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Full Reference (including all authors (presenter in bold) & title):

1. **Bai Z**, Barker L, Koh C, Solomon M, Shahab R, Alexander K, Karunaratne S, Ansari N, Pereira LSM, Drummond-Lage AP, Steffens D. *Association Between Preoperative Frailty and In-Hospital Costs Following Cytoreductive Surgery with Hyperthermic Intraperitoneal Chemotherapy.*
2. **Bai Z,** Barker L, Koh C, Solomon M, Shahab R, Alexander K, Karunaratne S, Ansari N, Pereira LSM, Drummond-Lage AP, Leopoldino AAO, Steffens D. *Association Between Preoperative Frailty and Survival and Surgical Outcomes in Patients Undergoing Cytoreductive Surgery with Hyperthermic Intraperitoneal Chemotherapy.*
3. **Bai Z**, Delbaere K, Solomon M, Shahab R, Koh C, Ambrens M, Karunaratne S, Steffens D. *Evaluating Feasibility and Acceptability of an eHealth Prehabilitation Program for Frail Patients Undergoing Gastrointestinal Cancer Surgery: A Pilot RCT Protocol.*
4. **Bai Z**, Barker L, Shahab R, Koh C, Solomon M, Alexander K, Karunaratne S, Ansari N, Pereira LSM, Drummond-Lage AP, Steffens D. *Impact of Preoperative Frailty on Postoperative Quality of Life Following Cytoreductive Surgery with Hyperthermic Intraperitoneal Chemotherapy*.

Conference/Meeting Name: World Congress of Prehabilitation and Perioperative Medicine 2025
Location: Vancouver, Canada
Dates: 2025 November 3-5
Presentation Type: Poster presentation



With my PhD supervisor, Professor Daniel Steffens.
Our poster explored the association between preoperative frailty and outcomes following cytoreductive surgery for cancer. It was an inspiring experience to present my PhD research and engage with international experts in cancer prehabilitation.

I attended the World Congress of Prehabilitation and Perioperative Medicine 2025, an international conference focused on improving perioperative outcomes, with a strong emphasis on cancer prehabilitation. The conference brought together several hundred delegates, including surgeons, oncologists, physiotherapists, and researchers. The main theme centred on optimising cancer patients before surgery through multimodal prehabilitation, including exercise, nutrition, and psychological support.

There was considerable attention on cancer prehabilitation as a strategy to improve recovery and long-term outcomes. In addition, several presentations highlighted the emerging role of frailty assessment in cancer surgery, demonstrating its value in identifying vulnerable patients and guiding personalised care. These discussions were particularly inspiring and stimulated new ideas for integrating frailty into prehabilitation research.

Together with my PhD supervisor, Professor Daniel Steffens, I presented a series of posters from our research program on frailty and cancer surgery. These included studies on the impact of frailty on quality of life, healthcare costs, surgical outcomes, and survival following cytoreductive surgery with HIPEC, as well as our pilot protocol investigating an eHealth prehabilitation program for frail cancer

patients. Presenting this body of work provided valuable opportunities to engage with international experts, receive feedback, and develop new collaborative connections.
The knowledge gained will directly benefit my current PhD research on eHealth prehabilitation for cancer patients, particularly in strengthening the integration of frailty assessment into intervention design.

These learning outcomes are highly relevant to Sydney Cancer Partners, as they support the development of personalised prehabilitation strategies to improve outcomes and care for cancer patients.

A personal highlight was presenting my research internationally alongside my supervisor and engaging with researchers whose work has influenced my future research direction.

Association Between Preoperative Frailty and In-Hospital Costs Following Cytoreductive Surgery with Hyperthermic Intraperitoneal Chemotherapy

SOuRCe
Surgical Outcomes Research Centre

Zirong Bai[12], Laura Barker[24], Cherry Koh[123], Michael Solomon[123], Rihan Shahab[24], Kate Alexander[12], Sascha Karunaratne[12], Nabila Ansari[1], Leani Souza Maximo Pereira[5], Ana Paula Drummond Lage[5], Daniel Steffens[123]

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BACKGROUND

- CRS+HIPEC is a complex and resource-intensive treatment for peritoneal malignancies.
- Preoperative frailty is linked to worse outcomes and higher healthcare use, but its economic impact in CRS+HIPEC is unclear.
- This study examined the association between frailty and in-hospital costs in CRS+HIPEC patients.

METHODS

- Retrospective cohort, May 2017–June 2024.
- Clinical Frailty Scale (≥4 = frail), in-hospital cost categories including staffing, critical care, diagnostics, operating theatre, ward care, and other services were collected.
- Age subgroup analysis (<65 vs ≥65 yrs).

