IMPROVING APPROPRIATE OUTPATIENT REHABILITATION MANAGEMENT OF MODERATELY SEVERE COVID-19 SURVIVORS IN HOSPITAL SUNGAI BULOH

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Abstract

Rehabilitation management is essential for improving moderately severe COVID-19 survivors by reducing the risk of complications, enhancing quality of life, and optimising functional outcomes. A verification study conducted from July to December 2020 (n=165) involving moderately severe COVID-19 survivors referred for rehabilitation intervention showed that only 16.3% received appropriate outpatient rehabilitation programs. This study aimed to improve the percentage of appropriate outpatient rehabilitation management for patients with moderately severe COVID-19 to ≥80%, in alignment with established standards. This quality improvement study employed universal sampling methods and assessed the appropriateness of outpatient rehabilitation management for moderately severe COVID-19 survivors. The primary contributing factor to sub-optimal rehabilitation practices was a lack of awareness and knowledge among rehabilitation personnel. Additional contributing factors included the unavailability of guidelines and recommendations for outpatient rehabilitation management; lack of awareness and knowledge among COVID-19 survivors; sub-optimal education; and accessibility to resources towards rehabilitation self-management. To address these issues, a phased implementation of remedial measures was undertaken including, in-service and out-service training sessions; the establishment of a clinical framework for outpatient rehabilitation management; the provision of a dedicated, coordinated and structured multidisciplinary COVID-19 Rehabilitation Outpatient Specialised Services (CROSS); integration of the framework into the electronic Hospital Information System (e-HIS), and the development of collaborative educational resources on rehabilitation self-management. As a result, the percentage of patients who received appropriate outpatient rehabilitation management increased from 16.3% to 44.2% in Cycle 1, then improved to 87.8% in Cycle 2, and subsequently reached 89.4% in Cycle 3. Moving forward, we aim to explore the potential application of this clinical framework and multidisciplinary service for improving other rehabilitation services, such as an early rehabilitation program for post-intensive care syndrome.

KEYWORDS: COVID-19, Rehabilitation, Outpatient, Multidisciplinary, Quality improvement study

Problem

COVID-19 was officially declared a global pandemic in March 2020 due to its highly contagious nature with catastrophic health outcomes (1,2). The world has since recorded over 704 million infections, with more than 7 million deaths (3). Meanwhile, in Malaysia, over 5 million infections and more than 37,000 fatalities have been reported (4). Although the majority of patients recover from acute COVID-19 infection, it is now evident that survivors are at risk of experiencing long-term persistent symptoms (1,5-7), universally known as Long COVID and later clinically defined by the World Health Organization (WHO) as post-COVID-19 condition (PCC) in October 2021 (7).

PCC is a condition that occurs in individuals with a history of probable or confirmed SARS-CoV-2 infection, typically three months after the diagnosis of COVID-19, with symptoms lasting for at least two months that cannot be explained by an alternative diagnosis. Common symptoms include fatigue, shortness of breath, and cognitive dysfunction, which generally impact daily functioning. Symptoms may either emerge following initial recovery from an acute COVID-19 episode or persist from the initial illness. Additionally, symptoms may fluctuate or relapse over time (7). PCC can result in disabling symptoms that affect quality of life, return to work or school, financial stability, and the ability to care for oneself and families (1,5,6,8). Currently, there are no validated effective treatments for PCC (1,5,6,8). Rehabilitation management plays a crucial role in reducing the risk of complications, improving quality of life, and optimising functional outcomes (2,6,8,9).

The Rehabilitation Medicine Department is one of the healthcare service providers under the Medical Directorate of Hospital Sungai Buloh (HSgB). It offers a wide range of rehabilitation medicine services, including but not limited to spinal cord injuries, traumatic brain injuries, stroke, paediatric disabilities, amputees, prosthetics, and orthotics. The rehabilitation services span across all age groups, from paediatric to geriatric. Since the pandemic, the rehabilitation medicine department has also provided rehabilitation services for post-COVID-19 survivors. These services were provided through inpatient and outpatient rehabilitation programs, involving interventions by a multidisciplinary team consisting of three rehabilitation specialists, ten medical officers, fifteen physiotherapists, eleven occupational therapists, ten rehabilitation nurses, and other supporting professionals.

HSgB, a 1,037-bedded tertiary hospital, serves the districts of Gombak, Petaling, and Kuala Selangor, catering to a combined population of more than 2.18 million (10). Throughout the COVID-19 pandemic, HSgB, being the national referral centre for infectious diseases, was subsequently converted into the main referral and admission centre for moderately severe COVID-19 infections in Malaysia (11). From the time it was designated as the primary COVID-19 hospital on 10th March 2020, until its status changed to a hybrid hospital on 22nd April 2022 (11-13), HSgB recorded more than 92,874 acute COVID-19 admissions (11,13). Of these, 6,758 patients were referred for outpatient rehabilitation management (14).

A verification study conducted from July to December 2020 (n=165) involving moderately severe COVID-19 survivors referred for rehabilitation intervention showed that only 16.3% received an appropriate outpatient rehabilitation program upon discharge. This sub-optimal rehabilitation support affected their recovery process, leading to 67.5% of survivors experiencing persistent symptoms beyond 12 weeks, consistent with a diagnosis of PCC. This study aims to increase the percentage of moderately severe COVID-19 survivors receiving appropriate outpatient rehabilitation from 16.3% to ≥80% within two years.

Background

At least 65 million individuals worldwide are estimated to have PCC (1). Evidence suggests that the severity of COVID-19 infection is correlated with PCC consequences (1,2,5). The physical, cognitive, and mental health burden experienced by people recovering from COVID-19 who were hospitalised may be

considerable (1,2,5,7). A systematic review reported a median proportion of 72.5% of individuals (n=9,751) experiencing at least one persistent symptom (15). Studies on PCC involving the Southeast Asian population are limited. In the local context, the prevalence of PCC was reported to be 31.1% in a community-based survey of 732 Malaysians, with common symptoms including fatigue, brain fog, depression, anxiety, insomnia, arthralgia, and myalgia (16).

