulted in two matched groups of n=260 each. Table 4 shows the patient characteristics and outcomes of the matched cohort of patients by compliance status to checklist assessments at 24 hours of admission to AMU. The matched groups had no significant differences in baseline characteristics: mean age, ethnicity, mean Charlson Comorbidity Score, mean admission National Early Warning Score and frailty. While showing a trend to benefit for all system and patient outcomes, the differences between these matched groups did not reach statistical significance: length of hospital stay (5.76 days vs 6.66 days; p=0.09), 30-day ED reattendance (14.6% vs 15.8%; p=0.81); 30-day hospital readmission (14.2% vs 14.6%; p=0.99) and inpatient mortality (2.3% vs 3.1%; p=0.79).

Similarly, while the AORs were favourable for the group with full compliance to AMU frailty checklist assessments compared with those without for all system and patient outcomes, the CIs did not reach statistical significance. Table 5 shows AOR and 95% CIs for full compliance to AMU frailty checklist assessments, adjusting for age, ethnicity, Charlson Comorbidity Score, Clinical Frailty Score and admission National Early Earning Score.

DISCUSSION

With the population ageing, acute care utilisation continues to rise globally. In Singapore, the rate of increase in ED attendance far outstrips population growth (5.6% vs 1.3% in 2016).[15] A study in the UK reports that population ageing may account for up to 40% of the increase in emergency admission to hospitals.[16] Frailty assessment and management in the acute care setting is challenging. A recent consensus study suggests that the AMU or care of the elderly ward is the most appropriate acute care setting to assess for frailty. Additionally, it is recommended that the assessments are done early in the patient journey: 'within 24 hours from arrival to hospital'.[17]

Time-pressured, high turnover and busy, fast-paced acute care environments are difficult settings to provide timely assessment and interventions for frailty. Tools that can promote patient safety, decrease clinical variation and improve the reliability of care for this vulnerable cohort are a priority.[12 18–20] The AMU frailty checklist comprises six clinically relevant assessment domains linked to evidence-based interventions. Specific interventions are to be triggered when the checklist assessments find the patient is at risk within the individual domains.

Our study finds that a frailty checklist for the first 24 hours of an older person's admission to the AMU was feasibly implemented and sustained over 6 months. The cohort appeared appropriate, with just over 50% being classified as frail by Clinical Frailty Score. However, full compliance with assessing all frailty domains was challenging, with only a weekly average of 14.7% of patient episodes reaching this standard. Overall, the full compliance rate was (260/1724) 15.1% for the 6 months. There

Table 2 Compliance to AMU frailty assessments at NUH by 24 hours of admission in patients over 65 years by frailty status as defined by Clinical Frailty Score

Clinical Frailty Score>4	Frail	Not frail	P value
n	896	828	
Full compliance with AMU Frailty checklist assessments	171 (19.1)	89 (10.7)	<0.001
Full compliance with cognitive domain assessments	695 (77.6)	389 (47.0)	<0.001
Full compliance with falls domain assessments	694 (77.5)	387 (46.7)	<0.001
Full compliance with nutrition and pressure ulcers domain assessments	701 (78.2)	389 (47.0)	<0.001
Full compliance with bowels and bladder domain assessments	482 (53.8)	245 (29.6)	<0.001
Full compliance with medicines management domain assessments	228 (25.4)	141 (17.0)	<0.001
Full compliance to limits of care domain assessments	403 (45.0)	152 (18.4)	<0.001

AMU, acute medical unit; NUH, National University Hospital.

was variation in average weekly compliance between the individual frailty domain assessments: 20.6%–62.9%. Where patients were found to be at risk for the specific frailty domain, the compliance for paired interventions also varied from 44.4% to 97.4% (table 2).