RESULTS

➢ ***Table 1.*** *Demographics and Characteristics by Clinical Frailty Scale.*

Characteristics	Not frail (N=406)	Frail (N=60)	Overall (N=466)	P-value
Age, years	54.0 (44.0 to 63.0)	64.0 (51.5 to 68.0)	55.5 (44.3 to 65.0)	<0.001
Body Mass Index (BMI), kg/m²	26.9 (23.7 to 30.7)	25.9 (23.7 to 30.8)	26.8 (23.7 to 30.7)	0.719
Gender				0.947
Male	171 (42.1)	25 (41.7)	196 (42.1)	
Female	235 (57.9)	35 (58.3)	270 (57.9)	
Peritoneal carcinomatosis Index	12.0 (6.0 to 21.0)	14.5 (7.8 to 21.3)	12.0 (6.0 to 21.0)	0.300
Surgery duration, hours	9.8 (8.0 to 10.8)	10.0 (9.1 to 11.5)	9.4 (8.0 to 11.0)	0.015
Length of ICU stay (days)	5.0 (4.0 to 5.9)	5.5 (4.6 to 6.3)	5.0 (4.0 to 6.0)	0.037
Length of hospital stay (days)	17.0 (13.0 to 22.0)	21.0 (15.0 to 35.3)	17.0 (13.0 to 23.0)	<0.001
Length of postoperative stay (days)	16.0 (13.0 to 21.0)	20.0 (15.0 to 27.5)	17.0 (13.0 to 22.0)	<0.001

➢ ***Table 2.*** *Comparison of in-hospital admission costs between frail and non-frail patients.*

Cost variables	Not frail (n = 406)	Frail (n = 60)	p - value
Staff	$30,623 ($21,839 to $54,517)	$33,067 ($23,328 to $68,401)	0.001
Critical Care	$15,246 ($10,151 to $21,361)	$16,202 ($11,220 to $22,883)	0.957
Diagnostic	$5,329 ($2,541 to $8,392)	$5,926 ($2,679 to $10,396)	0.027
Operating Theatre	$26,580 ($19,568 to $34,287)	$28,874 ($20,306 to $37,338)	0.578
Ward	$7,252 ($6,274 to $8,743)	$8,221 ($6,581 to $14,126)	<0.001
Other	$16,703 ($7,485 to $22,072)	$18,039 ($352 to $25,127)	0.073
Total in-hospital cost	$106,938 ($92,116 to $129,613)	$115,282 ($100,514 to $160,770)	0.005

Note: Data presented as median (interquartile range). Total in-hospital cost is the sum of staff, critical care, diagnostic, operating theatre and other costs. Frail was defined as a Clinical Frailty Scale score ≥ 4.

➢ ***Table 3.*** *Univariate and multivariate regression analysis with total in-hospital cost as the dependent variable within the frail cohort (N=60)*

Variables	Univariate*				Multivariate		
	R^2	Unstandardised coefficient (95%CI)	P-value		R^2	Unstandardised coefficient (95%CI)	P-value
Age (years)	0.004	212 (-691 to 1,114)	0.641				
BMI (kg/m²)	0.023	1212 (-901 to 3,325)	0.256				
Gender	0.040	-17427 (-39,832 to 4,977)	0.333				
Male							
Female							
Peritoneal Carcinomatosis Index	0.006	-334 (-1,434 to 765)	0.545				
Surgery duration (hours)	0.014	-2125 (-6789 to 2,540)	0.366				
Intensive Care Unit Stay (days)	0.086	2,189 (312 to 4,066)	0.023		0.086	2,189 (312 to 4,066)	0.023
Length of Hospital Stay (days)	0.031	302 (-141 to 745)	0.177				
Completeness of Cytoreduction	0.004	-7,120 (-36,196 to 21,956)	0.626				
CC0							
CC1-CC3							
Postoperative complication	0.000	-1,302 (-29,484 to 26,881)	0.927				
Clavien-Dindo	0.028	-12,841 (-8,712 to 34,394)	0.237				
Grade I-II							
Grade III-V							

Note: Variables highlighted in bold (P<0.2) were entered in a multiple regression using backward elimination. BMI, body mass index; ICU, intensive care unit. Frail was defined as a Clinical Frailty Scale (CFS) score ≥ 4. Equation to estimate total CRS and HIPEC cost = AU$102,411 + AU$2189 × ICU stay (days).

CONCLUSIONS

Preoperative frailty is independently associated with increased in-hospital costs among patients undergoing CRS+HIPEC. Routine frailty assessment may support early identification of high-risk patients and guide targeted perioperative strategies to optimize clinical outcomes and resource utilization in this vulnerable surgical population.

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Association Between Preoperative Frailty and Survival and Surgical Outcomes in Patients Undergoing Cytoreductive Surgery with Hyperthermic Intraperitoneal Chemotherapy

SOuRCe
Surgical Outcomes Research Centre

Zirong Bai[1,2], Laura Barker[2,4], Cherry Koh[1,2,3], Michael Solomon[1,2,3], Rihan Shahab[2,4], Kate Alexander[1,2], Sascha Karunaratne[1,2], Nabila Ansari[1], Daniel Steffens[1,2,3]

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BACKGROUND

Frailty is increasingly recognised as a predictor of poor surgical outcomes. However, its impact in determining outcomes following cytoreductive surgery (CRS) with hyperthermic intraperitoneal chemotherapy (HIPEC) remains underreported. Thus, this study aims to determine the association between preoperative frailty and surgical outcomes including survival in patients undergoing CRS+HIPEC.

METHODS

This retrospective cohort study included patients who underwent CRS+HIPEC at Royal Prince Alfred Hospital between May 2017 and June 2024. Frailty was assessed preoperatively using the Clinical Frailty Scale (CFS), with patients classified as frail (CFS ≥ 4) or not frail (CFS < 4). Other outcomes included surgery duration, intensive care unit (ICU) and hospital stays, postoperative complications, recurrence rates, and survival. Subgroup analyses were performed based on age group (<65 versus ≥65 years).