In another community-based study involving a total of 44,386 Malaysians who responded to the MySejahtera app platform, the PCC prevalence was reported at 3.4% (n=1,510) (17). Based on this study, the three most common symptoms experienced were cough, fatigue, and forgetfulness. Being females, having existing comorbidities, the presence of symptoms, and requiring hospital admission during the acute illness were associated with a higher likelihood of developing PCC. Another study in Thailand reported PCC in nearly half of the participants, with adolescents experiencing pulmonary symptoms, hair loss, muscle pain, and fatigue, while children exhibited rhinorrhoea, cough, and breathing difficulties (18).

The WHO regarded rehabilitation as an essential support in improving health outcomes, especially of patients with moderately severe COVID-19, and benefits health via optimising health and functional outcomes (19,20). Rehabilitation is defined as a set of interventions designed to optimise functioning and reduce disability in individuals with health conditions in interaction with their environment (20). Rehabilitation needs may exist in all care phases, including as part of acute care delivered in the Intensive Care Unit (ICU); during the subacute phase delivered in the ward or step-down facility, and during the long-term phase beyond hospital discharge within the community (19-21).

The multisystem characteristics of PCC and its high prevalence highlighted the need for continuity of care and multidisciplinary rehabilitation (8,9,19 – 22). However, comprehensive rehabilitation care faces multiple challenges, such as long waiting lists, difficulties in training clinicians, delivery of safe rehabilitation, barriers to access for patients with fatigue, absence of integrated rehabilitation, and funding sustainability (8,19 - 22).

Key components for outpatient PCC management may include but are not limited to multidisciplinary rehabilitation team engagement, coordination of care, personalised rehabilitation program, integration of patient education and self-management, and use of standardised outcome measures for monitoring of rehabilitation progress (2,6,8,9,19-23). Provision of hybrid rehabilitation delivery mode, including face-to-face and virtual mode, may be considered; however, the evidence concerning its safety, effectiveness, or non-inferiority to traditional delivery in an outpatient setting remains lacking (8,9, 19-23).

A meta-analysis involving 1,244 patients with PCC reported rehabilitation interventions were associated with improvements in functional exercise capacity, dyspnoea, and quality of life compared with the current standard of care (24). A randomised controlled trial recruited 39 PCC patients (the intervention group underwent an 8-week supervised aerobic and resistance exercise program at low to moderate intensity, whereas the control group undertook general physical activity in line with WHO guidelines, without supervised sessions), and reported significant between-group differences in changes of exercise capacity, strength, quality of life, dyspnoea, fatigue, and depression in favour of the intervention group (25).

Despite studies that have explored the prevalence, characteristics, risk factors, and effectiveness of multidisciplinary rehabilitation for PCC, there remains a scarcity of evidence specifically examining the appropriateness of outpatient rehabilitation management for PCC patients attending outpatient rehabilitation service facilities.

Measurement

The key indicator for improvement was measured using the percentage of moderately severe COVID-19 survivors provided with appropriate outpatient rehabilitation management. The indicator

was calculated from the total number of moderately severe COVID-19 survivors provided with appropriate rehabilitation management (numerator), divided by the total number of moderately severe COVID-19 survivors who attended for outpatient rehabilitation management (denominator). We chose the standard of ≥80% based on an adaptation from international literature (2,8,24-26).

Moderately severe COVID-19 survivors were those who endured acute category 4 & 5 infections based on the Ministry of Health (MOH) guideline (22). Every eligible moderately severe COVID-19 survivor who was considered to have received appropriate outpatient rehabilitation management will be required to fulfil all nine criteria as in Table 1.

This quality improvement study utilised a universal sampling approach. Malaysian citizens aged >12 years old with laboratory-confirmed COVID-19 who attended outpatient rehabilitation management during the study period were included. Prisoners, those with a pre-existing severe disability such as prolonged bedridden, severe stroke, or tetraplegia, and those clinically unstable to undergo rehabilitation physical evaluation and intervention were excluded.

Data from a verification study from July to December 2020 (n=165) involving moderately severe COVID-19 survivors referred for rehabilitation intervention showed that only 16.3% were provided with appropriate outpatient rehabilitation programs upon discharge. Following this verification study, remedial measures were implemented in phases from January 2021 through June 2024, with re-evaluations conducted on a 6-month interval to assess the effectiveness of these interventions.

Table 1: The nine criteria required for appropriate outpatient rehabilitation management of moderately severe COVID-19 survivors.

Criteria	Descriptions	Outcome measures
1	Comprehensive multisystem screening for PCC symptoms	Post-Covid-19 screening sheet (22)
2	Physical function assessment using standardised outcome measures	Hand dynamometer, 6-Minute Walk Test (6MWT) (21, 22)
3	Cognitive function assessment using standardised outcome measures	Mental State Examination (MSE) (21, 22)
4	Psychological function assessment using standardised outcome measures	Depression Anxiety Stress Scales (DASS) (21, 22)
5	Evaluation of PCC impact using standardised functional outcome measures	Post-Covid-19 Functional Status Scale (PCFS) (21, 22, 28)
6	Assessment of oxygen saturation at rest and during exertion	6-Minute Walk Test (6MWT) (21, 22)
7	Prescription of symptomatic treatment, order investigation, and make a referral as indicated	Not applicable
8	Provision of patient education and rehabilitation self-management resources	Not applicable
9	Prescription of a personalised exercise/therapy regime by the multidisciplinary rehabilitation team	Not applicable

Initial Assessment of the Problem

Based on discussions among the project group members and rehabilitation personnel, supported by literature reviews, the probable factors contributing to the problem were mapped out as depicted in Figure 1.



