Sustaining a multidisciplinary single-institution post-operative mobilization Clinical Practice Improvement Program during the Coronavirus Disease 2019 (COVID-19) pandemic

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Submitted to: JMIR Perioperative Medicine
on: May 17, 2021

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Abstract

Background: The Enhanced Recovery After Surgery (ERAS) protocol has been recently extended to hepatopancreatobiliary (HPB) surgery, with excellent outcomes reported. Early mobilization is an essential facet of the ERAS protocol but compliance has been reported to be poor. We recently reported our success in a 6-month clinical practice improvement program (CPIP) for early postoperative mobilization. During the COVID-19 pandemic, we experienced reduced staffing and resources available which can render sustainability of CPIP difficult.

Objective: We report outcomes at one year following our CPIP to improve the post-operative mobilization in patients undergoing major HPB surgery amidst the COVID-19 pandemic.

Methods: We divided our study into four phases: (1) phase 1: before CPIP (Jan to Apr 2019); (2) phase 2 (May to Sep 2019): implementation of CPIP; (3) phase 3: post-CPIP before COVID-19 (Oct 2019 to Mar 2020) and (4) phase 4: post-CPIP during COVID-19 (Apr 2020 to Sep 2020). Major HPB surgery was defined as any surgery on the hepato-pancreato-biliary system >2 hours and with anticipated blood loss ?500ml. Study variables included length of hospitalization stay, distance ambulated on POD2, morbidity, balance measures (incidence of fall and accidental dislodgement of drains), and reasons for failure to achieve targets. Successful mobilization was defined as able to sit out of bed for >6 hours on POD1 and ambulate ?30m on POD2. Target mobilization rate was ?75%.

Results: 114 patients underwent major HPB surgery from phase 2 to phase 4 of our study: 33 (29.0%), 45 (39.5%), and 36 (31.6%) patients in phase 2, phase 3 and phase 4 respectively. No baseline patient demographics was collected for phase 1 (pre-CPIP implementation); Majority of the patients were male (n=79, 69.3%) and underwent hepatic surgery (n=92, 80.7%). There were 76 (66.7%) patients who had ON-Q PainBuster insertion intra-operatively. The median mobilization rate was 22% for phase 1, 78% for phase 2 and 3 combined, and 79% for phase 4. The mean pain score was 2.7±1.0 on POD1 and 1.8±1.5 on POD2. The median length of hospitalization stay was six days (interquartile range (IQR) 5-11.8). There were no falls or accidental dislodgement of drains. Six patients (5.3%) had pneumonia. Twenty-one patients (18.4%) failed to ambulate ?30m on POD2 from phase 2 to 4. The commonest reason for failure to achieve ambulation target was pain (n=6/21, 28.6%) and lethargy or giddiness (n=5/21, 23.8%).

Conclusions: This follow-up study shows the sustainability of our CPIP in improving early postoperative mobilization rates following major HPB surgery one year after implementation, even during the COVID-19 pandemic. Further large-scale multi-institutional prospective studies should be conducted to assess compliance and determine its sustainability.

(JMIR Preprints 17/05/2021:30473)
DOI: https://doi.org/10.2196/preprints.30473

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Background

The Enhanced Recovery After Surgery (ERAS) protocol has been recently extended to hepatopancreatobiliary (HPB) surgery, with excellent outcomes reported. Early mobilization is an essential facet of the ERAS protocol but compliance has been reported to be poor. We recently reported our success in a 6-month clinical practice improvement program (CPIP) for early postoperative mobilization. During the COVID-19 pandemic, we experienced reduced staffing and resources available which can render sustainability of CPIP difficult.

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(39.5%), and 36 (31.6%) patients in phase 2, phase 3 and phase 4 respectively. No baseline patient demographics was collected for phase 1 (pre-CPIP implementation); Majority of the patients were male (n=79, 69.3%) and underwent hepatic surgery (n=92, 80.7%). There were 76 (66.7%) patients who had ON-Q PainBuster insertion intra-operatively. The median mobilization rate was 22% for phase 1, 78% for phase 2 and 3 combined, and 79% for phase 4. The mean pain score was 2.7±1.0 on POD1 and 1.8±1.5 on POD2. The median length of hospitalization stay was six days (interquartile range (IQR) 5-11.8). There were no falls or accidental dislodgement of drains. Six patients (5.3%) had pneumonia. Twenty-one patients (18.4%) failed to ambulate ≥30m on POD2 from phase 2 to 4. The commonest reason for failure to achieve ambulation target was pain (n=6/21, 28.6%) and lethargy or giddiness (n=5/21, 23.8%).

Conclusion

This follow-up study shows the sustainability of our CPIP in improving early postoperative mobilization rates following major HPB surgery one year after implementation, even during the COVID-19 pandemic. Further large-scale multi-institutional prospective studies should be conducted to assess compliance and determine its sustainability.

Keywords: Enhanced recovery after surgery; early mobilization; liver resection; pancreas surgery; quality improvement project

Introduction

Enhanced Recovery After Surgery (ERAS) is a multimodal, multidisciplinary peri-operative approach to improve surgical outcomes [1]. The implementation of ERAS protocols has improved peri-operative outcomes in patients undergoing elective major hepatopancreatobiliary (HPB) surgery [2]. Post-operative early mobilization is an integral component of the ERAS protocols as it reduces pleuro-pulmonary complications and deep vein thrombosis [3]. Early post-operative mobilization also reduces post-operative ileus and length of hospital stay [4, 5]. However, there are no standardized criteria to define mobilization, and compliance remains poor. Vague terminologies, including sitting out of bed, standing at the bedside, walking duration, and walking distances, are used to define mobilization. Recently, Grass et al. performed a retrospective study involving 1170 patients who had colorectal surgery in Switzerland to assess early post-operative mobilization (defined as sitting out of bed ≥ 6 hours on post-operative day (POD) 1). They showed that 58% of patients were non-compliant, with resulting increased post-operative morbidity (overall complications 55% vs. 29%, $p < 0.001$) and length of stay (12±14 days vs. 6±7 days, $p < 0.001$) compared to the early mobilization group [6].