RESULTS

➢ *Frailty Is Associated with Poorer Surgical and Survival Outcomes in CRS+HIPEC Patients:*

Of the 466 patients included, 60 (12.9%) were classified as frail. Frailty was associated with longer surgery duration (median: 10.0 vs. 9.8 hours; p = 0.015, Figure 1a), longer ICU stay (median: 5.5 vs. 5.0 days; p = 0.037, Figure 1b), hospital stay (median: 21.0 vs. 17.0 days; p < 0.001, Figure 1c), but there was no statistically significant in postoperative complications (p = 0.468, Figure 1d). and worse survival outcomes (p = 0.002).

Figure 1. Impact of frailty on surgical outcomes

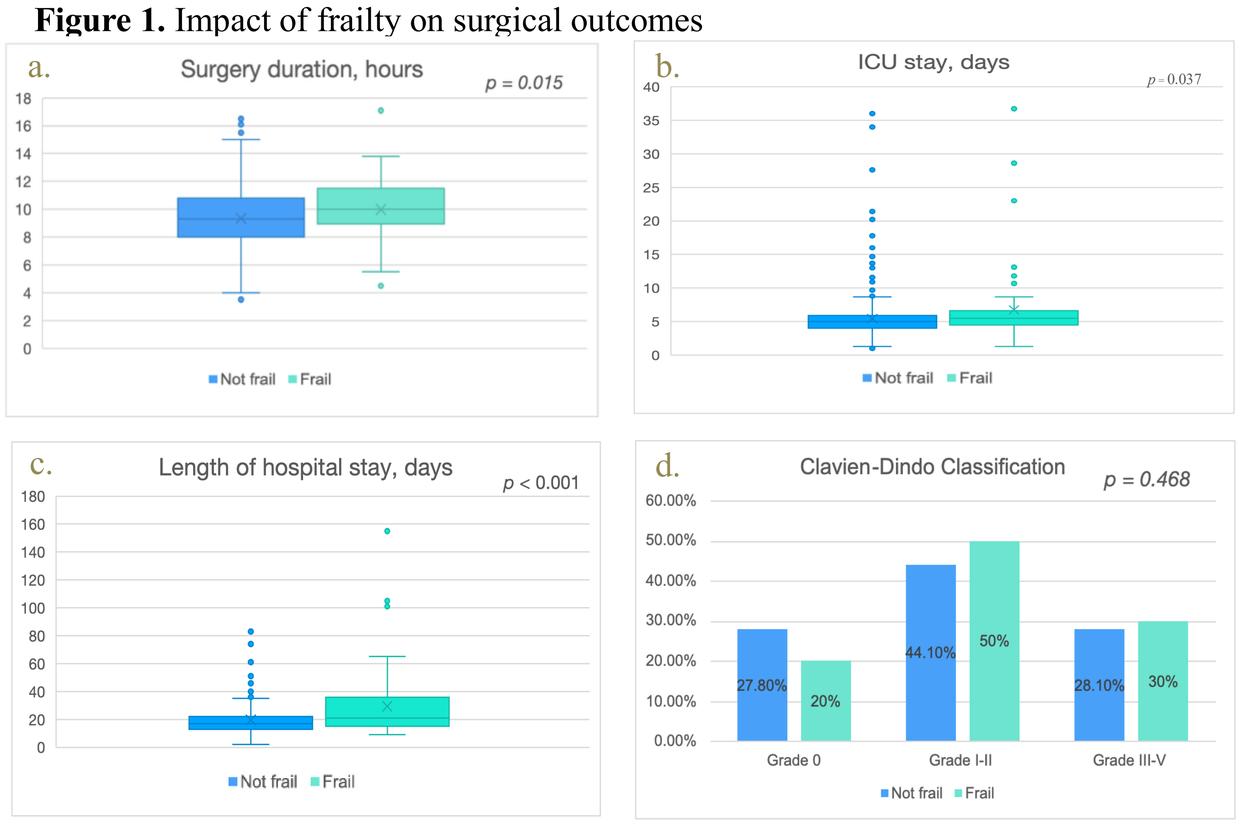
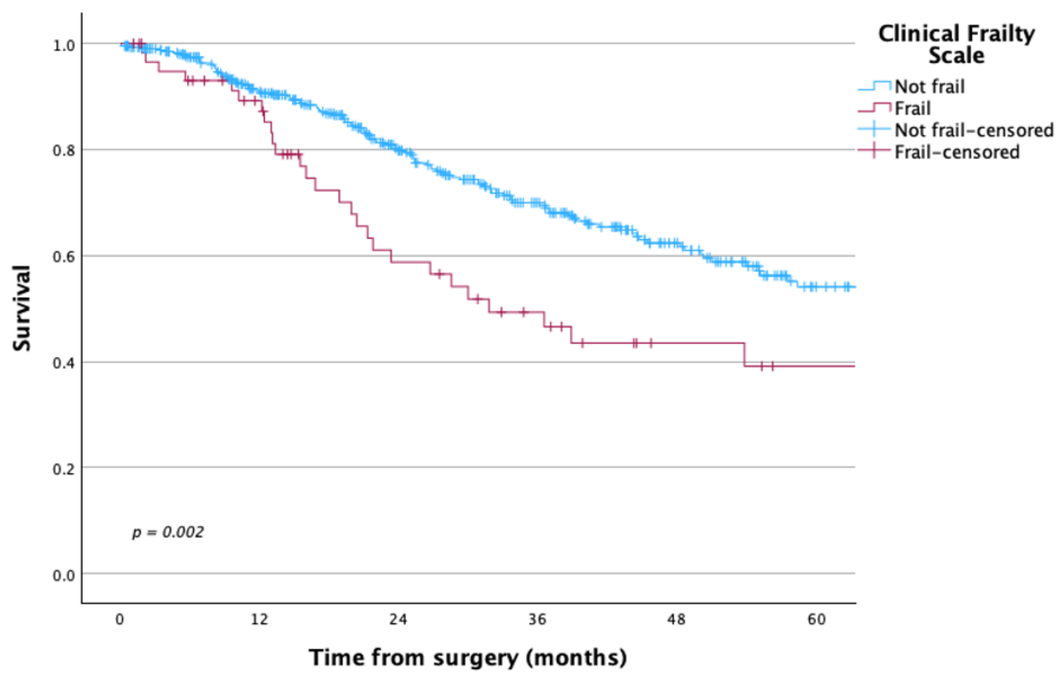