Figure 1 Problem analysis chart for the low percentage of appropriate outpatient rehabilitation management of moderately severe COVID-19 survivors.

A semi-structured survey was conducted to explore the knowledge and awareness of multidisciplinary rehabilitation personnel regarding outpatient management for moderately severe COVID-19 survivors. The survey questions were adapted from literature (2,9), and content validation was performed by a rehabilitation specialist. A total of 21 personnel were involved, consisting of two rehabilitation specialists, eight medical officers, four physiotherapists, three occupational therapists, and four rehabilitation nurses. The result of the survey showed that only nine (42.8%) respondents achieved passing marks of ≥80%. Notably, the multidisciplinary rehabilitation personnel opined on the need for regular training for improvement of their knowledge and skills in post-COVID-19 management.

Another semi-structured survey was conducted during outpatient rehabilitation sessions to evaluate the contributing factors from the patients' perspective. The survey questions were adapted from literature (2,9), and content validation was done by a rehabilitation specialist. A pre-test was done during the clinic consultation for the first three participants. A total of 28 moderately severe COVID-19 survivors attending the outpatient rehabilitation clinic were included in the survey. Demographically, the participants comprised 20 (71.4%) males; the mean age of 51.8 years; Malay, Chinese, and Indian ethnic distributions were 15 (53.5%), 4 (14.2%), and 9 (32.3%), respectively. The results found that only 13 (46.4%) of patients achieved the passing marks of ≥80%. All of the patients (100%) were not aware of any rehabilitation self-management techniques to enhance the improvement and recovery of the PCC symptoms they had, nor were they aware of the accessibility of any related educational resources to enhance their understanding of its application.

The existing process of care/ workflow was reviewed, and we identified the critical steps for improvement as shown in Figure 2.

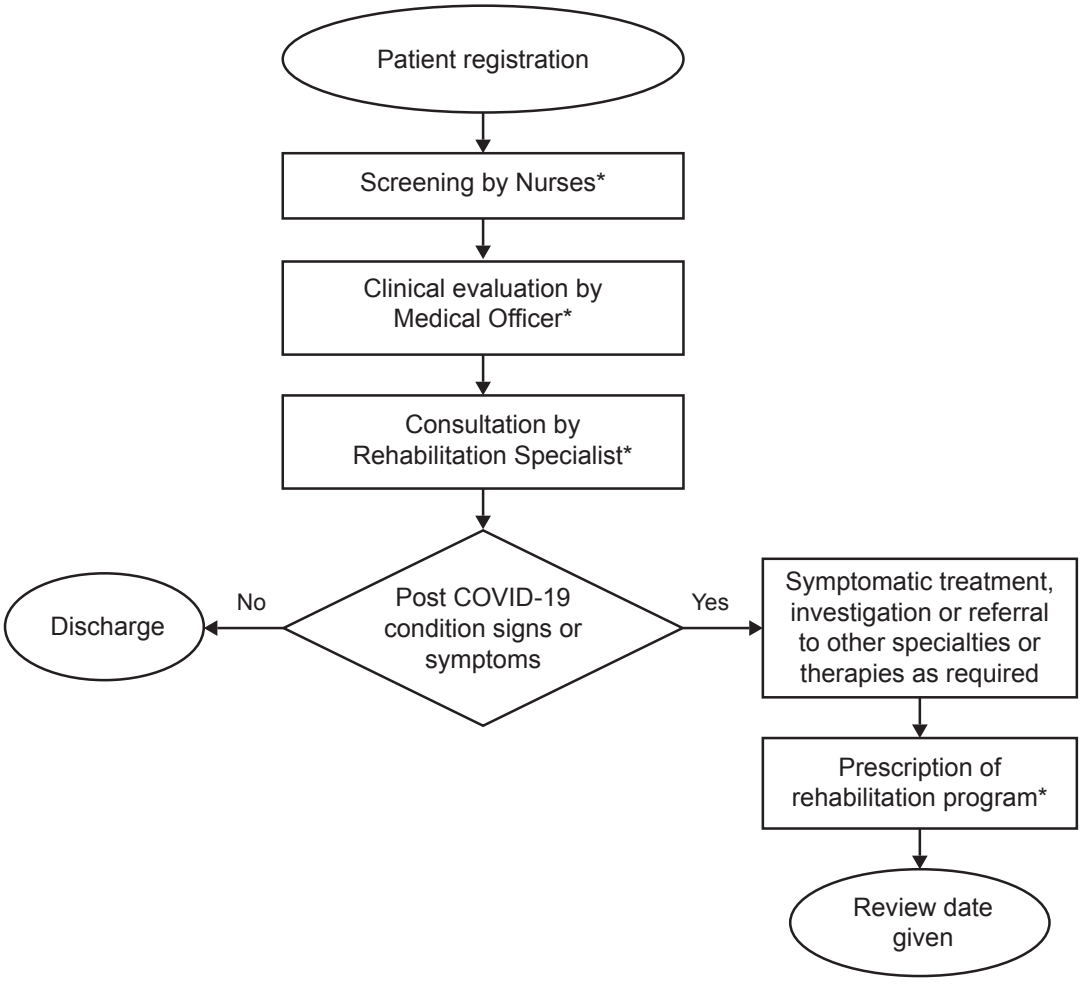


Figure 2 Process of care for moderately severe COVID-19 survivors attending an outpatient rehabilitation clinic.

The Model of Good Care (MOGC) parameters were established based on the critical steps in the process of care, adapted from international literature (2,8,24-27). A review of e-HIS medical records was conducted to assess compliance among rehabilitation personnel in providing appropriate outpatient rehabilitation management. Compliance was determined using an audit checklist that included all MOGC parameters.

