Abstract of dissertation entitled

“Evidence-based guidelines for preoperative physical exercise to reduce postoperative pulmonary complications in elective cardiac surgery patients”

Submitted by

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for the degree of Master of Nursing

at the University of Hong Kong

in July 2015

Background

Heart disease, as a global health concern, is among the top three killers in Hong Kong. Its rising prevalence leads to rising demand for cardiac surgery and the problem of such ever-expanding waiting list for the public health care services cannot be settled in a short time. Considering the potential benefits of preoperative physical exercise, a universally easily accessible and affordable evidence-based innovation, to slow down the adverse physical and psychological deterioration and improve elective adult
cardiac surgery patients’ postoperative outcomes utilizing the waiting period, is therefore necessary.

Recent studies have showed that preoperative physical exercise can reduce postoperative pulmonary complications in elective cardiac surgery patients. The relative risk of developing post-operative pneumonia is 0.45 with 95% confidence interval 0.24 to 0.83 and a p-value of 0.01. Additional benefits include improved ventilation function, reduced length of hospital stay, improved quality of life and sustained postoperative physical exercise willingness.

**Purpose**

The purposes of this translational nursing research are to (1) collect evidence through systematic review: whether the preoperative physical exercise can effectively reduce postoperative pulmonary complications for elective adult cardiac surgery patients; (2) write up evidence-based guidelines for both healthcare professionals and patients; (3) assess the feasibility of the guidelines; (4) implement and evaluate the effectiveness of preoperative physical exercise in clinical settings.
Methods

A systematic literature search was conducted using databases including PubMed (1980 till present), Medline via EBSCO Host (1966 till present), CINAHL Plus (1982 till present), ProQuest (1966 till present) and British Nursing Index (1980 till present). Six randomized controlled trials were identified for analyzing the level of evidence and critical appraisal using the grading system of Scottish Intercollegiate Guideline Network (SIGN). They were all of high quality and concluded that the occurrence of postoperative pulmonary complications was reduced by 50% compared with patients who received usual care.

After the systematic review, the implementation potential of the proposed innovation of preoperative physical exercise to reduce postoperative pulmonary complications on elective cardiac surgery patients was assessed in terms of target audience and setting, transferability, feasibility and cost-benefit ratio. Evidence-based guidelines were then developed based on the level of evidence and the grades of recommendations rated. An implementation plan was also included. After communicating with stakeholders and providing training to targeted cardiothoracic surgical staff, a pilot study test was carried out for concrete information on the feasibility of the innovation. An evaluation plan was designed to evaluate the effectiveness of the proposed guidelines in the end.
Conclusion

With the implementation of the evidence-based preoperative physical exercise guidelines, the incidence of postoperative pulmonary complications should be significantly reduced. The guidelines also help facilitate the decisions making of healthcare professionals. So that in the end, the decision on healthcare resource allocation would be able to fairly cater for the greatest portion of our cardiac surgical patients on the waiting list with the already stretched-thin finances. In addition, actively engaging in practice according to evidence-based not only can improve patients’ outcomes, but also uphold the professional nursing standard and nurture the continual nursing development.
Evidence-based guidelines for preoperative physical exercise to reduce postoperative pulmonary complications in elective cardiac surgery patients

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A dissertation submitted in partial fulfillment of the requirements for the degree of Master of Nursing at the University of Hong Kong

July 2015
Declaration

I declare that this dissertation represents my own work, except where due acknowledgment is made, and that it has not been previously included in a thesis, dissertation or report submitted to this University or to any other institution for a degree, diploma or other qualifications.

Signed: ____________________________

LOK PUI LAM
Acknowledgements

I would like to take this opportunity to express my deepest gratitude to my supervisor Dr. Marie Tarrant for her thoughtful guidance and timely encouragement throughout my writing process.

I am also grateful for the opportunities given by the School of Nursing, the University of Hong Kong. Not only do I expand my understanding towards nursing values and professionalism, but also achieve personal growth in my master course studies.

Last but not least, it is my pleasure to thank my classmates and colleagues who made this dissertation possible. Their willingness to share provocative insights, valuable experience and continual support are much appreciated.
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Chapter 1: Introduction – Statement of the problem

1.1 Background

Heart disease, among the top three killers worldwide, as well as in Hong Kong, accounts for over 4 million deaths in Europe (European Heart Network, 2014), over half a million deaths annually in the United States (National Vital Statistics Reports, 2011) and leads to 5,814 registered deaths in 2013 in Hong Kong (Department of Health, 2014). Its prevalence is rising as the aging Hong Kong population continues to grow and the demand for cardiac surgery is on the rise. Even with the continuous evolving advances in our medical healthcare system and the expanding medical resources (Department of Health, 2014), such demand still cannot be settled with immediate supply, which therefore resulted in long waiting lists.

Among all the cardiac surgeries carried out in Hong Kong settings, coronary artery bypass grafting (CABG) is the most common open heart surgery in Hong Kong requiring cardiopulmonary bypass for patients with ischemic heart disease and triple vascular disease caused by atherosclerosis (Hospital Authority, 2011a). While heart valve surgery is performed to repair or replace the diseased heart valves (American Heart Association, 2014).
Moreover, more elderly patients are presented to cardiac surgery nowadays with more co-morbidities than patients in the past (Rosenfeldt, Braun, Spitzer, Bradley, Shepherd, Bailey, van der Merwe, Leong & Esmore, 2011). And hence as a result they tend to have more complications, especially for the risk of postoperative pulmonary complications that contributes to an increase in postoperative morbidity and mortality; and consequently take a longer time for recovery and convalescence (Ephgrave, Kleiman-Wexler, Pfaller, Booth, Werkmeister & Young, 1993; Weismann, 2004; Hoogeboom, Dronkers, Hulzebos & van Meeteren, 2014).

Therefore, implementing tailored prophylactic preoperative intervention during such lengthy preoperative waiting period provides a window of opportunity to support patients, promote speedy recovery and reduce postoperative pulmonary complications such as atelectasis, pneumonia and pneumothorax; and in turn help alleviate the enormous healthcare expenses (Hulzebos, Helders, Favie, De Bie, Brutel de la Riviere & van Meeteren, 2006a; Hulzebos, van Meeteren, van den Buijs, De Bie, Brutel de la Riviere & Helders, 2006b; Ferreira, Rodrigues & Evora, 2008; Carvalho, Bonorino & Panigas, 2011).
1.2 Affirming the Need

As one of the three cardiothoracic surgical units in an acute and teaching hospital in Hong Kong, elective cardiac surgeries are tightly scheduled and emergency surgeries are expected, which consequently adds burden to the existing waiting list.

Current Situation

According to the original research conducted by Au, Sun, Lam, Cheng, Chiu & Das (2007), the mortality rates for adult patients waiting for CABG and heart valve surgery in Hong Kong were 2.9% and 4.8% respectively. Compared with the 3.8% of the patients suffered myocardial infarction and unstable angina while waiting in Ontario, Canada annually (Cardiac Care Network of Ontario, 2014). Moreover, patients undergoing cardiac surgery have a higher than average risk for pulmonary complications (Hulzebos, Smit, Helders & van Meeteren, 2012).

The current practice in Hong Kong clinical settings is simply providing preoperative education which advises patients to do deep breathing and coughing exercise, daily walking, early mobilization and quit smoking a day or two before surgery; and then carry out the mentioned exercise therapy postoperatively.
Breathing exercise helps compensate abnormal breathing pattern and helps lower the risk of atelectasis and pneumonia (Hulzebos et al., 2006a and Snowdon, Haines & Skinner, 2014). Smoking cessation is also beneficial. Keep smoking makes patients more prone to pneumonia and develops postoperative pulmonary complications. It also results in heavier cardiac workload and hence accelerates the atherosclerotic process (HA, 2011a; HA, 2011b).