A systematic review by Coolsen et al. in 2013 described poor compliance (mobilization rate 20-28%) to early post-operative mobilization on POD1 following liver surgery [2, 7, 8]. Similarly, our institution showed a poor post-operative mobilization rate of 22% in patients undergoing elective major HPB surgery, with improvement to >75% following the implementation of a multidisciplinary surgeon-led clinical practice improvement project (CPIP) [9]. The quality improvement process does not end with the implementation of a solution. Specific steps must be taken, and mechanisms established to hold the gains, for breakthroughs in results come from sustaining changes. Royal College of Physicians of London, United Kingdom, has incorporated sustainability within the Institute of Medicine's six quality domains [10]. The median follow-up time for healthcare CPIP is reported to be less than a year [11]. Only a sustained initiative can be spread for adoption by others at multiple locations so that communities can reap gains.

Ensuring sustainability is difficult due to the Coronavirus 2019 (COVID-19) pandemic. The COVID-19 pandemic has had a profound impact on the community, healthcare workers, and healthcare systems, with more than 3.1 million deaths as of May 2021 [12]. In light of this pandemic, our institution re-allocated resources preferentially for COVID-19 related-care to cope with clinical demands. Our HPB unit begun triaging and scaling down elective surgery to facilitate staff re-deployment and reduce patient exposure to novel coronavirus. Oncology-related services, however, are minimally disrupted given the time-sensitive nature of these diseases with the need for prompt management [13]. Saab et al. surveyed 82 centers in 28 countries and described reduced pain management and supportive care services by 26% and limitations in social services support by 74% [14]. To add on, mobilization mandates staff to be near patients, which violates safe distancing measures. A clinical practice guideline by Thomas et al. in 2020 for physiotherapy management during the COVID-19 pandemic recommended screening referrals for mobilization and exercise to minimize staff in contact and high filtration masks during physiotherapy sessions [15]. Locally, personal protective equipment (PPE) was mandatory for physiotherapists, and ambulation was limited to the patients' ward cubicle to minimize external contact. There are also increased stressors with fear and anxiety of becoming infected [16]. Hence, this study aims to assess the sustainability of our multidisciplinary single-institution CPIP 1-year post-implementation to improve post-operative mobilization rate in patients undergoing elective major HPB surgery during the COVID-19 pandemic.

Materials and Methods

Our institution is a university-affiliated tertiary hospital with 1,700 inpatient beds. ERAS started in

March 2016 in the colorectal surgery division. In line with the concept of ERAS, the HPB unit started inpatient prehabilitation for patients undergoing elective liver surgery in 2016 with a reduction in overall morbidity and improved social well-being [17]. The entire ERAS protocol subsequently expanded to the HPB unit for patients undergoing elective major HPB surgery in 2018. The HPB surgery dashboard for 2018 following implementation of ERAS protocol revealed a low observed/expected ratio in compliance, with a post-operative mobilization rate of 22%. Hence, relevant stakeholders agreed for a CPIP to improve post-operative mobilization, which begun in May 2019 [9].

2.1 Study protocol

The specific details of our CPIP were described in 2020 by Tang et al [9]. Successful mobilization was defined as sitting out of bed for >6 hours on POD1 and ambulation of ≥30m on POD2, with a target mobilization rate of ≥75%. Pre-operatively, the case managers counsel patients and caregivers on post-operative goals and emphasis on benefits of early mobilization. Postoperatively, the surgical teams emphasize the benefits of mobilization during POD1 evening rounds. The plan-do-study-act (PDSA) cycles were utilized to identify critical barriers to early mobilization and implemented the changes to identify outcomes. Major HPB surgery was defined as surgery involving the HPB system and lasting more than two hours. Exclusion criteria were patients who underwent cholecystectomy, common bile duct exploration, laparotomy for general surgical conditions, or major HPB surgery with intraoperative blood loss of ≥2L or more or duration of surgery >9 hours.

We summarized the entire mobilization improvement process into 4 phases:

(1) Phase 1 (Jan to Apr 2019): before implementation of CPIP
(2) Phase 2 (May to Sep 2019): implementation of CPIP, where there is direct oversight to improve post-operative mobilization using the PDSA cycles

(3) Phase 3 (Oct 2019 to Mar 2020): post-CPIP, before COVID-19, where there is indirect oversight of post-operative mobilization. This was also required routinely as part of our institution's protocol following the implementation of CPIP

(4) Phase 4 (Apr 2020 to Sep 2020): post-CPIP, during COVID-19, where there is no oversight on interventions to improve postoperative mobilization