In the verification study (n=165), we found full compliance (100%) on two of the MOGC parameters that included prescription of symptomatic treatment, order investigation, and make referral as indicated, and prescription of personalised exercise/ therapy by a multidisciplinary rehabilitation team. However, Shortfalls in Quality (SIQ) were detected across the other seven MOGC parameters. These include the assessment of multi-system screening for PCC symptoms (16.3%); physical function assessment using a standardised outcome measure (16.3%), cognitive assessment using a standardised outcome measure (16.3%), psychological function assessment using a standardised outcome measure (16.3%), evaluation of the impact of PCC on functional outcome measure (16.3%), assessment of oxygen saturation at rest and during exertion (32%) and provision of patient education and rehabilitation self-management resources (21%).

Strategies

Based on the study findings, structure-related and process-related remedial measures were formulated and implemented in four phases. A summary of structure-related and process-related remedial measures during the phased implementation is shown in Appendix 1.

a) Phase 1

Phase 1 remedial measures were conducted from January to June 2021 (6 months duration), focusing on structure-related (people) remedial measures, which involved serial training sessions for multidisciplinary rehabilitation personnel. Process-related remedial measures were then implemented through collaboration with other medical specialities to establish a one-stop, dedicated, structured, and coordinated outpatient rehabilitation service for COVID-19 survivors. The timeline for implementation of the remedial measures is as highlighted in Appendix 1.

- Serial training sessions were conducted and attended by the multidisciplinary rehabilitation personnel either physically or virtually. The training module included topics related to:
  - COVID-19 infection impact on multiorgan systems and the rationale for post-COVID-19 rehabilitation.
  - comprehensive multisystem screening for PCC using standardised outcome measures.
  - identification of red flag signs that require referral for further management by relevant medical specialties.
  - prescription of a personalised rehabilitation regimen/therapy tailored to the assessment findings.
  - provision of symptomatic treatment and, empowerment of patients with rehabilitation self-management.
- A requirement was made for all multidisciplinary rehabilitation personnel involved in post-COVID-19 management (N=43) to complete the OpenWHO online training on rehabilitation for COVID-19 (30). This online training comprised seven course modules addressing the diverse rehabilitation needs of patients recovering from COVID-19. The topics include management of cognitive, physical, respiratory, swallowing and communication impairments as well as addressing challenges in performing Activities of Daily Living (ADLs). Rehabilitation self-management methods to enhance symptoms recovery were also included. Certificates of participation were required for submission to the Head of Department to confirm training completion.
- Collaboration with other medical specialities involved in post-COVID-19 management was formalised, including General Medicine, Psychiatry, Geriatric Medicine, Endocrinology, Neurology, Respiratory Medicine, Rehabilitation Medicine, Physiotherapy, and Occupational Therapy to ensure comprehensive, structured, and coordinated care for COVID-19 survivors. This led to the establishment of a dedicated service known as COVID-19 Rehabilitation Outpatient Specialised

Services (CROSS) (14, 21). The service functions as a comprehensive, multidisciplinary centre where COVID-19 survivors undergo coordinated assessment by a rehabilitation nurse, occupational therapist, physiotherapist, medical officer, and rehabilitation specialist within a single setting. Standardised outcome measures, including the 6MWT, DASS, MSE, and PCFS scale, were employed to evaluate patient status (14, 21). Referrals to other medical specialities were initiated as clinically indicated by the attending rehabilitation specialist. In addition to clinical assessments, CROSS provides structured group and individual educational sessions focused on rehabilitation self-management. Personalised exercise and activity plans were developed and prescribed based on each patient's functional capacity and rehabilitation trajectory (14, 21).

b) Phase 2

Phase 2 remedial measures were conducted from January to June 2022 (6 months duration), focusing on process-related remedial measures through the establishment of teleconsultation and the integration of the CROSS framework into the HSgB e-HIS system. Additionally, structure-related (people) remedial measures for COVID-19 survivors were implemented by translating WHO online resources to improve patient education and enhance the empowerment process for COVID-19 survivors with rehabilitation self-management strategies (27).

- Teleconsultation was established predominantly through telephone calls. Video calls were initiated, when necessary, such as for reviewing pressure injury wounds, assessing general patient conditions, and evaluating home environments for COVID-19 survivors requiring short or long-term home oxygen therapy and monitoring. The primary aim of teleconsultation is to monitor the progress of COVID-19 survivors' recovery within the community. Medical advice was provided accordingly to enhance the recovery process, and dates for rehabilitation clinic in-person reviews were confirmed. In cases where red-flag conditions were a concern, patients and caregivers were advised to seek immediate medical consultation at the nearest healthcare facility.
- Collaboration with the Information Technology Department (ITD) of HSgB enabled the integration of the CROSS framework into the HSgB e-HIS system. All nine required MOGC criteria were incorporated into the e-HIS clinical documentation template, as required for appropriate outpatient rehabilitation management of moderately severe COVID-19 survivors. This section is subtitled in the e-HIS system as CROSS clerking and progress notes.
- The Malay language translation of post-COVID-19 rehabilitation self-management educational resources, consisting of six animated videos, was initiated and made available on the WHO website (https://who.canto.global/b/NTTVB) for public reference. The video topics are summarised in List 1 of Appendix 2. The videos were routinely broadcast in the clinic waiting area, and information regarding access to these online educational resources was provided to COVID-19 survivors attending the CROSS clinic.
- The Malay language translation of post-COVID-19 rehabilitation self-management educational resources, consisting of thirteen posters, was subsequently initiated and made available on the WHO website (https://who.canto.global/b/U076U) for public reference. The translated poster topics are summarised in List 2 of Appendix 2. Information on accessibility of these online educational resources was provided to COVID-19 survivors attending the CROSS clinic.

c) Phase 3

Phase 3 remedial measures were conducted from January to June 2023 (six months duration), addressing structure-related remedial measures for moderately severe COVID-19 survivors.