The contents of the practicing preoperative interventions have been studied and proved to be positively related to postoperative outcomes, such as reduced self-reported pain and increased well-being (Hulzebos et al., 2012). However, researches showed that physical exercise is best to be started preoperatively to lower the postoperative pulmonary complications, which is unfortunately contradictory to the practice in Hong Kong.

Degree of severity

The National Center for Health Statistics (2011) reported the total number of cardiovascular operations has a 484% increase from 1979 to 2005 in the United States. Such increase does not only limited to the US, but also applicable to the United Kingdom and Hong Kong. According to the latest data, there are almost
40,000 cardiac surgeries done annually which equals to roughly 650 cardiac surgeries per million populations per year in the UK; while there are 214 cardiac surgeries done per million populations per year in HK. Take coronary artery bypass grafting (CABG) as an example, there are around 400 operations per million populations each year in Europe; while comparatively, there are 86 operations per million populations each year in HK (The University of Hong Kong, 2011). The statistics gathered by the Chinese University of Hong Kong in 2012 stated that there are more than 400 patients on the list waiting for cardiac surgeries and these numbers are still expanding.

Evidence showed that the physical functioning and psychological well-being of patients could deteriorate during the waiting period (Bengtson, Herlitz, Karlsson & Hjalmarson, 1996; Arthur, Daniels, McKelvie, Hirsh & Rush, 2000 and Rosenfeldt et al., 2011). The longer the wait, the more likely the reduction on leisure activities, decreased physical and social functioning, causing anxiety, poorer vitality, so do the overall general health of patients (Rosenfeldt et al., 2011).

**Physical deterioration**

It is a well-known fact that surgery may lead to loss of muscle mass, physical deconditioning and respiratory muscles dysfunction (Wynne & Botti, 2004 and
Rosenfeldt et al., 2011). The resulted tidal volume, vital capacity and total lung capacity reduction may cause atelectasis and the increment of ventilation/perfusion mismatch affects gaseous exchange. Thus, increases the risk for pulmonary infections and consequently could lead to respiratory failure and even death (Hulzebos et al., 2006a), which in turn contributes to higher morbidity and mortality rate among cardiac surgery patients. These complications may prolong postoperative recovery, mechanical ventilation use and length of hospital stay; and subsequently increase the medical expenses (Hulzebos et al., 2012).

**Psychological distress**

Undergoing cardiac surgery is a significant life event and has a paramount psychoemotional impact on patients and their family members. Experience gathered from patients underwent open-heart surgery included high level of stress, apprehensiveness and anxiety about the heart disease, the impending treatment plan involved and postoperative pain (Bergmann, Huber, Machler, Liebl, Hinghofer-Szalkay, Rehak & Rigler, 2000; Karlsson, Johansson & Lidell, 2005). Emotional stress also exerts its effect on autonomic nervous system, platelet aggregation, increases myocardial oxygen demand and hence affects the morbidity (Krantz, Kop, Santiago & Gottdiener, 1996).
Benefits of physical exercise

It is a well-established fact that regular physical exercise can undoubtedly improve cardiorespiratory functions, as well as physical performance (Kendziorra, Walther, Foerster, Mobius-Winkler, Conradi, Schuler, Sabri, Hambrecht & Kluge, 2005). Randomized controlled studies found that cardiac patients performing regular moderate physical exercise have a higher functional capacity, increased muscle strength, better quality of life and a lower mortality rate when compared to non-exercise control groups, let alone a significant reduction on anxiety (Belardinelli, Georgiou, Cianci & Purcaro, 1999; Herring, O’Connor & Dishman, 2010).

Several recent and dated researches (Arthur et al., 2000; Hulzebos et al., 2006a; Hulzebos et al., 2006b; Ferreira et al., 2008; Carvalho et al., 2011 & Rosenfeldt et al., 2011) concluded that increasing physical fitness can improve the respiratory functional capacity of the patients and results in them being better prepared to stand against the physical stress brought about by cardiac surgery (Topp, Ditmyer, King, Doherty & Hornyak, 2002 and Carli & Zavorsky, 2005).

The potentials of the innovation

Noting all the positive outcomes, preoperative physical exercise training should be
highly recommended for patients waiting for cardiac surgery. Research conducted by Hulzebos and his colleagues (2006a) concluded that the occurrence of postoperative pulmonary complications was reduced by 50% compared with patients who received usual care. Moreover, several randomized studies also demonstrated that preoperative physical exercise has edges over postoperative care alone in patients having cardiac surgery. All in all, current researches conclude that physical exercise is best to be started preoperatively to speed up recovery, improve functional abilities and reduce postoperative pulmonary complications, length of hospital stay and medical costs. (Arthur et al., 2000; Hulzebos et al., 2006a; Hulzebos et al., 2006b; Ferreira et al., 2008; Carvalho et al., 2011 & Rosenfeldt et al., 2011).

That being so, an effective prophylactic intervention incorporating the current contents with new training exercise regimen is recommended. It is highly encouraged to deliver such important lifestyle changing messages to patients once they got scheduled for cardiac surgery, instead of following the old practice where patient education was delivered a day or two before surgery when patients got admitted to the ward (Hulzebos et al., 2012).

The latest holistic preoperative physical exercise program should include early
mobilization as a core component through aerobic exercises like daily walking, deep breathing and coughing exercise and inspiratory muscle training. Patient education regarding stopping smoking and different maneuvers for promoting lung expansion is vital. Besides, building a trusted partnership through monthly phone calls (Arthur et al., 2000) between patients and healthcare professionals are essential to sustain provision of care to patients, ensure caregivers’ engagement and sustain patients’ willingness to continue the postoperative rehabilitation program (Lau, Kong & Li, 2012).

With the need for cardiac surgery on the rise and the problem of ever-expanding waiting list for the public health care services not being able to be settled in a short time; as well as considering the potential benefits of preoperative physical exercise, a universally easily accessible and affordable innovation, to slow down the adverse physical and psychological deterioration and improve elective adult cardiac surgery patients’ outcomes utilizing the waiting period, is therefore necessary.

However, reviews and appraisal have to be done to confirm the validity of those research results before implementing and translating the preoperative physical exercise program into clinical practice.
1.3 Objectives and Significance

Research Question:

How effective is preoperative physical exercise compared with usual care in reducing the postoperative pulmonary complications among elective adult cardiac surgery patients?

This searchable and answerable question is formulated according to PICO framework (Sackett, Richardson, Rosenberg & Haynes, 1997), which focuses on population, intervention, comparison and outcome.

Objectives:

1. To collect evidence through systematic review: whether the preoperative physical exercise can effectively reduce postoperative pulmonary complications for elective adult cardiac surgery patients

2. Write up evidence-based guidelines

3. Assess the feasibility of the guidelines

4. Implement and evaluate the effectiveness of preoperative physical exercise in clinical setting
Significance:

Minimizing the incidence of such preventable postoperative pulmonary complications among the older and more fragile population and the heavy medical cost the cardiac surgery patients incurred during their entire lengthened hospital stay (Hulzebos, et al., 2006a and Hulzebos et al., 2006b) are significant issues to be addressed in order to maintain the quality and continue the quest for improving the healthcare service provided, a comprehensive and effective prophylactic intervention which targeted at optimizing both physical and psychological conditions is therefore warranted.