Figure 2. Impact of frailty on survival



Note: Overall difference in survival between frail and not frail patients after surgery. Frail patients had significantly worse overall survival, with a p-value of 0.002. Frail was defined as a Clinical Frailty Scale (CFS) score ≥ 4.

➢ *Age-Stratified Analysis Confirms Consistent Impact of Frailty Across Age Groups:*

Age-stratified analysis revealed that frailty was associated with prolonged hospital stay across both subgroups. In patients aged ≥ 65 years, frailty was also significantly associated with longer surgery durations (p < 0.001, Figure 3) and length of ICU stay (p = 0.013, Figure 4).

Figure 3. Frailty extended surgery duration in older patients.

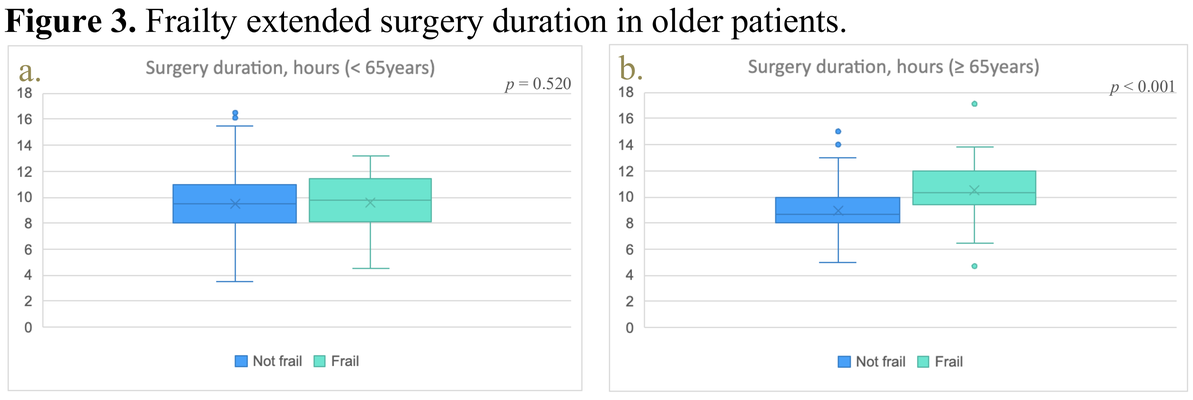


Figure 4. Frailty extended ICU stays in older patients.