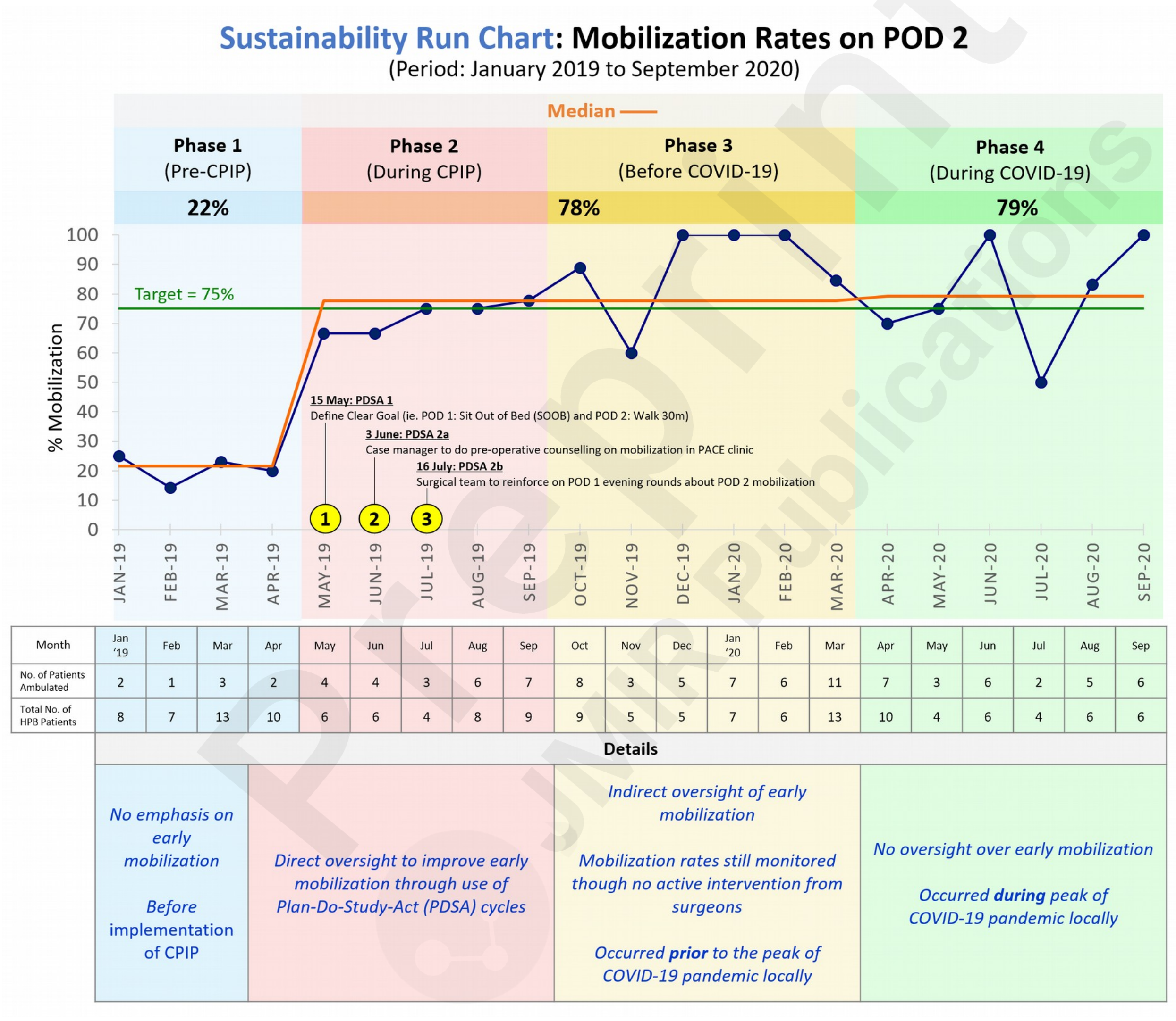

Figure 1 is a schematic representation of the 4 phases of the mobilization improvement process. As the purpose of this study is to assess the sustainability following our CPIP during the COVID-19 pandemic, we will be primarily describing about phase 4 of our study.

2.2 Impact of COVID-19 locally

The first case of COVID-19 was detected in January 2020 and, the national "Circuit breaker measures" announced on 7 April 2020 [18]. This gave us the chance to stratify the analysis into phase 3 (before COVID-19, from October 2019 to March 2020) and phase 4 (during COVID-19, from April 2020 to September 2020). During phase 4, there were three modifications to post-operative mobilization given COVID-19: (1) Physiotherapists had to wear full PPE during physiotherapy sessions, (2) mobilization was limited to within the patients' cubicles to limit the risk of infection, and (3) segregation of physiotherapy teams to reduce cross-contact amongst the healthcare personnel.

2.3 Peri-operative management and prehabilitation program (PP)

The HPB unit introduced an inpatient prehabilitation program (PP) of 2-4 weeks since 2016 [17]. The PP involves a multidisciplinary team comprising of physiotherapists, dieticians for nutrition optimization, and case managers for patient education on the surgery and post-operative expectations. All elective major HPB surgical patients were considered for PP unless excluded due to logistic reasons or resource constraints: (a) surgery date too close or (b) lack of slots for PP. Pain management is an integral part of PP and an essential component relevant to mobilization. We adopted a multimodal approach to managing post-operative pain; intra-operatively, ON-Q PainBuster® (B. Braun Melsungen AG, Hessen, Germany), an elastomeric pump device providing a continuous infusion of 400ml of ropivacaine, was inserted upon surgeon's discretion in the pre-peritoneal space. ON-Q PainBuster was not routinely inserted for laparoscopic procedures. Majority of patients were also on patient-controlled analgesia (PCA) (fentanyl) and paracetamol postoperatively. Epidural analgesia is infrequently used in our institution in view of the following reasons: (1) placement and removal of epidural analgesia is more technically challenging and slower compared to ON-Q painbuster; (2) Recommendations from the American Society of Regional Anesthesia (ASRA) that an international normalized ratio (INR) of 1.4 is the upper limit for safe removal of epidural cathether; in our group of patients undergoing major hepatic resections, deranged INR is to be expected and would require fresh frozen plasma coverage [19], and (3) local protocol mandating the need for monitoring in high dependency unit while on epidural analgesia; this precludes patients who are clinically improving and stable from transfer to general ward and occupy limited high dependency beds for patients who may require high dependency monitoring.

2.4 Data collection and study variables

Data were extracted for all patients included in this study from phase 2 to phase 4 (May 2019 to September 2020) from a prospectively maintained standing database for patients undergoing HPB surgery approved by the local institutional review board. Data was not extracted for patients for phase 1 (before implementation of the CPIP). Study variables included insertion of ON-Q PainBuster intra-operatively, pain score, length of hospitalization stay, distance ambulated on POD2, morbidity, balance measures, and reasons for failure to achieve targets. Length of hospitalization stay was defined as the duration of hospital stay calculated from admission to the point of discharge. Successful mobilization was defined as sitting out of bed >6 hours on POD1 and ambulation of ≥30m on POD2 [9]. Morbidity was defined as the incidence of pneumonia and deep vein thrombosis. Balance measures, defined as potential complications secondary to mobilization – (a) incidence of falls and (b) accidental drain dislodgement – were evaluated.

2.5 Statistical analysis

All the data were tabulated into an excel sheet and transposed into SPSS version 25.0 (SPSS Inc., Chicago, III., USA) for statistical analysis. Categorical values were described as percentages and analyzed by the chi-square test and Fisher exact test for variables with expected cell count <5. Continuous variables were described as median (interquartile range (IQR)) or mean (standard deviation (SD)) and were analyzed by Mann-Whitney U test or ANOVA, respectively. Statistical significance was defined as a p-value of <0.05.