Developing clinical guideline based on statistical evidence after doing a systematic review, which explores the effectiveness and appropriateness for and against the proposed intervention, is paramount. The guideline also helps facilitate the decisions making of healthcare professionals. So that in the end, the decision on healthcare resource allocation would be able to fairly cater for the greatest portion of our patients on the waiting list with the already stretched-thin finances (Snowdon et al., 2014).
Chapter 2: Critical Appraisal

2.1 Search and Appraisal Strategies

Identification of studies

An electronic search was conducted through renowned databases like PubMed, Medline (EBSCO Host), Allied Health Literature Plus (CINAHL Plus), ProQuest and British Nursing Index. Keywords search covering population, intervention and outcome includes preoperative physical exercise, preoperative intervention, respiratory muscle training, postoperative pulmonary complications and elective adult cardiac surgery patients were used. Further search was conducted using different keywords combinations and the search was stopped while there was no additional result generated from the searching engines.

Inclusion and exclusion criteria

Original research articles, published in English, whose main goals were to investigate the use of preoperative physical exercise as an intervention, were specifically included to undergo critical appraisal and to assess its efficacy in reducing postoperative pulmonary complications among adult patients waiting for elective cardiac surgery. Search was limited to randomized comparative studies published since 2000.
However, articles discussing other preoperative interventions with no physical exercise, no randomization, no control group, not targeting adult cardiac surgery patients and other type of outcome measured were all excluded from systematic review as these deviated from the main goal.

Data extraction

Data including author, publication year, study design, sample size, participants’ characteristics, training method, evaluation method, outcome measures and effect size are extracted. These data extracted from the eligible studies are then used to construct a table of evidence in Appendix II, according to SIGN (Scottish Intercollegiate Guidelines Network, 2013) in order to synthesize the existing relevant evidence and summarize them into categories, so as to help comparing and contrasting different research studies and answering the research question whether preoperative physical exercise is an effective method to reduce postoperative pulmonary complications.

Appraisal strategies

In order to determine and interpret if the evidence extracted from different research literature is of high quality, credible or trustworthy enough to apply in the clinical settings for the sake of patients, Scottish Intercollegiate Guidelines Network (SIGN,
2013), a critical appraisal tool for guideline development, is chosen. A methodology checklist for controlled trials designed by SIGN is used to appraise the research literature gathered. SIGN provides quality appraisal for internal validity and gives an overall assessment of the study to determine if the study is well conducted enough to minimize any bias involved. The assessment details, summary and synthesis of the results will be shown in this chapter (attached in Appendix 3).

2.2 Results

The initial searching was conducted on 25/11/2014, which yielded 1,404 articles from the following electronic databases: PubMed (1980 till present), Medline via EBSCO Host (1966 till present), CINAHL Plus (1982 till present), ProQuest (1966 till present) and British Nursing Index (1980 till present).

Search history

Relevant titles and abstracts were screened after individual and combined keywords search through 5 databases against the inclusion and exclusion criteria mentioned above in section 2.1. Studies were screened out when they were not original research (1,358 articles), not using physical exercise as preoperative intervention (26 articles),
no randomization or control group (5 articles), no relevant outcomes (4 articles) or not targeting adult elective cardiac surgery patients (5 articles). Afterwards, the full text of the remaining potentially appropriate studies were retrieved and read through to confirm eligibility. Reference lists from the identified studies were then used to further search for related literature.

After detailed screening, combining the results and eliminating overlapped articles from 5 databases (as seen in Appendix 1), 6 studies regarding preoperative physical exercise conducted between 2000 – 2011 met the inclusion criteria, which aim to investigate its efficacy to reduce postoperative pulmonary complications among elective adult cardiac surgery patients, were identified.

**Study characteristics summary**

Six randomized controlled trials (Arthur et al., 2000; Hulzebos et al., 2006a; Hulzebos et al., 2006b; Ferreira et al., 2008; Carvalho et al., 2011 & Rosenfeldt et al., 2011) were yielded to undergo quality assessment and present the data in table of evidence, as illustrated in Appendix 2. These studies were conducted from 2000 - 2011 in Canada (Arthur et al., 2000), the Netherlands (Hulzebos et al., 2006a & Hulzebos et al., 2006b), Brazil (Ferreira et al., 2008 & Carvalho et al., 2011) and Australia
All of them were single-centered studies. A total of 733 participants were recruited, among which Arthur and his colleagues (2000) included low-risk patients while the three studies conducted by Hulzebos et al. (2006a), Hulzebos et al. (2006b) and Carvalho et al. (2011) recruited patients with high-risk of developing postoperative pulmonary complications. But the remaining two studies did not mention enough patients’ details to determine whether high risk or low risk patients were recruited (Ferreira et al., 2009 & Rosenfeldt et al., 2011).

**Intervention group and comparison group**

All the baseline parameters of the recruited patients were comparable and evenly distributed with no statistical significant difference among the intervention group (receiving preoperative physical exercise) and the comparison group (receiving usual care without preoperative physical exercise). Parameters include demographic data (age, sex), past medical history (diabetes, chronic obstructive pulmonary disease) and lifestyle habits (smoking).

Each study reported one common outcome measure, the incidence of postoperative pulmonary complications according to Kroenke’s criteria (Arthur et al., 2000; Hulzebos et al., 2006a; Hulzebos et al., 2006b; Ferreira et al., 2009; Carvalho et al.,
Among which, 4 reported on atelectasis, 5 on pneumonia and 2 on prolonged mechanical ventilation for more than 48 hours. Secondary outcome measures include length of postoperative hospital stay and physical functionality (Arthur et al., 2000, Hulzebos et al., 2006a; Hulzebos et al., 2006b & Rosenfeldt et al., 2011). Arthur (2000) and Rosenfeldt (2011) and their respective colleagues additionally measured health-related quality of life.

Lung functions were measured by spirometry (Micro-Loop; PT Medical, Leek, the Netherlands) while the effectiveness of the inspiratory muscle strength was measured with a hand-held pressure gauge (Micro Medical MPM; PT Medical, Leek, the Netherlands). Specific Activity Scale (SAS) scored the functional performance while the quality of life was measured with the Short Form 36-item Health Survey Questionnaire (SF-36). All of the measurement tools were validated by previous studies (Arthur et al., 2000; Hulzebos et al., 2006a; Hulzebos et al., 2006b; Ferreira et al., 2009; Carvalho et al., 2011 & Rosenfeldt et al., 2011).

**Methodological issues summary**

By reviewing the combined research data using SIGN (2013) appraisal checklist, four of the six identified studies (Arthur et al., 2000; Hulzebos et al., 2006a; Hulzebos et
al., 2006b & Rosenfeldt et al., 2011) were graded as high quality (++++), which meant they were able to provide validated answers to the research question; while studies conducted by Ferreira et al. (2009) and Carvalho et al. (2011) were of fairly good quality.

All studies carried out only in one hospital, which may lead to underestimation of effects. The population size of the study conducted by Hulzebos et al. (2006b) might be too small to detect a difference in less frequent post operation complications like death and pneumothorax.

The risk for selection bias concerning the allocation concealment was minimized, by using a sealed opaque envelope (Arthur et al., 2000); while Hulzebos et al. (2006a) used an envelope picked by an investigator not included in the study. However, the risk for the other four studies was unclear, as the procedures were not described.

As for the risk for selection bias concerning the randomization, Arthur et al. (2000) recruited a study coordinator to prepare a randomization sequence; Hulzebos et al. (2006a & 2006b) and Rosenfeldt et al. (2011) used a computer generated randomization table. However, Ferreira et al. (2009) and Carvalho et al. (2011) also
used random assignment but no details were stated.