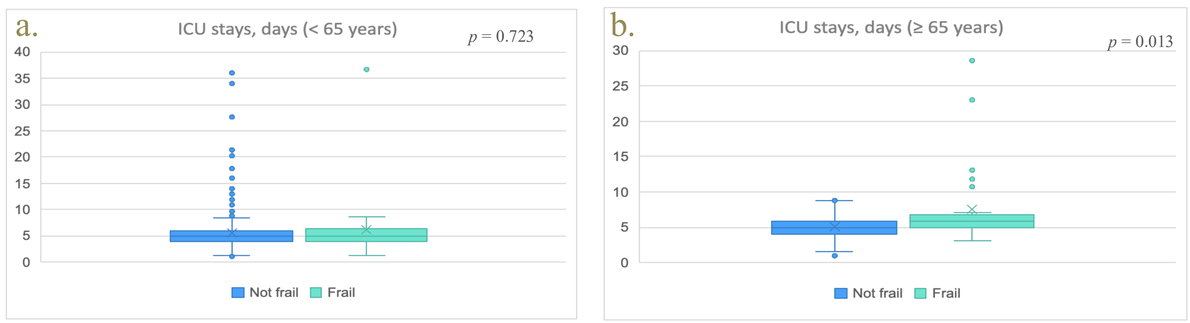
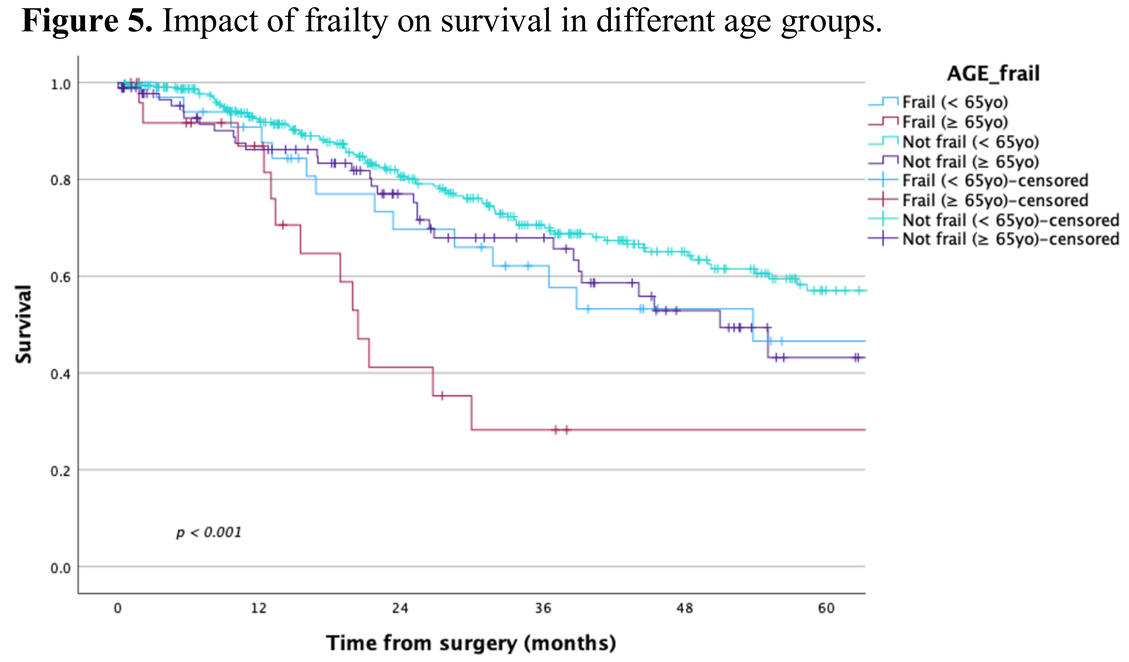


Figure 5. Impact of frailty on survival in different age groups.



Note: Impact of frailty on survival rates across different age groups in patients after surgery. Frail patients had significantly worse long-term survival, with a p-value < 0001. Frail was defined as a Clinical Frailty Scale (CFS) score ≥ 4.

CONCLUSIONS

Preoperative frailty is associated with worse postoperative outcomes in CRS+HIPEC patients, underscoring the need for routine frailty assessments. Future research should explore strategies to mitigate its adverse effects such as preoperative optimisation through prehabilitation.

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Evaluating Feasibility and Acceptability of an eHealth Prehabilitation Program for Frail Patients Undergoing Gastrointestinal Cancer Surgery: A Pilot RCT Protocol

SOuRCe
Surgical Outcomes Research Centre

Zirong Bai[1,2], Laura Barker[2,4], Cherry Koh[1,2,3], Michael Solomon[1,2,3], Rihan Shahab[2,4], Kate Alexander[1,2], Sascha Karunaratne[1,2], Nabila Ansari[1], Daniel Steffens[1,2,3]

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BACKGROUND

Frail patients undergoing cancer surgery are at heightened risk of postoperative complications and delayed recovery due to reduced physiological reserve and functional impairment. While prehabilitation can address modifiable risk factors before surgery, traditional face-to-face delivery methods often struggle with patient adherence and accessibility. Electronic health (eHealth) interventions offer an alternative mode of delivery, but their feasibility and acceptability in frail surgical oncology populations remain underexplored.

OBJECTIVE

This pilot randomised controlled trial will evaluate whether an eHealth prehabilitation exercise program is feasible and acceptable for frail patients scheduled for gastrointestinal (GI) cancer surgery, potentially offering a more accessible intervention to improve postoperative recovery.

METHODS

This two-arm, assessor-blinded, multi-site pilot RCT will recruit 40 frail adult patients (Clinical Frailty Scale ≥3) scheduled for elective GI cancer surgery. Participants will be randomized 1:1 to receive either standard care alone or standard care plus an eHealth-based exercise intervention, delivered via the *StandingTall* platform (Figure 1). The intervention will include tailored balance, strength, and aerobic training (three hours per week) beginning at least four weeks prior to surgery. Feasibility outcomes will include recruitment rate, retention rate, and adherence to the prescribed exercise dose. Acceptability will be assessed via a custom questionnaire and semi-structured interviews. Secondary outcomes include postoperative complications, length of hospital stay, quality of life (EQ-5D-5L), pain (numerical pain rating scale (NPRS)), days alive at home within 30 days (DAH-30), and self-reported physical activity (IPAQ-SF).