A review of the implementation of Frailsafe checklists in 12 hospitals in the UK finds a median overall full compliance rate of 6.8% (0.3%–60.8%).[21] Significant variation in the completion of both assessments and interventions was reported for the individual frailty domains across the 12 hospitals. The paired ethnographic study found both perceived benefits and challenges with implementing the Frailsafe checklist by the clinical teams. On the one hand, the checklist was felt to create a space to focus on frailty in the acute care setting: identifies problems with existing processes, an impetus to acquire equipment (eg, pressure mattress) and works as a helpful prompt. On the other hand, there was some perceived duplication of existing processes, 'check-and-challenge' was not often implemented, and definitive 'closed-loops' of care were difficult to achieve. Definitive care was found particularly difficult to accomplish as care processes continue over 24 hours and to other downstream wards.

Our study has surfaced some contextual patterns. First, assessment domains that are predominantly completed by nursing staff appeared to have high average compliance rates and less variability than those predominantly completed by physicians (online supplemental file 1). Mainly nursing assessments had average weekly compliance rates of 62.9%–63.4% with tight control limits: falls; cognitive assessment; and pressure ulcers. These compliance rates compared favourably to physician assessments predominantly completed with average weekly completion rates of 20%–42% with wider control limits: bowels and bladder; medicines management; and appropriate limits of care. This difference in compliance rates may have two explanations. First, nurses may be more socially adept at reliably adhering to protocoled pathways than physicians.[22] Second, nursing workforce continuity at this AMU was potentially more sustained when compared with physicians. The nursing staffing model comprised of three shifts covering 24 hours. The shifts tended to draw from the same pool of nurses. The physician staffing model included senior staff (consultants) who rotated weekly and junior staff who rotated on a 2 weekly basis from a hospital-wide pool. While efforts to maintain process continuity (eg, clinical orientation for new staff, clinical handover and preshift huddles) existed, achieving sustained compliance may have been affected by workforce change-over.

Second, the age-based criteria appeared to have afforded some efficiency. Using a Clinical Frailty Score of over four, almost 20% of frail patients fully complied with the frailty checklist assessments. Only 10.7% of patients who were not frail also received full compliance to the frailty checklist assessments (table 2). However, where assessed by the frailty checklist, patients who were not defined as frail by the score also appeared to have significant clinical frailty: 59 (15.2%) seemed to have a high risk of cognitive impairment, 355 (91.3%) had a risk of falls, 64 (16.5%) had a risk of malnutrition and pressure ulcers and 701 (84%) had a risk of bowel or bladder problems. These findings may reflect the lack of consensus on the best tool to assess frailty in the acute care setting.[17] While the Clinical Frailty Score has identified hospitalised older persons at risk of adverse outcomes in the Singapore public hospital setting,[23] it may still miss out on some who may benefit from early intervention.

Lastly, average weekly compliance to completion of the frailty checklist appears to be higher in the very aged (online supplemental tables 4–6; online supplemental figure 6). The explanation may be twofold. In a busy time-pressured environment with competing priorities, the clinicians may have preferentially applied the checklist to those who appeared clinically frail rather than focus on screening criteria. Alternatively, the checklist was initially used for those over 75 years and subsequently expanded to include those over 65 years. The clinicians may have defaulted to previous habits which had become subconsciously embedded into practice.

While not statistically significant, there was a trend to benefit system and patient outcomes for those who had

Table 3 Process measures: completed assessments and interventions for patients 65 years and older within 24 hours of admission to acute medical unit