Results

3.1 Baseline demographics and clinical profile

There was a total of 114 patients who underwent major HPB surgery from phase 2 to phase 4 of our study. 33 (29.0%), 45 (39.5%), and 36 (31.6%) patients in phase 2, phase 3 and phase 4 respectively. No baseline patient demographics was collected for phase 1 (pre-CPIP implementation); information on median mobilization rate of 22% during phase 1 was obtained from the HPB surgery dashboard in 2018 following implementation of ERAS protocol in our HPB unit. Majority of the patients were male (n=79, 69.3%) and underwent hepatic surgery (n=92, 80.7%). There were 76 (66.7%) patients who had ON-Q PainBuster insertion intra-operatively. Table 1 summarizes the demographics of the study population from phase 2 to phase 4 of the study.

Table 1: Patient demographics and clinical profile of the study population

	Overall cohort^ (n=114)	Phase 2^ (n=33)	Phase 3^ (n=45)	Phase 4^ (n=36)	p value
Age, median (IQR)					
Gender, male, n (%)	79 (69.3)	20 (60.6)	31 (68.9)	28 (77.8)	0.302
ASA score, n (%)					0.192
I	1 (0.9)	1 (3.0)	0 (0)	0 (0)	
II	38 (33.3)	11 (33.3)	19 (42.2)	8 (22.2)	
III	75 (65.8)	21 (63.6)	26 (57.8)	28 (77.8)	
Prehabilitation, n (%)	63 (55.3)	21 (63.6)	19 (42.2)	23 (63.9)	0.078
Surgical approach, n (%)					*0.014*
Laparoscopic	40 (35.1)	13 (39.4)	12 (26.7)	15 (41.7)	
Laparoscopic converted open	5 (4.4)	0 (0)	0 (0)	5 (13.9)	
Open	69 (60.5)	20 (60.6)	33 (73.3)	16 (44.4)	
Type of surgery					0.418
Hepatic	92 (80.7)	25 (75.8)	39 (86.7)	28 (77.8)	
Pancreatic	22 (19.3)	9 (24.2)	6 (13.3)	8 (22.2)	
Placement of ON-Q PainBuster, yes, n (%)	76 (66.7)	20 (60.6)	33 (73.3)	23 (63.9)	0.456
Abdominal drains, n (%)					0.488
0	31 (27.2)	12 (36.4)	13 (28.9)	6 (16.7)	
1	69 (60.5)	17 (51.5)	27 (60.0)	25 (69.4)	
2	13 (11.4)	4 (12.1)	4 (8.9)	5 (13.9)	
3	1 (0.9)	0 (0)	1 (2.2)	0 (0)	

^Overall cohort refers to the study population from phase 2 to 4. Phase 1 patients were excluded in the study demographics. Phase 2 refers to the period during implementation of the CPIP (May 2019 to Sep 2019), phase 3 refers to the sustainability phase post-CPIP before COVID-19 (Oct 2019 to Mar 2020), and phase 4 refers to the sustainability phase post-CPIP during COVID-19 (Apr 2020 to Sep 2020)

ASA: American Society of Anaesthesiology; CPIP: Clinical practice and improvement project; COVID-19: Coronavirus Disease 2019; IQR: interquartile range

Table 2: Study outcomes of the study population

	Overall cohort^ (n=114)	Phase 2^ (n=33)	Phase 3^ (n=45)	Phase 4^ (n=36)	p value
Operating time, median (IQR)	338 (240-489)	248 (178-379)	285 (228-353)	350 (259-456)	*0.012*
Blood transfusion, yes	20 (17.5)	5 (15.2)	6 (13.3)	9 (25.0)	0.356
Length of hospitalization stay (days), median (IQR)	6 (5-11.8)	6 (4-8)	6 (5-8)	6.5 (4-17)	0.785
Pain score, mean (SD)					
POD 1	2.7 (1.0)	2.7 (0.7)	2.7 (1.0)	2.7 (1.5)	0.982
POD 2	1.8 (1.5)	2.3 (1.8)	1.8 (1.2)	1.3 (1.3)	*0.013*
Ambulated ≥30m on POD2, yes	93 (81.6)	24 (72.7)	40 (88.9)	29 (80.6)	0.188
Actual distance walked (m), median (IQR)	50 (30-100)	40 (21-100)	70 (45-100)	50 (30-100)	0.160
Reasons for failing to achieve target ambulation (n=21)					0.512
Pain	6 (28.6)	2 (22.2)	2 (40.0)	2 (28.6)	
Lethargy / giddiness	5 (23.8)	3 (33.3)	1 (20.0)	1 (14.3)	
Nausea	2 (9.5)	1 (11.1)	1 (20.0)	0 (0)	
Hypotension / tachycardia	2 (9.5)	1 (11.1)	0 (0)	1 (14.3)	
Medical instructions (post-chest tube removal)	2 (9.5)	2 (22.2)	0 (0)	0 (0)	
Local protocols (ongoing blood transfusion)	2 (9.5)	0 (0)	1 (20.0)	1 (14.3)	
Admitted in ICU	2 (9.5)	0 (0)	0 (0)	2 (28.6)	
Morbidity					
Falls	0 (0)	0 (0)	0 (0)	0 (0)	N/A
Pneumonia	6 (5.3)	2 (6.1)	1 (2.2)	3 (8.3)	0.457
Deep vein thrombosis	0 (0)	0 (0)	0 (0)	0 (0)	N/A

^Overall cohort refers to the study population from phase 2 to 4. Phase 1 patients were excluded in the study demographics. Phase 2 refers to the period during implementation of the CPIP (May 2019 to Sep 2019), phase 3 refers to the sustainability phase post-CPIP before COVID-19 (Oct 2019 to Mar 2020), and phase 4 refers to the sustainability phase post-CPIP during COVID-19 (Apr 2020 to Sep 2020)

CPIP: Clinical practice and improvement project; COVID-19: Coronavirus Disease 2019; ICU:

intensive care unit; IQR: interquartile range; POD: post-operative day; SD: standard deviation

3.2 Postoperative outcomes

Table 2 summarizes the outcomes of the study population in each phase of the study.