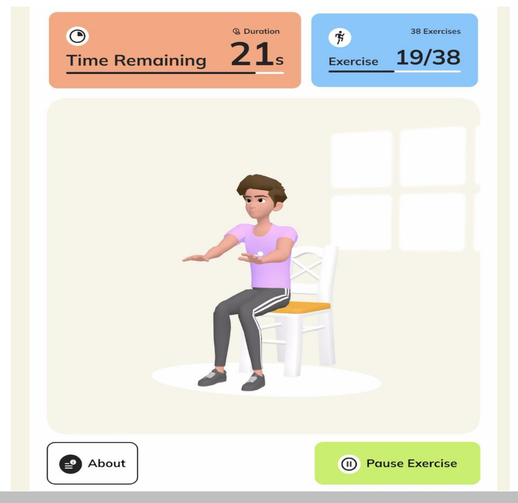
1 Initial Assessment & Onboarding

Chris O'Brien Lifehouse

Preoperative referral

- Recruitment of frail GI cancer patients (CFS ≥ 3);
- Screening and consent at RPAH & COBLH;
- Baseline data and device setup (tablet if needed).

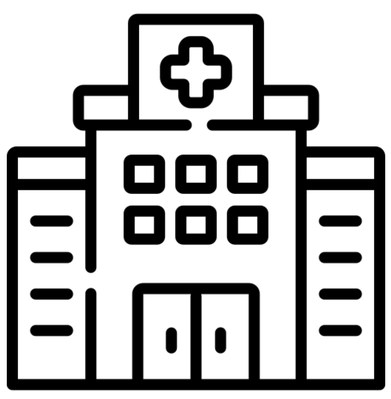
2 Preoperative Phase Getting Fit (4 weeks)



Preoperative Intervention

- Home-based digital exercise via *StandingTall*;
- Tailored balance, strength, and aerobic training;
- Virtual onboarding + remote physiotherapist support.

3 In Hospital Phase (1 – 3 weeks)



Surgery

- Usual perioperative hospital care;
- Data capture: complications, LOS, DAH-30;
- Safety monitoring + continuation post-discharge.

4 Post-Discharge Phase Recovery (Up to 3 months)



Follow up

- Follow-up to 3 months;
- QoL, pain, and physical-activity assessment;
- Feasibility & acceptability evaluation (survey + interview).

CONCLUSIONS

This pilot trial will determine whether an eHealth prehabilitation program is feasible and acceptable for frail cancer surgery patients. Findings will inform the refinement of intervention protocols, outcome measurement, and sample size estimates for a future full-scale randomised trial.

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Impact of Preoperative Frailty on Postoperative Quality of Life Following Cytoreductive Surgery with Hyperthermic Intraperitoneal Chemotherapy

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Zirong Bai[1,2], Laura Barker[2,4], Cherry Koh[1,2,3], Michael Solomon[1,2,3], Rihan Shahab[2,4], Kate Alexander[1,2], Sascha Karunaratne[1,2], Nabila Ansari1, Daniel Steffens[1,2,3]

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BACKGROUND

- Frailty predicts poor postoperative outcomes.
- Impact on QoL after CRS+HIPEC remains underreported.
- This study explores frailty's effect on postoperative QoL.

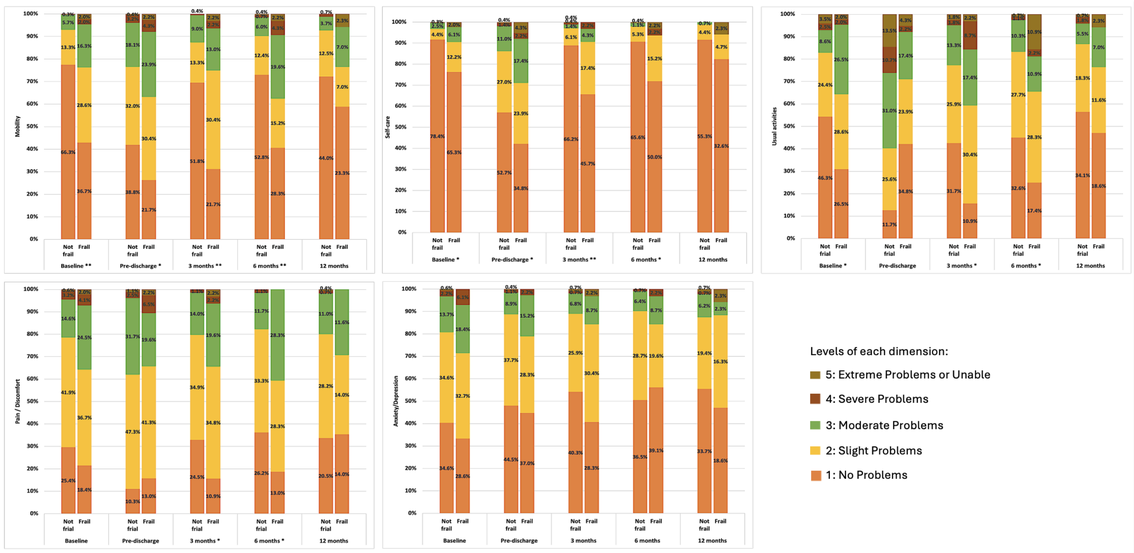
METHODS

- Retrospective cohort, May 2017–June 2024.
- Clinical Frailty Scale (≥4 = frail), QoL assessed with EQ-5D-5L, SF-36.
- Age subgroup analysis (<65 vs ≥65 yrs).