- Due to the challenges faced by COVID-19 survivors in understanding Western-style animated videos and poster resources, we took the initiative to collaborate with the Health Education Division, MOH Malaysia, to produce Malay language, live-action, locally adapted educational videos for social media circulation. This initiative aims to enhance understanding,

thereby improving the education and empowerment of local COVID-19 survivors with rehabilitation self-management strategies. Eight live-action, three-minute Malay-language videos were produced through this collaboration and made accessible on the MyHEALTH Portal's TikTok and YouTube channels (29). By October 2024, the TikTok videos had at least 47,792 collective views, while the YouTube versions garnered more than 6,500 views. View counts and topics are detailed in List 3 of Appendix 2. The video series has also been routinely played in clinic waiting areas, and information on accessing these social media educational resources has been provided to the COVID-19 survivors.

- To further enhance patient empowerment in rehabilitation self-management within the community, we initiated the publication of a free digital e-book based on WHO recommendations for rehabilitation self-management (27). The e-book, entitled "OPTIMUM: Panduan, Sokongan serta Inspirasi Bagi Pengurusan Kendiri Rehabilitasi Individu Pasca Jangkitan COVID-19" (29), comprises a total of 13 chapters on rehabilitation self-management post-COVID-19 as summarised in List 4 of Appendix 2. This e-book has since been made accessible to all patients through the Health Education Division, MOH (29). A link to the e-book is displayed in the clinic waiting area, and information on accessing these online educational resources was provided to COVID-19 survivors attending the CROSS clinic. By October 2024, the e-book had been downloaded 445 times by COVID-19 survivors (32.4%), healthcare personnel (56.9%), and others (10.7%).

Results

These comprehensive, multifaceted remedial measures have led to an increasing percentage of moderately severe COVID-19 survivors receiving appropriate outpatient rehabilitation management.

Results following Phase 1 remedial measures that focused on serial trainings of the multidisciplinary rehabilitation personnel and establishment of a one-stop dedicated, structured, and coordinated outpatient rehabilitation service for post-COVID-19 survivors (CROSS) have shown outcome improvement in Cycle 1 to 44.2% (153/346). We observed sustained 100% compliance in MOGC parameters, including symptomatic treatment, investigations and referrals, and personalised exercise prescriptions by the multidisciplinary rehabilitation team. An additional 100% compliance was observed in the MOGC parameter on comprehensive multi-system screening for PCC symptoms.

The other five MOGC parameters also showed a favourable increase to 68.5% (237/346), including standardised assessments of physical, cognitive, and psychological function, evaluation of PCC impact using functional measures, and oxygen saturation assessment at rest and during exertion. However, the MOGC parameter result on the provision of patient education and rehabilitation self-management resources still showed marginal improvement (44.2%, 153/346).

Results following Phase 2 remedial measures that focused on sustenance of Phase 1 remedial measures, with additional initiation of teleconsultation, integration of the CROSS framework into the HSgB e-HIS system, Malay language translation of WHO online resources on rehabilitation self-management strategies (27); showed further improvement in Cycle 2 to 87.8% (58/66).

We observed a sustainable outcome with 100% compliance on the MOGC parameters that included prescription of symptomatic treatment, order investigation, and make referral as indicated, prescription of personalised exercise/therapy by a multidisciplinary rehabilitation team, and assessment of multi-system screening for PCC symptoms. Additionally, we observed 100% compliance with another two MOGC parameters that included the assessment of oxygen saturation at rest and during exertion, and provision of patient education and rehabilitation self-management resources.

We observed further increments across the other four MOGC parameters to 92.4% (61/66), including standardised assessments of physical, cognitive, and psychological function, and evaluation of PCC impact using functional measures.

Results from Phase 3 remedial measures, which focused on sustaining efforts from Phases 1 and 2 and included the production of Malay-language live-action educational video series and an e-book on

rehabilitation self-management of common post-COVID-19 symptoms, showed a further increase in outcomes in Cycle 3 to 89.4% (42/47).

We observed sustainable outcome with 100% compliance on the MOGC parameters that included prescription of symptomatic treatment, order investigation and make referral as indicated; prescription of personalised exercise/therapy by multidisciplinary rehabilitation team; assessment of multi-system screening for PCC symptoms; assessment of oxygen saturation at rest and during exertion; and provision of patient education and rehabilitation self-management resources.

We observed further increments across the other MOGC parameters to (95.7%, 45/47). These included physical, cognitive and psychological function

Table 2: Improvement across the study cycle on the MOGC parameters following Phase 1 through Phase 3 remedial measures.

No	Critical Steps	Criteria	Std	Ver	Cycle 1	Cycle 2	Cycle 3
1	Screening by nurses	Comprehensive multi-system screening for PCC symptoms	100%	16.3%	100%	100%	100%
2	Clinical examination by a medical officer	Physical function assessment using a standardised outcome measure	100%	16.3%	68.5%	92.4%	95.7%
		Cognitive function assessment using a standardised outcome measure	100%	16.3%	68.5%	92.4%	95.7%
		Psychological function assessment using a standardised outcome measure	100%	16.3%	68.5%	92.4%	95.7%
		Evaluation of PCC impact on standardised functional outcome measure	100%	16.3%	68.5%	92.4%	95.7%
		Assessment of oxygen saturation at rest and during exertion	100%	32%	68.5%	100%	100%
3	Consultation by Rehabilitation Specialist	Prescription of symptomatic treatment, order investigation, and make referral as indicated	100%	100%	100%	100%	100%
4	Prescription of rehabilitation program	Provision of patient education and rehabilitation self-management resources	100%	21%	44.2%	100%	100%
		Prescription of personalised exercise / therapy by multidisciplinary rehabilitation team	100%	100%	100%	100%	100%