The median mobilization rate was 22% for phase 1, 78% for phase 2 and 3 combined, and 79% for phase 4 (Figure 1). We combined the median mobilization rate for phase 2 and 3 as the mobilization rate at the start of phase 2 will be lower as it takes time for the effects of the CPIP to be seen; in April 2019 (start of phase 2), the mobilization was n=2/10 (20%). The mean pain score was 2.7±1.0 on POD1 and 1.8±1.5 on POD2. Pairwise comparison of pain score on POD2 showed a significant difference in pain score between phase 2 and phase 4 (pain score 2.3±1.8 during phase 2 to 1.3±1.3 during phase 4, p=0.010). The median length of hospitalization stay was six days (interquartile range (IQR) 5-11.8). There were no falls or accidental dislodgement of drains. Six patients (5.3%) had pneumonia.

3.3 Reasons for failure of early postoperative mobilization

Table 2 summarizes the reasons for the failure of early postoperative mobilization. Twenty-one patients (18.4%) failed to ambulate ≥30m on POD2. Among these 21 patients,

15 patients (71.4%) underwent open surgery, and 17 (81.0%) had ON-Q PainBuster inserted intra-operatively. Thirteen (61.9%) had either inpatient or outpatient prehabilitation before the surgery. The commonest reason for failure to achieve ambulation target was pain (n=6/21, 28.6%), followed by lethargy or giddiness (n=5/25, 23.8%). Two patients (9.5%) were required to have complete rest in bed due to chest tube removal, and two patients (9.5%) had ongoing blood transfusions upon review by the physiotherapist and hence did not ambulate. Another two patients (9.5%) were admitted in the intensive care unit and were unstable to carry out physiotherapy.

Discussion

Our study demonstrated the long-term sustainability of CPIP to promote early mobilization following elective major HPB surgery following the implementation of CPIP. The mobilization rate during the COVID-19 pandemic was 79%.

CPIPs target a specific, measurable goal, identify critical barriers, and develop a model for improvement. We previously described the success of our CPIP in the improvement of post-operative mobilization [9]. Quality dashboard inclusive of a Pareto chart was provided to clinician stakeholders in 2018. Engagement of physiotherapy and nursing colleagues was done to understand the micro and macro workflow relevant to mobilization. Root cause analysis for barriers to mobilization was done by a core team trained in CPIP. The surgeon-led multidisciplinary quality improvement initiative with multiple PDSA cycles adhering to the CPIP philosophy led to improve process outcomes along with cost savings [9]. However, any CPIP can only be successful if sustainable. Sustainability is defined as the capacity of a health service to deliver healthcare over time with consideration for future generations [10]. It is an essential facet of healthcare innovation. It hence has been incorporated to be part of the Institute of Medicine's six domains of quality by the Royal College of Physicians [10]. Alexander et al. concluded that the median follow-up time for healthcare quality improvement projects was less than one year, which is insufficient to observe the long-term effects of any implementation on clinical outcomes [11]. We continued the follow-up of our CPIP one year following implementation and divided our analysis into phase 3 (before COVID-19) and phase 4 (during COVID-19) to observe the difference during these two periods. During both periods, we achieved ≥75% target mobilization rate.

Early mobilization is a facet of the ERAS program; a meta-analysis by Ji et al. on the use of ERAS in pancreatic surgery demonstrated lower incidence of delayed gastric emptying (odds ratio (OR) = 0.58, 95% confidence interval (CI): 0.48-0.72, $p < 0.001$), lower postoperative complication rates

(OR = 0.57, 95% CI: 0.45-0.72, p < 0.001) and shorter length of hospital stay (weighted mean difference = -4.45, 95% CI: -5.99 to -2.91, p < 0.001) [20]. However, compliance was not reported in the meta-analysis. Failure of ERAS programs may be due to lack of compliance rather than the concept of ERAS itself [21, 22]. Elias et al. published the Reporting on ERAS Compliance, Outcomes, and Elements Research (RECOvER) checklist to improve compliance, including the need to describe a strategy for early mobilization [23]. They defined early mobilization as fulfilling all of the following: (a) at the post-operative anesthesia unit, to ambulate to the chair from bed (b) on POD0, to ambulate three times and sit out of bed for all meals (no distance or time duration specified), and (c) on POD1, to sit out of bed ≥8 hours. This provides a standardized checklist with a clear definition, but the definition of early mobilization is heterogeneous in other studies. Wind et al. defined early mobilization as sitting out of bed >2 hours on POD0, >6 hours on POD1, and >8 hours on POD2 [24]. Gatt et al. defined it as sitting out of bed on POD0 and ambulating the length of the ward on POD1 [25]. We defined early mobilization as sitting out of bed for >6 hours on POD1 and ambulating ≥30m on POD2. Review of existing literature on ERAS programs showed heterogenous definitions of early post-operative mobilization, ranging from “time spent out of bed”, “time ambulated” to “distance or steps walked on POD2 or beyond”. Hence, the value of “30m” was chosen based on past experience and practical needs of patients in our local context: 30m is the approximate distance to ambulate to-and-fro the toilet from the living room; ability to do so would suggest that the patient is able to be independent in activity of daily living and hence meaningful. Furthermore, the to-and-fro distance from patients’ cubicle the ward entrance is approximately 30m, making it logistically easier for physiotherapists and nurses to record the distance ambulated [9, 26]. It is important to note that the terminologies "mobilization" and "ambulation" are not synonymous. Patients were required to fulfil both criteria of (a) sitting out of bed >6 hours on POD1 and (b) ambulating ≥30m on POD2 to be deemed successful in early postoperative mobilization. While we agree that patients are instructed to sit out of bed usually on either POD0 or POD1, it is the act of ambulating which is more relevant to patients' physiologic function and activities of daily living, hence we defined mobilization by the act of ambulating, rather solely sitting out of bed. Further prospective studies examining post-operative mobilization should use standardized and concise definitions of mobilization to have a clear endpoint and for results to be reproducible for large volume meta-analysis.