RESULTS

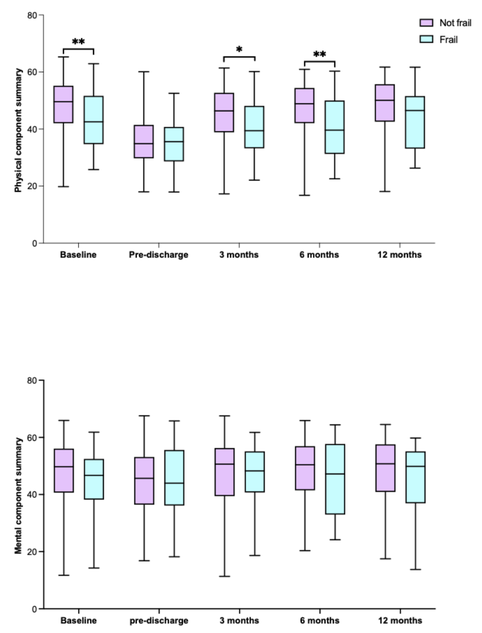
➢ *Frailty Strongly Predicts Poorer Quality of Life After CRS+HIPEC:*

Figure 1. Quality of Life (EQ-5D-5L)



Note: Frail was defined as a Clinical Frailty Scale (CFS) score ≥ 4. * - p < 0.05; ** - p <0.001.

Figure 2. 36-Item Short Form Survey (SF-36)

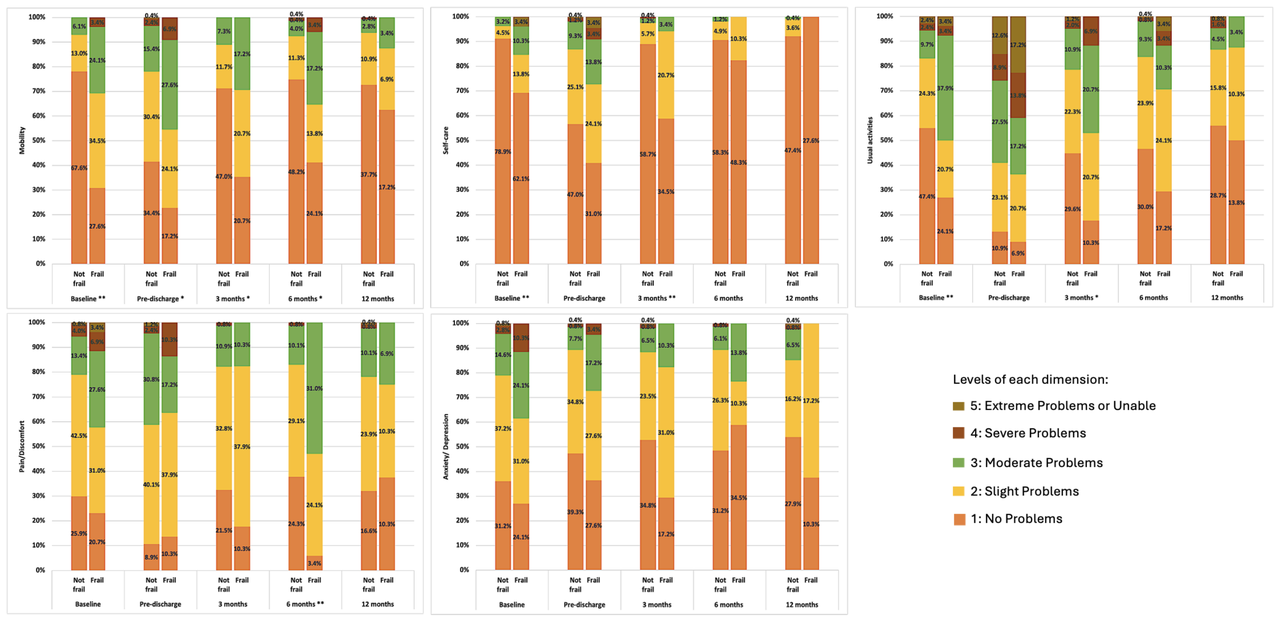


- ❑ Out of 364 patients, only 13.5% were frail — but their outcomes were markedly worse.
- ❑ Frail patients were significantly older (61 vs 54 years, p = 0.018), had longer surgeries, and required more ICU and hospital time.
- ❑ More importantly, they entered surgery with lower quality of life, especially in mobility (p < 0.001), self-care, and daily functioning — and these impairments did not improve, even 6 months after surgery.
- ❑ Mental health (MCS) scores remained similar across groups, but pain and discomfort were consistently worse in frail patients at both 3 and 6 months (p = 0.018 and 0.005).

➢ *In Younger Patients (< 65), Frailty Hits Early and Hard:*

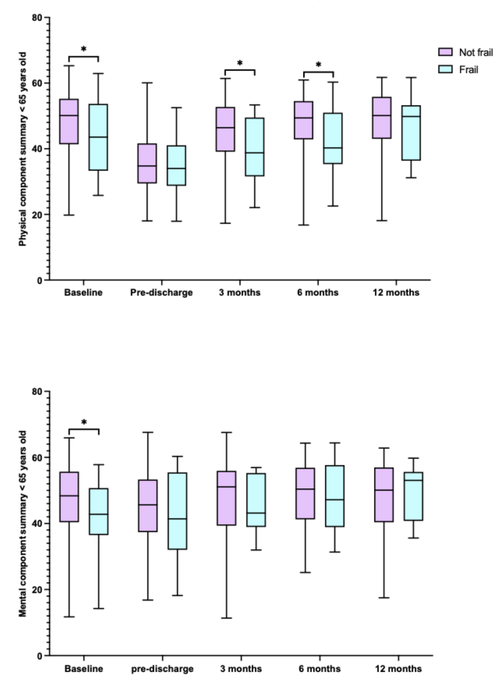
- ❑ Among patients under 65 (n = 276), those classified as frail showed significant deficits in mobility, self-care, daily activities, and physical health (PCS) — even before surgery, and these persisted at 3 months post-op (all p ≤ 0.031).
- ❑ Despite being younger, frail patients still experienced delayed recovery and prolonged hospitalization, revealing that chronological age alone does not protect against vulnerability.