Cognitive impairment	
Assessments completed; N (%)	1084 (62.9)
Found to be high risk; N (%)	410 (37.8)
Interventions	
Behaviour charting; N (%)	281 (68.5)
Reality orientation; N (%)	330 (80.5)
AMT documented; N (%)	182 (44.4)
Memory clinic referral considered; N (%)	213 (52.0)
Transfer to hyperacute delirium ward considered; N (%)	203 (49.5)
Falls risk	
Assessments completed; N (%)	1081 (62.7)
Found to be high risk; N (%)	952 (88.1)
Interventions	
Referral to therapist; N (%)	723 (75.9)
Analgesia; N (%)	616 (64.6)
Falls clinic referral considered; N (%)	443 (46.5)
Nutrition and pressure ulcers	
Assessments completed; N (%)	1090 (63.2)
Found to be high risk; N (%)	415 (38.1)
Interventions	
SSKIN bundle applied	385 (92.8)
Referral to dietician	352 (84.8)
Bowels and bladder	
Assessments completed; N (%)	727 (42.1)
Found to be high risk; N (%)	388 (53.4)
Interventions	
Laxatives prescribed; N (%)	338 (87.1)
Clean intermittent catheter; N (%)	353 (91.0
Indwelling urinary catheter; N (%)	377 (97.2)
Regular toileting; N (%)	378 (97.4)
Medicines management	
Assessments completed; N (%)	369 (21.4)
Medicines reconciled; N (%)	369 (100)
Medicines optimised; N (%)	356 (96.5)
Limits of care	
Assessments completed; N (%)	420 (24.4)
Resuscitation order completed; N (%)	379 (90.2)
Advanced care planning discussions; N (%)	334 (79.5)

AMT, abbreviated mental test; SSKIN, skin, surface, keep moving, incontinence/moisture and nutrition/hydration.

full compliance to the frailty checklist compared with those with incomplete compliance (tables 4 and 5). As factors that affect these outcomes are multifactorial, it is unclear if an intervention focused on the first 24 hours of care may have an effect size sufficient to shift these outcomes. These findings may also be the consequence of the overall low full compliance rate.

Future directions

While the AMU frailty checklist provided a framework for the assessment and early intervention for frailty at a specific place (the AMU) and time (within 24 hours of hospital admission), it must be recognised that optimal care for frailty spans the entire patient journey. Longitudinal pathways of care may be more appropriate for specific cohorts of frail elderly. Given resource restraints, how to identify these vulnerable cohorts is an area of future study. For example, suppose two or more dimensions of the checklists frailty domains are identified as high risk. In that case, the patient may benefit from a different pathway, such as a specialist geriatric review with comprehensive geriatric assessment or admission to an acute frailty unit.[24]

The AMU frailty checklist was a collection of assessments and paired interventions. It represented an effort to integrate many different care processes into a care bundle. Efforts to improve compliance would require exploring and improving each of the six specific frailty domain processes individually to optimise the intervention's overall performance. There have been separate quality improvement projects at this acute hospital to improve processes for the specific domains of medicines management and limits of care after implementation of the AMU frailty checklist: improving conversations and communication at the end of life, dedicated pharmacist to join the team ward rounds, and removal of intravenous cannula when no longer needed.

Given resource constraints, there is an argument to focus on narrower screening criteria. The original Fail-safe checklist included patients for further assessment if they were 75 years and older and fulfilled at least one of three criteria: decreased mobility, increased confusion and care home resident.[25] While these may in theory highlight more severely frail patients who may benefit most from the intervention, it is unclear if that threshold is appropriate. It may be that these interventions have a more significant effect size on those with mild to moderate frailty instead. The optimal patient selection remains an area for further study.

Our evaluation of the AMU Frailty checklist has necessarily been a technical intervention. However, the successful implementation of checklists in healthcare may stem from the ability of a quality improvement programme to influence and alter sociocultural patterns of work, communication and group dynamics.[21 26] Evaluation from this perspective may require more qualitative approaches to methodology but yield more meaningful system learning.

Strength and limitations

This study has some strengths. This large quality improvement study reports the implementation process of a complex intervention. The lead time allows improvements

Table 4 Patient characteristics and system outcomes of the matched* cohort of patients by compliance status to checklist assessments at 24 hours of admission to AMU