The risk for performance bias regarding the binding was considered high for studies conducted by Ferreira et al. (2009), Carvalho et al. (2011) and Rosenfeldt et al. (2011) because the treatment allocation were not double-blinded, they did not include any form of control treatment or placebo therapy and they did not include outside reviewers for outcome assessment, which in turn could influence the detection of post operation complications. However, Arthur et al. (2000) mentioned patients were not blinded, but the physicians were blinded to group assignment; Hulzebos et al. (2006a) described an external investigator was blinded to the allocation sequence; while Hulzebos et al. (2006b) stated measurements were taken by an experienced examiner who were blinded for group allocation. All of the three studies were single blinded.

The risk for attrition bias for all studies except Carvalho et al. (2011) was low. As the study reported all predetermined outcomes for all included patients. Arthur et al. (2000) and Hulzebos et al. (2006b) minimized the risk by excluding those cancelled the surgery before intervention and died before the surgery respectively.
2.3 Summary and Synthesis

After confirming the high validity and quality of the research methodologies used, different conclusions and results from different studies need to be summarized and synthesized to develop a guideline with the best available evidence.

Reduced risk of postoperative pulmonary complications

Five researches recruited 448 patients reported a significant reduction on the risk of postoperative atelectasis and pneumonia in the group that received preoperative physical exercise targeting inspiratory muscle training (Weiner, Zeidan, Zamir, Pelled, Waizman & Beckerman, 1998; Hulzebos et al., 2006a; Hulzebos et al., 2006b & Carvalho et al., 2011). Studies carried out by Hulzebos et al. (2006b) found that there is a 36% increase in inspiratory muscle strength, including strength and endurance.

The relative risk of developing post-operative pneumonia is 0.45 with 95% confidence interval 0.24 to 0.83 and a p-value of 0.01. However, a study with 45 cardiac surgery patients did not have a reduced risk on postoperative pneumothorax.

The relative risk is 0.12 with 95% confidence interval 0.01 to 2.11 and a p-value of 0.15 (Snowdon et al., 2014). And the post-operative respiratory cause of death did not differ between groups with the relative risk of 0.14, 95% confidence interval 0.01 to 2.70 with a p-value of 0.19.
Improved ventilation function

The results gathered by Ferreira et al. (2008) showed significant improvement in ventilation function as judged by increased forced vital capacity and maximum voluntary ventilation. One study by Carvalho et al. (2011) reported better performance (with effect size of +101.3m, 95% confidence interval 38.82m to 163.78m with a p-value less than 0.001) on the six-minute walk test postoperatively for patients received preoperative physical exercise.

Reduced length of stay

Studies results further proved that inspiratory muscle training also promoted postoperative recovery as shown by the shorter duration of postoperative hospitalization in intervention group compared to the control group (Arthur et al., 2000; Hulzebos et al., 2006a; Hulzebos et al., 2006b & Rosenfeldt et al., 2011). All in all, the total length of hospital stay for patients receiving preoperative physical exercise was reduced by 3.21 days with 95% confidence interval -5.73 to -0.69 and a p-value of 0.01.
Improved quality of life and sustain postoperative physical exercise

Research results showed that patients could sustain the willingness to participate in postoperative exercise with 70% of the patients who began preoperative training elected to continue the postoperative cardiac rehabilitation program while only 57% of the control group patients, who had not been exposed to preoperative physical exercise, joined the program; while the dropout rate for the intervention group was lowered compared to the control group with 12.2% and 18.7% respectively (Arthur et al., 2000). Part of the reason is due to the fact that the physical health-related quality of life scores (effect size of +8.47 with a p-value of p<0.001) was significantly higher in the intervention group, which suggested the positive functional outcomes encouraged and sustained adult cardiac surgery patients to continue with postoperative rehabilitation exercise training (Arthur et al., 2000 and Rosenfeldt et al., 2011);

The health-related quality of life measurement based on the validated Short Form-36 showed a significantly better score for patients in treatment group (Rosenfeldt et al., 2011) and the positive benefits the study by Arthur et al. (2000) included a one day reduction for the length of postoperative hospital stay and an enhancement in physical quality of life 6 to 8 weeks after surgery compared to the control group, with such
advantages still exist 6 months postoperatively; while Ferreira and his colleagues (2008) concluded that the effects of preoperative exercise training could last for several weeks post-training, which could support adherence to the program.

Effective inspiratory muscle training

In addition, based on the above analysis, out of all the preoperative interventions for cardiac surgical patients analyzed, inspiratory muscle training significantly reduced postoperative pulmonary complications (the relative risk of developing pneumonia is 0.45, with 95% confidence interval 0.24 to 0.83 and a p-value of 0.01 and the relative risk of developing atelectasis is 0.52 with 95% confidence interval 0.32 to 0.87 and p-value of 0.01), shortened the time to extubation (Hulzebos et al., 2006a) and hence the length of hospital stay (mean difference is -3.21 with 95% confidence interval -5.73 to -0.69 and p-value of 0.01).

Summary of the effects of intervention

Therefore, all in all, there is sound evidence with high quality concluding that preoperative physical exercise prior to cardiac surgery is effective in reducing the decline in functional disability, the occurrence of postoperative pulmonary complications including atelectasis and pneumonia, and the length of hospital stay
after cardiac surgery; as well as allowing patients to have a better quality of life when compared to the patients in control group having a sedentary lifestyle (Arthur et al., 2000; Hulzebos et al., 2006a; Hulzebos et al., 2006b; Ferreira et al., 2009; Carvalho et al., 2011 & Rosenfeldt et al., 2011).

Controversies

However, not every study conducted yielded favorable prophylactic efficacy for preoperative physical exercise. Pasquina, Tramer & Walder (2003) contrarily concluded preoperative respiratory physical therapy is ineffective to prevent post-surgery pulmonary complications. Such controversies could be due to not-as-sound methodological research method and results of lower level of evidence (Hulzebos et al., 2012). Nonetheless, considering the clinical benefits derived from various quality studies outweighing individual prophylactic inefficacy, preoperative physical exercise should be implemented on adult cardiac surgery patients who have to wait for at least 8 weeks (Ferreira et al., 2008).

Patient safety

Patient safety is always of utmost priority to health care professionals and it must never be comprised (Nursing Council of Hong Kong, 2002). Therefore the safety of
any preoperative physical exercise should be considered and tolerable for cardiac surgery patients. Findings also suggested that the preoperative intervention was safe and viable and without causing any adverse effect as no death was observed over the average of 3 months of waiting time. Arthur et al. (2000) and Ferreira et al. (2008) reported none of the patients in the treatment group had to leave the program due to adverse events while two different researches targeting two different patient groups conducted by Hulzebos in 2006 also had no adverse events. Therefore, it further confirmed that there’s only a minimum risk of enrolling patients awaiting elective cardiac surgery in preoperative physical exercise training and it is vital to act according to the Code of Ethics and Professional Conduct for Nurses in Hong Kong (NCHK, 2015), making sure that the concept of nonmaleficence is in place.

Since the selected researches were conducted worldwide, the similar favorable results generated from the vigorous appraisal were therefore highly generalizable. After evaluating the efficacy and safety of preoperative physical exercise in cardiac surgery patients, some recommendations in terms of assessment, preparation, contents of the preoperative physical exercise program, duration and frequency of preoperative physical exercise and evaluation are generated accordingly, targeting all elective adult cardiac surgery patients.
Not only should our healthcare professionals consider the feasibility of implementing an intervention with high effectiveness, wide-acceptance, well compliance, and lack of side effects; but also measures to shorten the waiting time for cardiac surgery and maintain a low mortality rate for continual quality improvement. Moreover, in reality, with the ever-expanding waiting list and influx of emergency cases, the support from cardiothoracic surgeons, nurses, perfusionists and anaesthetists are paramount and indispensable. Together, the healthcare professionals strive to maximize resource allocation and hence quality and timely service could be provided to patients in need (Cardiac Surgery Report, 2012). So that, in the end, Hong Kong public healthcare service is on a par with international standards.