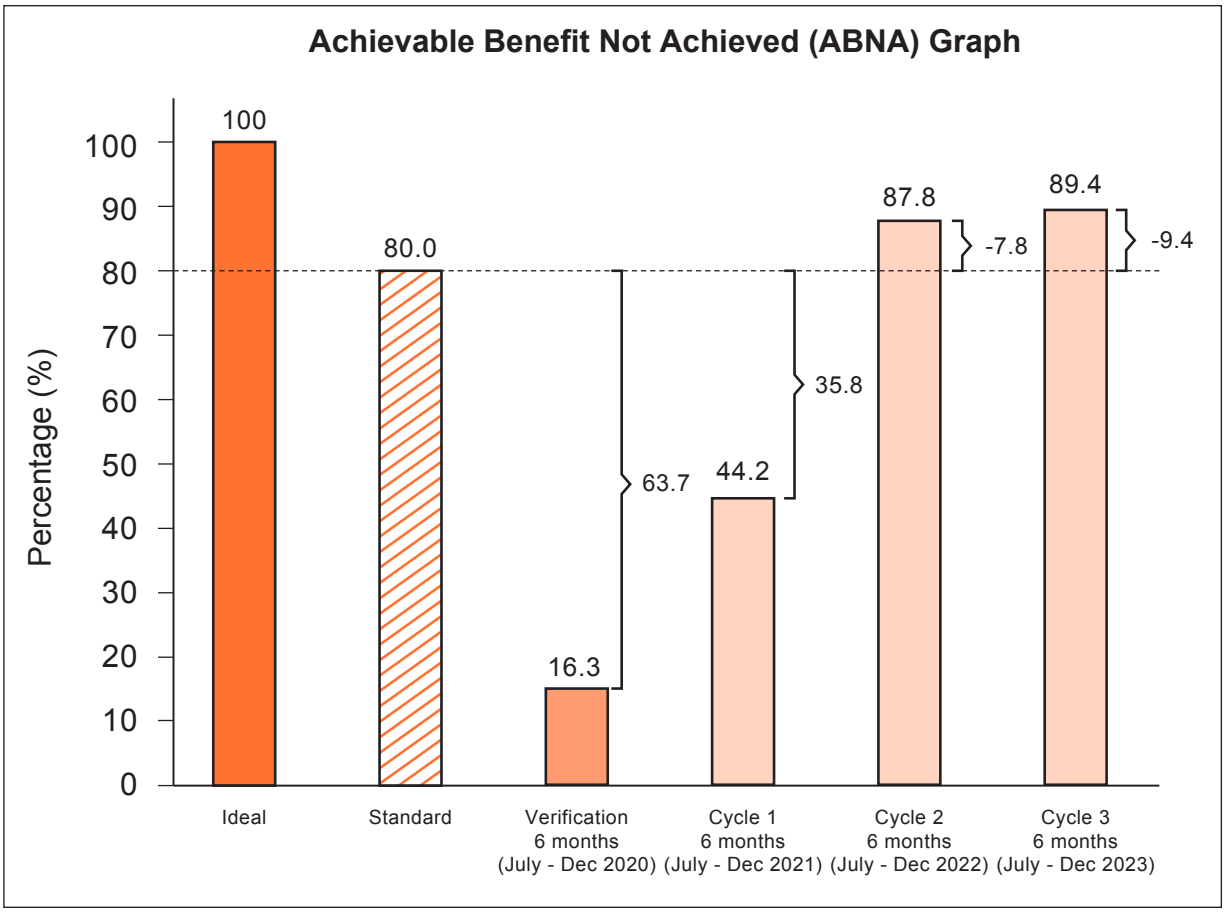


Figure 3: Information on ABNA and the percentage of moderately severe COVID-19 survivors provided with appropriate outpatient rehabilitation management from verification through Cycle 3 study analysis.

assessment using a standardised outcome measure, and evaluation of the effect of PCC using a functional outcome measure.

The details of each study cycle MOGC parameter achievement post Phase 1 through Phase 3 remedial measures implementation are summarised in Table 2.

Improvement of the Achievable Benefits Not Achieved (ABNA) was observed from 63.7% pre-intervention, reduced to 35.8% following Phase 1 remedial measures. Subsequently, following Phase 2 remedial measures, the ABNA has further improved to -7.8% post-intervention. We observed sustainability of the ABNA achievement to -9.4% following Phase 3 remedial measures.

Lessons and Limitations

The phased implementation of multi-faceted remedial measures has led to the improvement in the percentage of moderately severe COVID-19 survivors receiving appropriate outpatient rehabilitation management in our facility, with evidence of sustainability observed during the re-evaluation cycles.

This study highlights the importance of effective teamwork, commitment, and dedication among multidisciplinary rehabilitation personnel in completing the project. Collaboration across all levels, including interdisciplinary units within the Rehabilitation Medicine Department, other medical speciality units and departments involved in post-COVID-19 management, the Information Technology Department, hospital administration, the State Health Department, and the Ministry of Health Malaysia has facilitated the phased implementation of remedial measures. This collaborative effort has ultimately contributed to the successful completion of this study.

Continuous professional development activities involving multidisciplinary rehabilitation personnel caring for moderately severe COVID-19 survivors are of pivotal importance. The establishment of a dedicated, structured, and

coordinated service (CROSS), along with the provision of a clear clinical framework for comprehensive outpatient rehabilitation management, has enabled a more focused intervention. The integration of this comprehensive framework into the hospital e-HIS system documentation provides clear guidance for multidisciplinary rehabilitation personnel on the required assessments, management, and interventions.