The COVID-19 pandemic has resulted in disruption in the delivery of healthcare services, especially in the surgical subspecialties. Recommendations were made for postponing elective surgical cases where possible [27]. Locally, there was a shift towards non-operative management for stable, benign conditions such as uncomplicated acute cholecystitis [28]. This was to redirect resources towards the management of COVID-19 patients. Our study, however, showed that we were able to maintain mobilization targets even during the pandemic. Following the CPIP, we continued implementing pre-operative counseling and reinforcing the importance of early mobilization on POD1 during routine ward rounds. Reasons which were previously identified for failure to ambulate continue to be addressed. The pain was the most common reason for failure to achieve the ambulation target (n=6, 28.6%). In our institution, the ON-Q pain buster was placed intra-operatively in the pre-peritoneal space for major open surgeries to deliver bupivacaine or ropivacaine through continuous infusion. This is reported to be effective in reducing post-operative pain and facilitating early ambulation compared to placebo [29]. PCA was also used as part of our multimodal approach for analgesia. Nevertheless, the pain remained the most typical reason for failure to achieve ambulation targets; this is likely because of the need to balance the side effects of excessive analgesic use, such as non-steroidal inflammatory drugs, with the risk of renal impairment adverse cardiac events, and gastrointestinal bleeding [30]. Use of opioids is also associated with delayed recovery of bowel function, post-operative nausea & vomiting, which may limit ambulation. Therefore, titration of analgesia needs to obtain the best control of pain and limit side effects to improve mobilization.

Interestingly, there was a significant reduction in pain score on POD2 from 2.3±1.8 during phase 2 to 1.3±1.3 during phase 4 ($p = 0.010$) with comparable incidence of laparoscopic surgery, which may have contributed to the sustainability of early post-operative mobilization. While improved pain incentivizes patients to mobilize early, Ni et al demonstrated improved pain score on POD5 in patients who had early ambulation compared to the control group. (3.1 ± 1.1 vs 3.8 ± 2.4, $p<0.05$) [31]. To add on to the discussion, while epidural analgesia is an alternative for pain control, our institution prefers ON-Q PainBuster to epidural infusion as ON-Q PainBuster is relatively easier to insert and remove and does not require INR ≤1.4 for safe removal unlike epidural catheter. A systematic review by Mungroop et al in 2019 showed that pre-peritoneal wound catheters provide statistically, but not clinically significantly different pain control in rest on POD1 as epidural analgesia (mean difference 0.44, 95% CI: 0.06–0.79; $P = 0.02$), with lower incidence of hypotension (RR 0.29, 95% CI 0.13-0.68, $p=0.004$) and patient satisfaction [32]. While pain is the commonest reason for failure of ambulation, we have attempted to mitigate it via adoption of a multipronged approach of pain control.

To add on, a plausibility for the sustainability in having high postoperative mobilization rates despite no active oversight could be due to the manpower empowerment following the CPIP. Our CPIP has made and emphasised the importance of early postoperative mobilization, with the aim of ambulating ≥30m on POD2. Chong et al. who studied nurses' practices regarding early mobilization among mechanically ventilated patients found that majority (99.2%) of nurses had in bed mobilization, but only a minority (14.4%) had out-of-bed mobilization for patients. They attributed the lack of doctors' order for physiotherapy or the lack of nursing manpower as possible reasons for the lack of out-of-bed mobilization [33, 34]. In line with this, we feel that the strong reinforcement of early postoperative mobilization provides nursing staff with confidence to allow patients to sit out of bed on POD1 and promote early mobilization where feasible and when manpower permits. Other indirect measures played by nursing colleagues include charting of pain score and provision of adequate analgesia to manage pain, the commonest factor for the lack of early postoperative mobilization [35].

Early post-operative mobilization has been shown to improve clinical outcomes, with reduced length of hospitalization stay, pneumonia, and deep vein thrombosis incidence [2, 3].

Incidence of post-operative pneumonia following liver surgery has been reported to be 8.2-13% [36-39]. Mobilization has been postulated to elicit cardiopulmonary responses which enhance oxygen transport, increase tidal volume which may reverse atelectasis and improve gas exchange or reduce risk of aspiration in view of upright position [40]. Our study showed a relatively lower 5.3% overall incidence of post-operative pneumonia from phase 2 to 4, which may be multifactorial: laparoscopic surgery, prehabilitation, early mobilization, and multimodal analgesia with adequate pain control [41].

To improve clinical outcomes, it is integral to improve the process outcomes of all integral components of ERAS protocols. Increasing compliance to existing protocols is an important step forward [2]. Our study demonstrated improvement in early post-operative mobilization rates within our institution; however, our sample size is relatively small, and the generalizability of results is limited due to the heterogeneous patient population. The concept and technology of Health Information Exchange (HIE) may be adopted to improve the situation. HIE as defined as the use of technology to share clinical and administrative data electronically across healthcare institutions and repositories; it may be considered to facilitate large-scale prospective studies to provide improved quality of healthcare and cost savings [42]. A novel method of tracking compliance and development of predictive risk scores for various clinical outcomes was recently developed by Cochran et al [43]. Research Electronic Data Capture (REDCap), which is an electronic data management system primarily used for data collection, was used to track compliance to ERAS protocols in our institute.

With use of health informatics, this simplifies the process of tracking of clinical outcomes and dissemination of clinical performance indicators. This allows quick update of the ERAS dashboard, planning of targeted interventions to improve outcomes and easy sharing of data across institutions through the technology of HIE. Furthermore, embracing the technology facilities reduces missing data and recording bias to some extent. Institutions with ongoing ERAS protocols should also re-examine their respective surgery dashboards to ensure continued quality improvements. Inter-institutional collaboration should also be encouraged to facilitate high-powered evidence.

The strength of our study is that it is, to our knowledge, the only study to report the long-term sustainability of mobilization during the COVID-19 pandemic. We also included reasons for failure for the achievement of ambulation targets to enhance future CPIPs better. However, this study has a few limitations. Heterogeneity of the study population that includes patients who underwent liver surgery and pancreatic surgery limits the generalizability of results. We also did not access the benefits of early post-operative mobilization on clinical outcomes, such as length of hospitalization and post-operative morbidity [2]. The primary aim of this study was descriptive, to describe our experience in sustaining CPIP at one year following implementation during the COVID-19 pandemic. This study also included patients who underwent prehabilitation which may indirectly have led to the achievement of the mobilization target.