In addition, actively engaging in practice according to evidence-based not only can improve patients’ outcomes, but also uphold the professional nursing standard and nurture the continual nursing development.

In view of this, the feasibility of such statistically significant evidence-based practice recommended has to be considered before implementation, which will be discussed in the following chapters.
Chapter 3: Implementation Potential Assessment of the proposed innovation

After vigorous comparison of various evidence-based researches, it is found that implementing physical exercise training before heart surgery minimizes physical and psychological deterioration during the wait for surgery and an effective preoperative preparation is necessary and crucial in relieving symptoms, enhancing body resistance, reducing postoperative pulmonary complications, speeding up recovery, reducing length of stay and hospital expenses (Arthur et al., 2000; Hulzebos et al., 2006a; Hulzebos et al., 2006b; Ferreira et al., 2008; Carvalho et al., 2011 & Rosenfeldt et al., 2011). Therefore, preoperative physical exercise should be translated into clinical settings and be promoted to adult patients once they got scheduled for cardiac surgery.

Therefore, developing clinical guideline based on the strong statistical evidence from above chapters is paramount. The guideline also helps facilitate the decisions making of healthcare professionals. So that in the end, the decision on healthcare resource allocation would be able to fairly cater for the greatest portion of our patients on the waiting list with the already stretched-thin finances (Snowdon et al., 2014).

In this chapter, the translational applicability of the proposed recommendations into
Hong Kong clinical settings will be discussed. Using the checklist developed by Polit and Beck (2004) can help evaluate the implementation potential under scrutiny in terms of transferability of the evidence, feasibility of the intervention and its cost-benefit ratio.

### 3.1 Target group and setting

#### Clinical setting

The preoperative physical exercise is proposed to be implemented in the cardiothoracic surgical unit in a public acute teaching hospital in Hong Kong. Each year, hundreds of cardiac patients are scheduled for cardiac surgery after the consultations from the cardiothoracic surgical specialist outpatient department (The University of Hong Kong, 2011) and currently there are around 100 cardiac patients on the waiting list (Queen Mary Hospital, 2013).

Since the innovation will be implemented in the cardiothoracic surgical department, it is homogenous in terms of the clinical settings and the patients’ characteristics between the target patients and the selected studies. Besides, there were no statistical significant differences in perioperative baseline characteristics concluded from all the
selected studies in terms of patient demographics (Arthur et al., 2000; Hulzebos et al., 2006a; Hulzebos et al., 2006b; Ferreira et al., 2008; Carvalho et al., 2011 & Rosenfeldt et al., 2011).

Clinical issue

With the need for cardiac surgery on the rise and the problem of ever-expanding waiting list for the public health care services not being able to be settled in a short time. And it is found that there is a lack of patient support between the period of after diagnosing and before receiving suitable treatment (Care For Your Heart, 2013). As well as considering the potential benefits of preoperative physical exercise, a universally easily accessible and affordable innovation, to slow down the adverse physical and psychological deterioration and improve elective adult cardiac surgery patients’ outcomes utilizing the waiting period, is therefore necessary (Lau, et al., 2012).

3.2 Transferability

Philosophy of care

Care is not only limited to diagnosis and successful treatment of patients’ medical
problems, but should also provide total patient care, from disease prevention, health assessment, lifestyle management to rehabilitation (American Nurses Association, 2010).

The Hospital Authority (2009) promoted its mission of “helping people stay healthy” and aimed to ensure quality and safe service (HA, 2015). These can be done by continual development and utilization of evidence based guidelines, which are also highly emphasized in the Hospital Accreditation Program (2010).

Such philosophy matched the aims of the proposed innovation – better in, better out, that is to say, preoperative intervention is effective in reducing postoperative complications. Therefore, the guideline generated in the next chapter should be transferred into clinical settings and recommended to frontline healthcare professionals after considering the safety concerns and balancing the costs and benefits issues.

Selection of patients

All elective adult cardiac surgery patients, mainly undergoing coronary artery bypass grafting (CABG) and heart valve surgery, were targeted to be included in the
intervention, regardless of their risk of developing postoperative pulmonary complications. It is because findings suggested that the preoperative intervention was safe and without causing any adverse effect as no death was observed over the average of 3 months of waiting time. Arthur et al. (2000) and Ferreira et al. (2008) reported none of the patients in the treatment group had to leave the program due to adverse events while two different researches targeting two different patient groups conducted by Hulzebos (2006) also had no adverse events.

Benefiting sufficient patients

According to the clinical data from the Hong Kong Census and Statistics Department (2013) and the Department of Health (2012), there were 155,299 in-patient discharges and deaths in all hospitals related to the diseases of the circulatory system in 2012, accounting for 7.9% of all diseases. While there were 29,866 patients suffering from coronary heart diseases, accounting for 1.5% of all in-patient discharges and deaths in 2013. All these numbers showed an increasing trend over the past few years, which reflected there were more and more patients undergone heart surgeries and also forecasted there would be an increasing trend for the need of heart surgeries in the future.
Such data coincides with the statistical findings gathered by HKU (2011) and CUHK (2012), stating there are 400 cardiac patients scheduled and waiting for cardiac surgery after the consultations from the cardiothoracic surgical specialist outpatient department per year. This shows a promising future for the effective preoperative intervention benefiting an expanding group of patients.

**Time for implementation and evaluation**

The period for the proposed intervention implementation and evaluation will last for one year, having two months allocated to preparation of proposal planning and getting administrative support, seven months for pilot test including promoting the intervention to frontline healthcare professionals, providing training to nurses in cardiothoracic surgical department, and hosting preadmission preoperative physical exercise training program to the targeted patients; and the remaining three months for evaluation. Such timeframe is realistic and reasonably achievable in terms of preparation, training, data collection and implementation and evaluation of the proposed protocol.

A detailed timeline for intervention preparation, implementation and evaluation is attached in Appendix 5.
In short, due to the fact that there are great extent of homogeneity for settings, target population and philosophy of care between the selected studies and the targeted cardiothoracic surgical department; plus a large number of patients benefiting from the intervention and the manageable implementation and evaluation time frame, the proposed innovation will therefore be well transferable to the targeted CTSD settings.

### 3.3 Feasibility

**Staff availability**

There are three main duty allocations for nurses in the cardiothoracic surgical department, namely hosting preadmission preoperative physical exercise training program to the targeted cardiac surgical patients; monitoring their use of the incentive spirometers; and following up their progress until the scheduled surgery via telephone calls. The existing staff from all levels will be trained to provide related patient education and incentive spirometer demonstration; hence it is not necessary to employ new staff. The staff training session will be hosted three times covering all the staff over three spans of duty and therefore does no interrupt regular duty.
Equipment availability

Preoperative physical exercise includes daily walking, deep breathing and coughing exercise and inspiratory muscle training facilitated by a simple mechanical device.

Triflow II Incentive Spirometers (Physioworks, 2015) are currently used on postoperative patients in the cardiothoracic surgical intensive care unit (ICU) and general ward in order to train their inspiratory muscles back to preoperative functionality. Incentive spirometry exercise is proved to be effective in reducing postoperative pulmonary complications when patients starting using in preoperative period (Arthur et al., 2000; Hulzebos et al., 2006a; Hulzebos et al., 2006b; Ferreira et al., 2009; Carvalho et al., 2011 & Rosenfeldt et al., 2011). Such device is a self-financed item which costs $26; each cardiac surgical patient is required to buy from Patient Co-op Store.