From the patients' perspectives, direct accessibility of educational resources on rehabilitation self-management for commonly reported post-COVID-19 symptoms on various social media platforms has enhanced patients' experience for their better compliance to rehabilitation interventions, hence ensuring better outcomes throughout their recovery process.

From the clinical impact's perspective, we observed an improvement in the percentage of patients with symptom resolution, leading to a lower prevalence of PCC, which decreased from 67.5% pre-intervention to 47.7% (165/346) post-intervention in Cycle 1, followed by a further reduction to 43.9% (29/66) post-intervention in Cycle 2, and finally to 42.2% (20/47) post-intervention in Cycle 3.

PCC imposes significant economic burdens on affected individuals, primarily through increased healthcare expenses, reduced earnings, and lower quality of life (31). From a cost-saving perspective, the estimation focused exclusively on the rise in outpatient healthcare expenses. Based on estimates from Malaysia's Full Paying Patient fee schedule (32), a single outpatient multi-disciplinary rehabilitation cost for COVID-19 survivors with PCC is at least MYR420 per visit. This is inclusive of registration (MYR10), specialist consultation (MYR100), one-on-one education session (MYR20), group therapy (MYR20), functional evaluation (MYR50), cognitive evaluation (MYR60), rehabilitation program for all disabilities (MYR120), physiotherapy (MYR20), and occupational therapy (MYR20). Considering the requirement of at least two visits per COVID-19 survivor with PCC complications, the 245 PCC recoveries observed in this study have led to an estimated savings of at least MYR205,800 in outpatient healthcare expenditure.

Quality is closely associated with customer satisfaction, either fulfilling or exceeding their expectation. A self-administered customer satisfaction survey form, which was randomly distributed during the CROSS clinic between July to December 2021, achieved 253 total responses composed of 85% (215/253) moderate COVID-19 survivors and 15% (38/253) severe COVID-19 survivors. The CROSS service has been rated as excellent in 33.2% (84/253) and good in 66.8% (169/253). This reflected the primary importance of patient-centred service delivery in the healthcare system.

Our experience in managing COVID-19 survivors in this study led us to provide a national symposium training on post-COVID-19 Focused Rehabilitation Medicine, conducted on 7th March 2022, which was virtually attended by 460 multidisciplinary rehabilitation personnel from all states in Malaysia. Subsequently, another national training session, post-COVID-19 Focused Rehabilitation Medicine 2.0, was conducted on 29th May 2023 at HSgB, and was physically attended by 246 multidisciplinary rehabilitation personnel involved in post-COVID-19 management across Malaysia.

Our primary limitation was the change in COVID-19 virus virulence throughout the entire study, which resulted in limited data comparability across the three study cycles as reflected in the high variation of the number of COVID-19 survivors involved in this study (n=165 verification study; n=346 post-intervention Cycle 1; n=66 post-intervention Cycle 2; and n=47 post-intervention Cycle 3). Even though the current Omicron variant of COVID-19 has been reported to be more transmissible (33), the lower number of moderately severe COVID-19 survivors being referred for outpatient rehabilitation management and the favourable clinical outcome in the later Cycle studies may have been attributed by the lesser virulence of the current Omicron variant of COVID-19 compared to the Delta variant of COVID-19 at the beginning of the study (34,35).

Another limitation of this study is the limited generalisability of its results and outcomes at the state or national level. This is due to the study being conducted in a single specific facility, HSgB, the national referral centre for infectious diseases, which has the highest number of moderately severe COVID-19 survivor admissions.

The status change of HSgB from a full COVID-19 function to a hybrid hospital on 22nd April 2022 (13) has led to the challenge of having to attend to the influx of other diverse conventional rehabilitation cases. This is accommodated via rescheduling all moderately severe COVID-19 survivors referred for the CROSS clinic to a single day of the week.

Conclusion and the Next Steps

While there is availability of scientific evidence on the feasibility and effectiveness of multidisciplinary rehabilitation interventions for improving functional and exercise capacity and symptoms recovery post COVID-19 infection such as fatigue, dyspnoea mental health challenges (24,25), to our best knowledge there is still a dearth of studies examining the appropriateness of outpatient rehabilitation interventions in any given healthcare facility similar to the study being conducted. Hence, this study may be considered a baseline study, which has the potential to be replicated in other hospitals that face similar challenges.

This study found that only 16.3% of moderately severe COVID-19 survivors were provided with appropriate outpatient rehabilitation management. We identified the key contributing factors as a lack of awareness and knowledge involving multidisciplinary rehabilitation personnel; poor awareness and knowledge among post-COVID-19 survivors, non-availability of dedicated, structured, and coordinated multidisciplinary outpatient rehabilitation service, and limited access to educational resources related to rehabilitation self-management. Multi-faceted structure-related and process-related remedial measures have been implemented in phases, including serial training sessions, teleconsultation, a comprehensive one-stop centre known as CROSS, integration of framework into the e-HIS system, and provision of access to educational resources via social media engagement. These remedial measures have been effective, with post-intervention analysis showing an increased percentage from 16.3% to 44.2% in Cycle 1, to 87.8% in Cycle 2. The sustainability of the achievement was evident with a further increment of percentage to 89.4% in Cycle 3.

With these favourable outcomes achieved in this study, we aimed to expand the relatable structure-related and process-related remedial measures in this study for the improvement of other conventional rehabilitation services with fairly similar challenges, such as for post-intensive care survivors, in the future.

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Appendix 1: Summary of structure-related and process-related remedial measures during the phased implementation.