	AMU frailty checklist full compliance with all assessments	AMU frailty checklist incomplete compliance with all assessments	P value
n	260	260	
Patient characteristics			
Age (mean (SD))	83.70 (5.53)	83.66 (5.69)	0.938
Race (%)			0.125
Chinese	207 (79.6)	202 (77.7)	
Malay	29 (11.2)	19 (7.3)	
Indian	10 (3.8)	17 (6.5)	
Other	14 (5.4)	22 (8.5)	
What is the Charlson Comorbidity Score? (mean (SD))	2.73 (1.91)	2.72 (2.04)	0.965
What is the Clinical Frailty Scale (%)			0.339
1	0 (0.0)	0 (0.0)	
2	0 (0.0)	0 (0.0)	
3	8 (3.1)	12 (4.6)	
4	81 (31.2)	70 (26.9)	
5	49 (18.8)	50 (19.2)	
6	43 (16.5)	56 (21.5)	
7	57 (21.9)	43 (16.5)	
8	21 (8.1)	26 (10.0)	
9	1 (0.4)	3 (1.2)	
What is the NEWS Score on admission? (mean (SD))	1.58 (2.32)	1.64 (2.18)	0.741
System and patient outcomes			
Length of hospital stay (mean (SD))	5.76 (6.31)	6.66 (5.95)	0.096
30-day ED reattendance (%)	38 (14.6)	41 (15.8)	0.807
30-day hospital readmission (%)	37 (14.2)	38 (14.6)	1
Inpatient mortality (%)	6 (2.3)	8 (3.1)	0.786

*Matched for age, Charlson Comorbidity Score, Clinical Frailty Score and admission NEWS using Propensity Score with 'nearest neighbour' method.
AMU, acute medical unit; ED, emergency department; NEWS, National Early Warning Score.

Table 5 Adjusted ORs (AORs) and 95% CIs for full compliance to AMU frailty checklist assessments at 24 hours of AMU admission

System and patient outcomes N=1724	Adjusted OR*	95% CI
30-day emergency department reattendance	0.91	0.61 to 1.33
30-day hospital readmission	0.95	0.63 to 1.41
Inpatient mortality	0.69	0.24 to 1.75
Length of hospital stay	0.86	0.72 to 1.02

*Adjusted for age, ethnicity, Charlson Comorbidity Score, Clinical Frailty Score and admission national early warning score.
AMU, acute medical unit.

to processes to stabilise before assessing for sustainability. The study tracks process, system and patient measures for up to 6 months of follow-up with no drop-out rate. To ensure the intervention and control groups are as similar as possible for accurate comparison of outcomes, both groups have had appropriate matching for known risk factors. Similarly, adjustment for known risk factors in multivariate regression allows the whole dataset to be used.

This study has some weaknesses. This retrospective observational study case notes review. It is, therefore, susceptible to recall and detection bias. Efforts to avoid transcription error include direct data input into an electronic CRF and automated validation tools within the REDCap platform. However, this cannot be excluded.

CONCLUSION

This large retrospective observational study reports the implementation of a safety checklist for frailty in the setting of an AMU in a public hospital in Singapore. The study finds the checklist was feasibly implemented and sustained for 6 months, though full compliance with all checklist standards was difficult to achieve. The checklist assessments resulted in the early application of evidence-based interventions. There was no significant difference in rates of inpatient mortality, 30-day ED reattendance, 30-day readmission and length of hospital stay between those who had full compliance with all checklist standards compared with those who did not.

Acknowledgements We would like to extend our gratitude to the clinicians and other hospital staff members who took part and supported this research. We specifically thanks members of the quality improvement team for their invaluable contributions: Claudia Tan, Tan Bee Ngoi, Amanda Chin, WenShen Yang, Reshma Merchant and Amelia Santosa

Contributors JTYS designed, carried out the study procedures, wrote the first draft and is gurantor for the study. MTK-C, CYY, DKYT and BM-YH contributed to study design and ongoing writing.

Funding This study is supported by two grants: NUHS (NUHSRO/2020/099/RO5+6/Seed-Mar/05) and NMRC (MOH-000770).

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 applicable.

Ethics approval The National Health Group Ethics Committee have approved this study.

Provenance and peer review Not commissioned; externally peer reviewed.

Data availability statement No data are available.

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