For the purposes of staff training, demonstration to patients and return demonstration, as well as the infection control issues, the cardiothoracic surgical department should buy 30 Triflow II Incentive Spirometers. Each reusable device should strictly follow the manufacturer recommendations on disinfection after each training session.
Organization culture

Nurses in the cardiothoracic surgical department enjoy high autonomy and freedom to try implementing innovative practices with support and cooperation from each party. Such culture could be seen by the success of implementing different guidelines in the past few years like protocols for Intra-aortic balloon pump (IABP) troubleshooting, clinical pathway for patients undergoing CABG, to name a few. However, like any other previous interventions, the anticipated proportion of staff disapproving this innovation would be 20%.

Autonomy of nurses is highly promoted according to the Hospital Accreditation Program (2010). Nurses should make use of their professional knowledge to take the initiation to assess whether the patients are physically fit enough to continue the exercise training. The program should be discontinued when the patients complained about dyspnea, chest pain, dizziness, nausea or vomiting, tiredness or any discomfort severe enough to prevent continuous exercise.

Administrative support

Due to the fact that the innovation has the potential to benefit cardiac surgical patients to a large extent while utilizing relatively small portion of the departmental resources;
administrative support from the Chief of Service (COS) and Department Operations Manager (DOM) of the cardiothoracic surgical department would be seek.

Multidisciplinary consensus would be gathered before innovation implementation to ensure surgeons, nurses, physiotherapists and patients are all willing to try and accept new effective practices.

**Potential obstacles**

In view of the aging population with rising expectation and demand in healthcare services, there would be an influx of patients requiring cardiac surgeries (Hospital Authority, 2012). External multidisciplinary cooperation and assistance from surgeons and physiotherapists is therefore needed to strive for maximization of operation efficiency and effectiveness, as well as releasing the pressure of tight nursing manpower (District Council, 2012).

**Clinical evaluation**

Evaluation of the process and outcome is part of the preoperative physical exercise program. During the preadmission preoperative physical exercise training program, patients would be encouraged to independently perform regular incentive spirometry training after receiving proper instruction and return demonstration from nurses.
Direct monitoring and supervision of every patient is not needed once the patients show mastery of the technique (Restrepo, Wettstein, Wittnebel & Tracy, 2011).

However, intermittent monthly reassessment following the questions in Appendix 7 via telephone calls is crucial to ensure ideal performance (Lau et al., 2012).

3.4 Cost-benefit ratio of the innovation

For the purpose of validating the innovative preoperative physical exercise training program, the estimated costs and expected benefits of the program should be compared and analyzed. Cost-benefit ratio is an effective indicator that reflects the value and worthiness of the program.

Benefits of the implementation

For patients, preoperative physical exercise training minimizes physical and psychological deterioration during the wait for surgery and it is effective in reducing postoperative pulmonary complications, speeding up recovery, reducing length of stay and hospital expenses (Arthur et al., 2000; Hulzebos et al., 2006a; Hulzebos et al., 2006b; Ferreira et al., 2008; Carvalho et al., 2011 & Rosenfeldt et al., 2011) when compared to the usual practice of simply distributing pamphlets to patients on admission.
As for nurses, actively engaging in practice according to evidence-based not only can improve patients’ outcomes, but also uphold the professional nursing standard and nurture the continual nursing development; which in turn improve staff recruitment as the department supports on-the-job training.

For health system as a whole, the healthcare professionals from all hospital levels strive to maximize resource allocation and hence quality and timely service could be provided to patients in need (Cardiac Surgery Report, 2012). So that, in the end, Hong Kong public healthcare service is on a par with international standards (Kong, Yang, Gao, Guan, Liu, Wang & Ma, 2015).

Risks and potential harms

Carrying out every intervention has its potential risks and harms, for both patients and nurses. This intervention would be ineffective unless performed as instructed. Improper training not adhering to the recommended guideline could result in fatigue and interrupt the remaining preoperative physical exercise program; it could also increase the workload of the heart, lead to hypoxemia and aggregate the severity of the existing heart functionality. Moreover, intensive training could lead to hyperventilation and possibly causing respiratory alkalosis in severe cases (Restrepo
et al, 2011).

Considering the fact that not all staff welcome the change, some staff may have a low morale or even absent from their duty, which could interrupt the normal functioning of the department.

As shown above, the benefits outweigh the potential harms involved, and maintaining current practice on admission could not meet patients’ needs and delay recovery as evident by the studies (Arthur et al., 2000; Hulzebos et al., 2006a; Hulzebos et al., 2006b; Ferreira et al., 2008; Carvalho et al., 2011 & Rosenfeldt et al., 2011), preoperative physical exercise is definitely a beneficial intervention worthy to be implemented.

Costs of the implementation

Costs of the implementation could be broken down into material and non-material costs. For the material cost, it can be further divided into set-up and operational cost. Set up cost includes buying equipment like Triflow II incentive spirometers in bulk. While operational cost includes those ongoing expenditure like expenses incurred on the time used for staff training, patient demonstration and telephone follow up.
As for the non-material cost, transition period should be allowed for frontline nurses to get familiar with the intervention, so that they are able to identify patients’ need for intervention, response to therapy and the need to terminate ineffective intervention. Otherwise, haste implementation could lead to burdened staff, low morality, high absence and turnover rate, as well as do harm to the patients.

Detailed breakdown for the benefits and the costs of implementation are listed in Appendix 6 to calculate the ratio.

In conclusion, based on the high transferability of the evidence, feasibility of the intervention and cost effectiveness, the implementation of the proposed innovation is therefore strongly recommended.
Chapter 4: Evidence-based practice guideline development (Recommendations)

Title: Preoperative physical exercise for elective adult cardiac surgery patients

4.1 Aims and purposes

The objectives of this guideline are to:

- Summarize the clinical evidence for giving instructions on preoperative physical exercise to adult cardiac surgery patients

- Formulate clinical practice recommendations for preoperative physical exercise based on the best evidence available

- Standardize the instructions on preoperative physical exercise given to elective adult cardiac surgery patients

4.2 Target patients

This guideline is intended to support nurses in cardiothoracic surgery unit of all levels to promote and give instructions on preoperative physical exercise. The patient population covered are all adult cardiac surgery patients, targeting elective coronary artery bypass grafting (CABG) and heart valve surgery once they got scheduled after medical consultation and have to wait for at least 8 weeks, regardless of their risk of development postoperative pulmonary complications.
Criteria of rating the recommendations

The grades of the recommendations and the levels of evidence of the selected research articles were rated against the checklist designed by Scottish Intercollegiate Guidelines Network (SIGN, 2013), as seen in Appendix 8.

4.3 The proposed guidelines

A. Assessment

Recommendation 1.0

All elective adult cardiac surgery patients are eligible (Grade of recommendation: A)

A) The length of the waiting period depends on the severity and condition of the heart disease of individual patient. However, the result of no-adverse-effects-observed indicated that all patients, no matter with high risk or low risk of developing postoperative pulmonary complications, could be safely enrolled into the program (Arthur et al., 2000; level of evidence: 1+; Hulzebos et al., 2006a; level of evidence: 1+ and Ferreira et al., 2008; level of evidence: 1-).
Recommendation 2.0

Intervention starts when patients are being scheduled and have to wait for at least 8 weeks before cardiac surgery (Grade of recommendation: A)

Once the patients got scheduled for cardiac surgery, the prophylactic preoperative physical exercise program should be started as it needs time to yield the maximum postoperative effects (Arthur et al, 2000; level of evidence: 1+; Hulzebos et al 2006a; level of evidence: 1+; Hulzebos et al 2006b; level of evidence: 1+; Ferreira et al, 2009; level of evidence: 1-; Carvalho et al, 2011; level of evidence: 1- & Rosenfeldt et al, 2011; level of evidence: 1+).