Figure 3. Quality of life (EQ-5D-5L, patients < 65 years old)



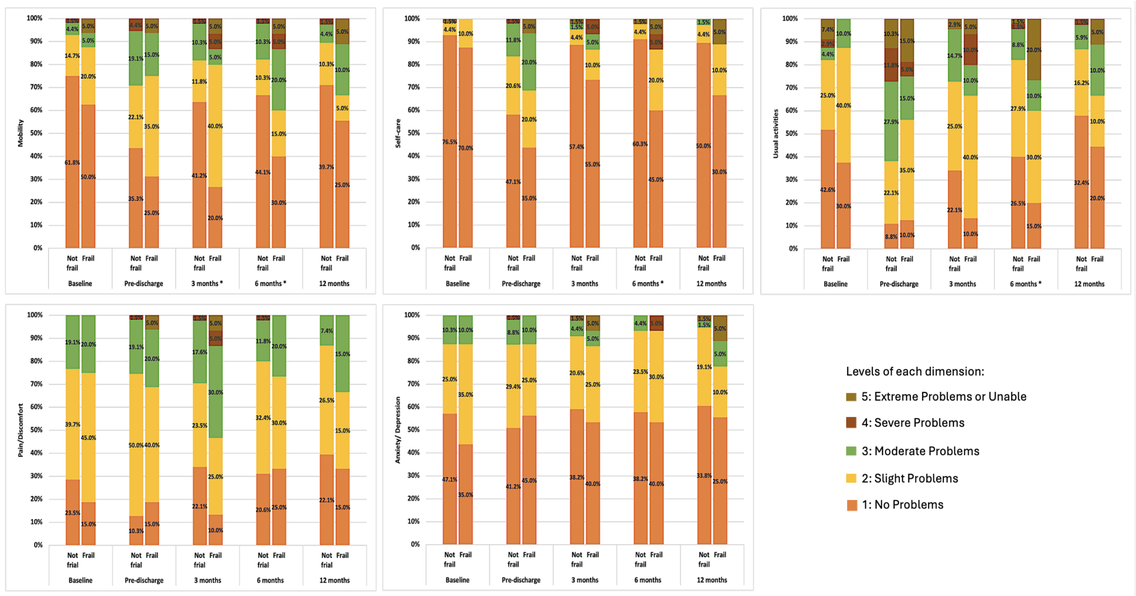
Note: Frail was defined as a Clinical Frailty Scale (CFS) score ≥ 4. * - p < 0.05; ** - p <0.001.

Figure 4. 36-Item Short Form Survey (SF-36, patients < 65 years old)



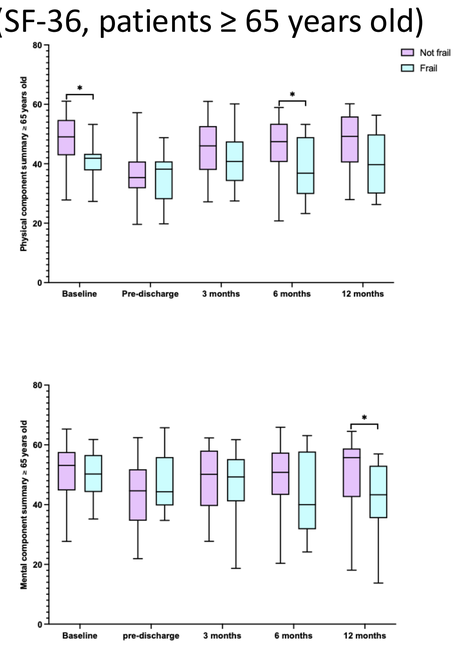
➢ *In Older Patients (≥ 65), Frailty Worsens Long-Term Mental and Physical Recovery:*

Figure 5. Quality of life (EQ-5D-5L, patients ≥ 65 years old)



Note: Frail was defined as a Clinical Frailty Scale (CFS) score ≥ 4. * - p < 0.05.

Figure 6. 36-Item Short Form Survey (SF-36, patients ≥ 65 years old)



- ❑ Frail patients aged ≥ 65 had longer surgeries, prolonged ICU stays, and slower physical recovery (p < 0.05).
- ❑ By 6 months, they continued to show significantly worse mobility, independence, and physical functioning (all p ≤ 0.041).
- ❑ Alarmingly, at 12 months post-op, older frail patients also reported lower mental health scores (MCS) (p = 0.048), suggesting frailty's long-term burden spans both body and mind.

CONCLUSIONS

Preoperative frailty predicts impaired recovery and reduced QoL following CRS+HIPEC. Routine frailty screening and prehabilitation strategies are recommended to optimise outcomes.

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