Conclusion

This follow-up study shows the sustainability of our CPIP in improving early post-operative mobilization rates in patients who underwent elective major HPB surgery one year following implementation, even during the COVID-19 pandemic. Further large-scale multi-institutional prospective collaboratives are needed to define mobilization and assess compliance to early mobilization initiatives. Sustaining a clinical improvement initiative is an essential determinant of value-driven patient-centric healthcare.

Acknowledgments

We would like to thank all doctors, nurses and allied health professionals who were involved in this quality improvement project to improve early postoperative mobilization rates in our institution.

Conflicts of Interest

The authors declare no conflict of interest.

References

1. Taurchini M, Del Naja C, Tancredi A. Enhanced Recovery After Surgery: a patient centered process. J Vis Surg. 2018;4:40-.

2. Coolsen MME, Wong-Lun-Hing EM, van Dam RM, van der Wilt AA, Slim K, Lassen K, et al. A systematic review of outcomes in patients undergoing liver surgery in an enhanced recovery after surgery pathways. HPB. 2013;15(4):245-51.

3. Greco M, Capretti G, Beretta L, Gemma M, Pecorelli N, Braga M. Enhanced Recovery Program in Colorectal Surgery: A Meta-analysis of Randomized Controlled Trials. World Journal of Surgery. 2014;38(6):1531-41.

4. Waldhausen JH, Schirmer BD. The effect of ambulation on recovery from postoperative ileus. Annals of surgery. 1990;212(6):671-7.

5. Pashikanti L, Von Ah D. Impact of Early Mobilization Protocol on the Medical-Surgical Inpatient Population: An Integrated Review of Literature. Clinical Nurse Specialist. 2012;26(2):87-94.

6. Grass F, Pache B, Martin D, Addor V, Hahnloser D, Demartines N, et al. Feasibility of early postoperative mobilisation after colorectal surgery: A retrospective cohort study. Int J Surg. 2018;56:161-6.

7. Hendry PO, van Dam RM, Bukkems SF, McKeown DW, Parks RW, Preston T, et al. Randomized clinical trial of laxatives and oral nutritional supplements within an enhanced recovery after surgery protocol following liver resection. Br J Surg. 2010;97(8):1198-206.

8. Koea JB, Young Y, Gunn K. Fast track liver resection: the effect of a comprehensive care package and analgesia with single dose intrathecal morphine with gabapentin or continuous epidural analgesia. HPB surgery : a world journal of hepatic, pancreatic and biliary surgery. 2009;2009:271986-.

9. Tang JH, Wang B, Chow JLJ, Joseph PM, Chan JY, Abdul Rahman N, et al. Improving

postoperative mobilisation rates in patients undergoing elective major hepatopancreatobiliary surgery. Postgraduate Medical Journal. 2021;97(1146):239.

10. Mortimer F, Isherwood J, Wilkinson A, Vaux E. Sustainability in quality improvement: redefining value. Future Healthc J. 2018;5(2):88-93.

11. Alexander JA, Hearld LR. What can we learn from quality improvement research? A critical review of research methods. Medical Care Research and Review. 2009;66(3):235-71.

12. World Health Organization. WHO Coronavirus (COVID-19) Dashboard 2021 [Accessed on 3 May 2021]. Available from: https://covid19.who.int/.

13. Barry A, Apisarnthanarax S, O'Kane GM, Sapisochin G, Beecroft R, Salem R, et al. Management of primary hepatic malignancies during the COVID-19 pandemic: recommendations for risk mitigation from a multidisciplinary perspective. The Lancet Gastroenterology & Hepatology. 2020;5(8):765-75.

14. Saab R, Obeid A, Gachi F, Boudiaf H, Sargsyan L, Al-Saad K, et al. Impact of the coronavirus disease 2019 (COVID-19) pandemic on pediatric oncology care in the Middle East, North Africa, and West Asia region: A report from the Pediatric Oncology East and Mediterranean (POEM) group. Cancer. 2020;126(18):4235-45.

15. Thomas P, Baldwin C, Bissett B, Boden I, Gosselink R, Granger CL, et al. Physiotherapy management for COVID-19 in the acute hospital setting: clinical practice recommendations. Journal of Physiotherapy. 2020;66(2):73-82.

16. Tan BY, Chew NW, Lee GK, Jing M, Goh Y, Yeo LL, et al. Psychological impact of the COVID-19 pandemic on health care workers in Singapore. Annals of Internal Medicine. 2020;173(4):317-20.

17. Wang B, Shelat VG, Chow JJL, Huey TCW, Low JK, Woon WWL, et al. Prehabilitation Program Improves Outcomes of Patients Undergoing Elective Liver Resection. J Surg Res. 2020;251:119-25.

18. Ministry of Health Singapore. Circuit Breaker to minimise further spread of COVID-19 2020 [Accessed on 30 April 2021]. Available from: https://www.moh.gov.sg/news-highlights/details/circuit-breaker-to-minimise-further-spread-of-covid-19.

19. Horlocker TT, Wedel DJ, Rowlingson JC, Enneking FK, Kopp SL, Benzon HT, et al. Regional Anesthesia in the Patient Receiving Antithrombotic or Thrombolytic Therapy: American Society of Regional Anesthesia and Pain Medicine Evidence-Based Guidelines (Third Edition). Regional Anesthesia & Pain Medicine. 2010;35(1):64-101-64-.

20. Ji H-B, Zhu W-T, Wei Q, Wang X-X, Wang H-B, Chen Q-P. Impact of enhanced recovery after surgery programs on pancreatic surgery: A meta-analysis. World journal of gastroenterology. 2018;24(15):1666-78.

21. Dickson EL, Stockwell E, Geller MA, Vogel RI, Mullany SA, Ghebre R, et al. Enhanced Recovery Program and Length of Stay After Laparotomy on a Gynecologic Oncology Service: A Randomized Controlled Trial. Obstet Gynecol. 2017;129(2):355-62.

22. Phan TD, An V, D'Souza B, Rattray MJ, Johnston MJ, Cowie BS. A Randomised Controlled Trial of Fluid Restriction Compared to Oesophageal Doppler-Guided Goal-Directed Fluid Therapy in Elective Major Colorectal Surgery within an Enhanced Recovery after Surgery Program. Anaesthesia and Intensive Care. 2014;42(6):752-60.