Furthermore, patient education is proved to be best taught and could take in the most information taught preoperatively as it would be difficult to emphasize the importance of the intervention to a patient who may suffer from postoperative pain and sedated from analgesia (Hulzebos et al., 2012; level of evidence: 1++).
B. Preparation

Recommendation 3.0

**Informed consent from patients** (Grade of recommendation: B)

Despite the preoperative physical exercise being a relatively safe intervention, an informed consent has to be obtained beforehand, explaining all the risks and targeted benefits involved (Mulsow, Feeley & Tierney, 2012; level of evidence: 1+).

C. Contents of preoperative physical exercise program

Preoperative physical exercise program should include aerobic exercises like daily walking, deep breathing and coughing exercise and inspiratory muscle training as a core component. Patient education regarding stopping smoking and instructions on different maneuvers for promoting lung expansion is vital. Besides, monthly follow up phone calls is included to ask for progress and encourage to continue with postoperative cardiac rehabilitation program.
Recommendation 4.0

Inspiratory muscle training as a core component of the preoperative physical exercise program (Grade of recommendation: A)

According to a recent systematic review, out of all the preoperative interventions for cardiac surgical patients analyzed, inspiratory muscle training showed the most significant reduction on postoperative pulmonary complications (Snowdon et al, 2014; level of evidence: 1++; Mans, Reeve & Elkins, 2014; level of evidence: 1++).

A simple mechanical device named Triflow helps developing, improving and maintaining respiratory functions by facilitating inspiratory muscle training, sustaining deep breaths and hence lung expansion.

Active deep breathing, coughing and forced expiration techniques should also be promoted based on the improved patients’ outcomes found (Arthur et al, 2000; level of evidence: 1+; Rosenfeldt et al, 2011; level of evidence: 1+).
Recommendation 5.0

A 60-minute session, 7 times a week for at least 8 preoperative weeks (Grade of recommendation: B)

Concluding from the treatment designs researches utilized in the six RCTs, as seen in Appendix IV, the most suitable training interval should be carried out seven times weekly for at least 8 weeks. (Arthur et al, 2000; level of evidence: 1+; Hulzebos et al 2006a; level of evidence: 1+; Hulzebos et al 2006b; level of evidence: 1+; Ferreira et al, 2009; level of evidence: 1-; Carvalho et al, 2011; level of evidence: 1-; Rosenfeldt et al, 2011; level of evidence: 1+ & Mans et al, 2014; level of evidence: 1++).

Each 60-minute session includes 20 minutes inspiratory muscle training as the core component, along with 10 minutes for deep breathing and coughing exercise and other aerobic exercises for the remaining time. Within the 20-minute period, at least 10 times each set per 5 minutes for Triflow training(Arthur et al, 2000; level of evidence: 1+; Rosenfeldt et al, 2011; level of evidence: 1+).

To promote the above recommendations, an instruction guideline on how to use the Inspiratory spirometer (Triflow) and its evaluation is developed and attached in Appendix 7.
Recommendation 6.0

**Monthly follow up phone calls from nurses** (Grade of recommendation: B)

Maintaining a close contact with patients during the waiting period had proved to be an effective way in improving the psychological well-being of patients (Arthur et al, 2000; level of evidence: 1+), sustaining their willingness of participation in postoperative rehabilitation program, as well as their caregivers’ engagement (Lau et al, 2012; level of evidence: 3).

Patients will receive a monthly follow up telephone call allowing them to raise difficulties encountered and express their fears and expectations; so that nurses can identify the problems and needs of the patients, provide reassurance and clarify any misconceptions (Lamarche, Taddeo & Pepler, 1998; level of evidence: 2++).

Sample of the questions asked during the phone call is attached in Appendix 7.
A highly transferable, feasible and cost effective evidence-based guideline with the above recommendations was developed from the quality research results synthesized from the six randomized controlled studies reviewed. Developing clinical guideline based on statistical evidence after doing a systematic review, which explores the effectiveness and appropriateness for and against the proposed interventions, is paramount. By following the clinical pathway developed as illustrated in the Appendices, it helps to facilitate the decisions making of healthcare professionals and extend the scope of care from only covering the postoperative recovery stage to preoperative preparation phrase. So that in the end, the decision on healthcare resource allocation would be able to fairly cater for the greatest portion of our population with the already stretched finances.
Chapter 5: Implementation Plan

As illustrated from the previous chapter, such beneficial findings should be promoted and implemented into clinical setting by frontline healthcare professionals, organization and health care system, otherwise the analysis would be in vain (Grove, Burns & Gray, 2012).

It is vital to gain approval and support from the managerial level. A collaborated implementation plan based on the communication plan with potential users and a proposal discussing the need of change based on the quality findings of literature review, effectiveness of the recommended evidence-based guideline, the feasibility and potential obstacles of the proposed intervention when undergo pilot testing of the guidelines in the cardiothoracic surgical department for elective cardiac surgery patients, is therefore needed for review in advance and to convince colleagues to practice such beneficial innovation.
5.1 Communication Plan

1. Identifying stakeholders

First of all, stakeholders, are most affected by the proposed changes and anticipated results brought by the recommended innovation (Maltby, Williams, McGarry & Day, 2010). They should be talked to and persuaded first in order to guarantee an effective communication process. The potential stakeholders for the preoperative physical exercise guidelines include the administrators who will approve and fund the proposed program; nurses from all levels of the cardiothoracic surgical department who will implement the proposed program; and surgeons and physiotherapists who will give advices to the proposed program; patients scheduled for elective cardiac surgery who may be benefited from the proposed program and their relatives.

The Organizing Committee

An organizing committee, comprises of the proposer and advanced practice nurses in-charge, should be formed to persuade stakeholders, monitoring the progress and facilitate the implementation process. Starting off the communication plan with administrators in the managerial level, using the top-down approach, is proved to be more effective (Cummings & Worley, 2014).
Communication plan with administrators

Department Operations Manager (DOM), Chief of Service (COS) and Ward Managers (WM) of the cardiothoracic surgical department (CTSD), as the major decision makers, should be consulted first as the proposed innovation could not be implemented without their prior approval. Their endorsement ensembles full support and hence a higher chance to obtain necessary resources for the intervention.

Communication plan with frontline nursing staff

With the support from higher tier, it sends out the message that the proposed innovation is an initiative to better patient care; and hence it will be easier to disseminate the message to the frontline nurses, including advanced practice nurses (APN) and registered nurses (RN) (Cummins & Worley, 2014). The benefits of making good use of the time waiting for heart surgery should be raised to arouse their attention regarding the significance of preoperative physical exercise training.

However, it is also essential to take those not favoring the intervention into consideration. Their concerns regarding the problems of burnout and additional workload need to be addressed and reassured first, so that they are more willing to accept the proposed guidelines and open to changes after understanding the positive
outcomes of the intervention (Straus, Tetroe & Graham, 2013).

**Communication plan with surgeons and physiotherapists**

As the innovation does not change the usual treatment procedures of both parties, the organizing committee only has to inform them about the innovation implementation and ask for feedbacks after a 30-minute briefing session introducing the proposal.

**Communication plan with eligible patients**

Patients who fulfill the inclusion criteria (as stated in chapter 4) will be recruited for the pilot test in month 8-14. Nurses will obtain their demographic data. The nurse will explain the purpose and contents of the intervention. An informed consent will be signed after they agree to participate (Treweek, Oxman, Alderson, Bossuyt, Brandt, Brożek & Alonso-Coello, 2013).
2. Communication strategies

a. Initiating the change

An effective communication plan (Appendix 13) starts with identifying current clinical problem and search for the best available evidence for reducing postoperative pulmonary complications and improving cardiac surgical patients’ recovery progress before discussing the proposal with administrators of the Cardiothoracic surgical department. Approval and support will be sought from one after another up the managerial level. From the ward managers, department operations manager to chief of service who has the authority in making decisions, approving and endorsing the proposed change. The proposer must have a clear vision on the need of change (Straus, Tetroe & Graham, 2013).