Remedial Measures	Implementation Phases			
	Phase 1 Jan – June 2021	**Phase 2** Jan – June 2022	**Phase 3** Jan – June 2023	**Phase 4** Jan – June 2024 (Sustainable)
Structure-related (multidisciplinary rehabilitation personnel)				
1. Physical and virtual **training series**	✓	✓	✓	✓
2. OpenWHO **online training** & **certification**	✓	✓	✓	✓
Process-related				
3. Dedicated, structured, and coordinated one-stop outpatient rehabilitation service (**CROSS**)	✓	✓	✓	✓
4. **Teleconsultation**		✓	✓	✓
5. CROSS service framework integration into the **e-HIS system**		✓	✓	✓
Structure-related (moderately severe COVID-19 survivors)				
6. Malay language translation of the WHO online rehabilitation self-management **animated educational video and poster resources**		✓	✓	✓
7. HSgB Malay language **e-book** on rehabilitation self-management "OPTIMUM"			✓	✓
8. HSgB rehabilitation self-management **live-action video resources**			✓	✓

Appendix 2:

List 1: Topics of Malay language translation of post-COVID-19 rehabilitation self-management education video

The Malay language translation of post-COVID-19 rehabilitation self-management educational video topics available on the WHO website (https://who.canto.global/b/NTTVB):

i. Managing Activities of Daily Living (*Menguruskan aktiviti harian kehidupan*)
ii. Managing Issues with Eating and Drinking (*Menguruskan masalah berkaitan makan dan minum*)
iii. Exercise After COVID-19 Infection (*Bersenam selepas jangkitan COVID-19*)
iv. Managing Breathlessness (*Menguruskan kesukaran bernafas)*
v. Managing Problems with Attention, Memory, and Thinking (*Menguruskan masalah berkaitan*
vi. *perhatian, daya ingatan, dan berfikir dengan jelas*)
vii. Managing Problems with Voice (*Menguruskan masalah berkaitan suara*)

List 2: Topics of the Malay language translation of post-COVID-19 rehabilitation self-management educational poster

The Malay language translation of post-COVID-19 rehabilitation self-management educational poster topics available on the WHO website (https://who.canto.global/b/U076U):

i. Managing Activities of Daily Living (*Menguruskan aktiviti harian kehidupan*)
ii. Managing Issues with Eating and Drinking (*Menguruskan Masalah Berkaitan Makan dan Minum*)
iii. Exercise After COVID-19 Infection (*Bersenam Selepas Jangkitan COVID-19*)
iv. Exercise and Post-Exertional Malaise (*Senaman dan Post-Exertional Malaise*)
v. Managing Breathlessness (*Menguruskan Kesukaran Bernafas*)
vi. Positions to Relieve Breathlessness (*Posisi-Posisi bagi Mengurangkan Kesukaran Bernafas*)
vii. Managing Problems with Attention, Memory, and Thinking (*Menguruskan Masalah Berkaitan Perhatian, Daya Ingatan, dan Berfikir dengan Jelas*)
viii. Managing Pain (*Menguruskan Kesakitan*)
ix. Managing Nutrition, Smell, and Taste (*Menguruskan Nutrisi, Deria Bau, dan Rasa*)
x. Managing Stress (*Menguruskan Tekanan*)
xi. Managing Problems with Voice (*Menguruskan Masalah Berkaitan Suara*)
xii. Managing fatigue (*Menguruskan kelesuan*)
xiii. Return to Work (*Kembali Bekerja*)

List 3: Topics of the Malay language live-action video series

The topics of the Malay language live-action video series and the respective view counts on Tik Tok channel:

i. Managing Insomnia (*Menangani gejala kesukaran tidur nyenyak*) – 6,307 views
ii. Managing Issues with Smell and Taste (*Menangani masalah berkaitan deria bau dan rasa*) – 6,307 views
iii. Exercise After COVID-19 Infection (*Bersenam selepas jangkitan COVID-19*) – 16,100 views
iv. Managing Breathlessness (*Menangani kesukaran bernafas*) – 3,974 views
v. Managing Problems with Brain Fog (*Menangani masalah berkaitan kekabutan otak*) – 4,954 views
vi. Managing Problems with Emotion (*Menangani masalah berkaitan emosi*) – 2,982 views
vii. Managing Problems with Cough (*Menangani gejala batuk*) – 4,104 views
viii. Managing Problems with Fatigue (*Menangani masalah berkaitan kelesuan*) – 2,939 views

List 4: Chapters of e-book “OPTIMUM”

The 13 chapters of the e-book “OPTIMUM: Panduan, Sokongan serta Inspirasi Bagi Pengurusan Kendiri Rehabilitasi Individu Pasca Jangkitan COVID-19”:

i. Identifying Red Flags (*Mengenali gejala-gejala amaran*)
ii. Managing Issues with Swallowing (*Menangani masalah berkaitan penelanan*)
iii. Physical Activities and Exercise After COVID-19 Infection (*Aktiviti fizikal dan bersenam selepas jangkitan COVID-19*)
iv. Managing Fatigue (*Menangani gejala kelesuan*)
v. Managing Breathlessness (*Menangani kesukaran bernafas*)
vi. Positions to Relieve Breathlessness (*Posisi-posisi bagi mengurangkan kesukaran bernafas*)
vii. Managing Problems with Cognitive Dysfunction and Brain Fog (*Menangani gejala fungsi kognitif dan kekabutan otak*)
viii. Managing Pain (*Menangani gejala kesakitan*)
ix. Managing Changes in Smell and Taste, and Healthy Nutrition (*Menangani gejala berkaitan deria bau dan rasa serta nutrisi yang sihat*)
x. Managing Emotion, Anxiety, and Insomnia (*Menangani gejala berkaitan emosi, keresahan, dan kesukaran tidur nyenyak*)
xi. Managing Problems with Voice (*Menangani masalah berkaitan suara*)
xii. Returning to Work (*Melangkah kembali bekerja*)
xiii. Social Support (*Sokongan sosial*)