23. Elias KM, Stone AB, McGinigle K, Tankou JI, Scott MJ, Fawcett WJ, et al. The Reporting on ERAS Compliance, Outcomes, and Elements Research (RECOvER) Checklist: A Joint Statement by the ERAS(®) and ERAS(®) USA Societies. World J Surg. 2019;43(1):1-8.

24. Wind J, Hofland J, Preckel B, Hollmann MW, Bossuyt PMM, Gouma DJ, et al. Perioperative strategy in colonic surgery; LAparoscopy and/or FAst track multimodal management versus standard care (LAFA trial). BMC Surgery. 2006;6(1):16.

25. Gatt M, Anderson AD, Reddy BS, Hayward-Sampson P, Tring IC, MacFie J. Randomized

clinical trial of multimodal optimization of surgical care in patients undergoing major colonic resection. Br J Surg. 2005;92(11):1354-62.

26. Neville A, Lee L, Antonescu I, Mayo NE, Vassiliou MC, Fried GM, et al. Systematic review of outcomes used to evaluate enhanced recovery after surgery. British Journal of Surgery. 2014;101(3):159-70.

27. Moletta L, Pierobon ES, Capovilla G, Costantini M, Salvador R, Merigliano S, et al. International guidelines and recommendations for surgery during Covid-19 pandemic: A Systematic Review. Int J Surg. 2020;79:180-8.

28. Chia CLK, Oh HB, Kabir T, Tan YP, Thiruchelvam N, Pang NQ, et al. Impact of COVID-19 Pandemic on Management of Acute Cholecystitis in Singapore. Ann Acad Med Singap. 2020;49(10):817-24.

29. Baig MK, Zmora O, Derdemezi J, Weiss EG, Nogueras JJ, Wexner SD. Use of the ON-Q pain management system is associated with decreased postoperative analgesic requirement: double blind randomized placebo pilot study. Journal of the American College of Surgeons. 2006;202(2):297-305.

30. Rainsford KD. Profile and mechanisms of gastrointestinal and other side effects of nonsteroidal anti-inflammatory drugs (NSAIDs). The American Journal of Medicine. 1999;107(6, Supplement 1):27-35.

31. Ni C-y, Wang Z-h, Huang Z-p, Zhou H, Fu L-j, Cai H, et al. Early enforced mobilization after liver resection: A prospective randomized controlled trial. International Journal of Surgery. 2018;54:254-8.

32. Mungroop TH, Bond MJ, Lirk P, Busch OR, Hollmann MW, Veelo DP, et al. Preperitoneal or Subcutaneous Wound Catheters as Alternative for Epidural Analgesia in Abdominal Surgery: A Systematic Review and Meta-analysis. Annals of Surgery. 2019;269(2):252-60.

33. Chong M. Patient early mobilization: a Malaysia’s study of nursing practices. Journal of Intensive and Critical Care. 2017;3(3):29.

34. Pandullo SM, Spilman SK, Smith JA, Kingery LK, Pille SM, Rondinelli RD, et al. Time for critically ill patients to regain mobility after early mobilization in the intensive care unit and transition to a general inpatient floor. Journal of Critical Care. 2015;30(6):1238-42.

35. Balas MC, Vasilevskis EE, Burke WJ, Boehm L, Pun BT, Olsen KM, et al. Critical care nurses' role in implementing the "ABCDE bundle" into practice. Crit Care Nurse. 2012;32(2):35-48.

36. Pessaux P, van den Broek MA, Wu T, Olde Damink SW, Piardi T, Dejong CH, et al. Identification and validation of risk factors for postoperative infectious complications following hepatectomy. J Gastrointest Surg. 2013;17(11):1907-16.

37. Nobili C, Marzano E, Oussoultzoglou E, Rosso E, Addeo P, Bachellier P, et al. Multivariate analysis of risk factors for pulmonary complications after hepatic resection. Ann Surg. 2012;255(3):540-50.

38. Choudhuri AH, Chandra S, Aggarwal G, Uppal R. Predictors of postoperative pulmonary complications after liver resection: Results from a tertiary care intensive care unit. Indian J Crit Care Med. 2014;18(6):358-62.

39. Sakamoto K, Tamesa T, Tokuhisa Y, Matsukuma S, Tokumitsu Y, Maeda Y, et al. Perioperative Microbiologic Monitoring of Sputum on Postoperative Day One as a Predictor of Pneumonia After Hepatectomy. J Gastrointest Surg. 2015;19(9):1662-7.

40. Zafiropoulos B, Alison JA, McCarren B. Physiological responses to the early mobilisation of the intubated, ventilated abdominal surgery patient. Aust J Physiother. 2004;50(2):95-100.

41. Baba H, Tokai R, Hirano K, Watanabe T, Shibuya K, Hashimoto I, et al. Risk factors for postoperative pneumonia after general and digestive surgery: a retrospective single-center study. Surgery Today. 2020;50(5):460-8.

42. Sadoughi F, Nasiri S, Ahmadi H. The impact of health information exchange on healthcare quality and cost-effectiveness: A systematic literature review. Comput Methods Programs Biomed. 2018;161:209-32.

43. Cochran AR, Raub KM, Murphy KJ, Iannitti DA, Vrochides D. Novel use of REDCap to develop an advanced platform to display predictive analytics and track compliance with Enhanced Recovery After Surgery for pancreaticoduodenectomy. International Journal of Medical Informatics. 2018;119:54-60.

Abbreviations

CI: confidence interval

COVID-19: Coronavirus Disease 2019

CPIP: Clinical practice improvement programme

ERAS: Enhanced Recovery after surgery

HIE: Health Information Exchange

HPB: hepatopancreatobiliary

ICU: intensive care unit

IQR: interquartile range

OR: odds ratio

PDSA: Plan-Do-Study-Act

POD: post-operative day

SD: standard deviation

Figure Legends

Figure 1: Schematic diagram on the four phases of the improvement of early postoperative mobilization and their respective time frame and details with respective mobilization rates on post-operative day 2 per month and the median mobilization rates at different phases

Supplementary Files

Figures

Schematic diagram on the four phases of the improvement of early postoperative mobilization and their respective time frame and details with respective mobilization rates on post-operative day 2 per month and the median mobilization rates at different phases.