Various dissemination strategies utilizing different communication channels will be adopted to ensure maximum coverage of the stakeholders. The committee will put up posters in the changing room, distribute pamphlets in the tearoom, send out messages through intranet emails, advertise on monthly newsletters and do presentations in monthly departmental meetings. So that stakeholders from all levels will be well-informed of the proposed changes (Parsons, 2013).
b. Guiding the change

A timeline on implementation and evaluation (Appendix 5) is used to guide the nurses about the change and to let the administrators know the time needed for the benefits of the proposed intervention to emerge. All levels of nurses will be fully trained in accordance with the new evidence-based guidelines before full scale implementation. They can act as role models to one another and motivate each other to be more competent by taking turns to host the educational talks (Bradshaw & Lowenstein, 2013). Additional materials including the quick-reference guideline on Triflow usage (Appendix 9) and up-to-date manuals for lung expansion and physical exercise strategies (Appendix 10) are provided.

c. Sustaining the change

The organizing committee is responsible to facilitate the entire process. The compliance level of patients and nurses will be assessed from time to time; skills and knowledge on Triflow usage will be audited; and patients’ outcomes will be monitored. Feedbacks and recommendations from both parties are crucial to refine the guidelines. Moreover, successful stories from literature and previous experience should be circulated among the staff so as to encourage participating and sustaining the proposed change (Straus et al., 2013).
5.2 Pilot testing plan

After communicating with the stakeholders, a small scale pilot test would be conducted to evaluate the feasibility, strength and weakness of the proposed change. Through such process, potential barriers and unexpected difficulties could be avoided and hence appropriate revision could be made before the actual large scale implementation take place (Streubert-Speziale & Carpenter, 2003).

1. Aims of the pilot test

- To try out the proposed guideline in clinical settings; and test its transferability and the feasibility;

- To test the study measures including the participants’ recruitment strategies and the process of the innovation implementation;

- To test if the outcomes can be feasibly measured and examine the acceptability of the staff towards the change in practice;

- To collect feedback from frontline nurses and patients;

- To identify unexpected difficulties and potential logistic problems occurred during the implementation so as to modify and refine the guideline.
2. **Participants and target sample size**

The inclusion and exclusion criteria of the patients of the pilot test are identical with the actual recruitment of the proposed innovation (Straus et al., 2013). Non-probability convenience sampling is adopted to obtain a sample size of 40. The proposed preadmission preoperative physical exercise training program would be offered to those who have scheduled for elective adult cardiac surgery and exclude those who had undergone cardiac surgery before.

3. **Settings and duration of the pilot test**

The pilot study, including recruitment, implementation, outcome analysis and evaluation of results, will last for seven months (month 8-14) and take place in the seminar room of the cardiothoracic surgical general ward, the same place as the full-scale implementation. A timeline is attached in Appendix 5.
4. Content

The pilot study will be guided by the organizing committee while the intervention will be carried out by nurses who have received the one-hour training. They are trained to provide related patient education and incentive spirometer demonstrations following the guideline (Appendix 9). The staff training session will be hosted one month before pilot test at month 7.

Eligible patients are recruited after scheduling for surgery on medical consultation. Informed consent will be sought from participants stating all the risks and benefits involved and the right to withdrawal.

Participants will attend the preoperative physical exercise training program during their waiting period for cardiac surgery (Oates & Paasche-Orlow, 2009). The program includes aerobic exercises like daily walking, deep breathing and coughing exercise. Education regarding stopping smoking and instructions on different maneuvers for promoting lung expansion including the use of Triflow for inspiratory muscle training will be performed by nurses at the one-hour talk. Monthly follow up phone calls will also be provided (Arthur et al., 2000).
The evaluation form on triflow use (Appendix 9) will be used to measure the effectiveness of inspiratory muscle training at different preoperative and postoperative stages including a return demonstration on the day of the talk, verbalize the usage via telephone follow ups; and during postoperative recovery period and rehabilitation.

A questionnaire (Appendix 14) will be distributed to evaluate patients’ outcomes at the end of the whole program. The questions in Appendix 15 will guide frontline nurses to give feedback on their own performance during the focus group interview at month 12-14. Analyzing all the data generated from stakeholders, the feasibility of the proposed evidence-based guidelines will be shown (Straus et al., 2013).

The organizing committee is also responsible for logistics arrangement like keeping track of the stocking materials from time to time (e.g. Triflow), so as to ensure consistent material supply for training purposes over the pilot test and full scale implementation period (Treweek et al., 2013).
5. Outcome measures and statistical method

Assessing compliance and acceptability of the guidelines

Patient’s adherence to the preoperative physical exercise training program will be assessed through the questionnaire as attached in Appendix 14. While all frontline nurses undergone training will be invited to attend the focus group interview in order to collect data on their compliance, acceptability and performance satisfaction level in terms of skills, knowledge and confidence in delivering patient education (Appendix 15).

Assessing feasibility of the guidelines

The feasibility of the guidelines can be assessed based on the resources availability and whether the actual expenses lie within the estimated cost through cost-benefit ratio analysis (Appendix 6).
6. **Feedbacks from frontline nursing staff and patients**

Based on the feedbacks collected from nurses and patients through focus group interviews and questionnaires, the process efficacy of the preoperative physical exercise training program can be evaluated.

7. **Refinement of the guidelines**

After evaluating the process efficacy through measuring the outcomes (i.e. compliance, acceptability and feasibility) and collecting feedbacks from stakeholders in the pilot test, the organizing committee will examine and refine the guidelines from month 12 to 14. Such review can eliminate potential barriers, enhance the smoothness of implementation and thus lower the cost of the program before conducting in full scale (Straus et al., 2013).
Chapter 6: Evaluation Plan

Evaluation of the process and the outcomes are crucial for stakeholders to appreciate the effectiveness of the program in achieving its objectives in clinical settings (Treweek et al., 2013). It allows the administrators to determine whether budget and resources should be allocated to sustain the program or not; and to provide direction for future guidelines refinement and future research (Straus et al., 2013).

6.1 Identifying outcomes

Patient outcomes

Postoperative pulmonary complications

Patient outcomes can be divided into primary and secondary. The primary outcome is the rate of postoperative pulmonary complications including atelectasis and pneumonia. As shown from the results of literature, there is a reduced risk of postoperative pulmonary complications (according to Kroenke’s criteria) after receiving preoperative physical exercise when compared to usual practice (Hulzebos, et al., 2006a). Therefore, by comparing the results from both groups, the effectiveness of the program can be measured.
Effective inspiratory muscle training

As for the secondary outcomes, the effectiveness of the inspiratory muscle training and correct usage of Triflow can indicate whether the ventilation function has improved or not. Research results (Arthur et al., 2000; Hulzebos et al., 2006a; Hulzebos et al., 2006b; Ferreira et al., 2008; Carvalho et al., 2011 & Rosenfeldt et al., 2011) showed a positive outcome through lung function test and concluded that increasing physical fitness can improve the respiratory functional capacity of the patients and results in them being better prepared to stand against the physical stress brought about by cardiac surgery (Carli & Zavorsky, 2005). Therefore, similar findings are expected for the proposed implementation.

Compliance and satisfaction

Patient’s satisfaction and compliance with the program can indicate whether their quality of life has improved and whether they are willing to sustain the postoperative physical exercise.
Health care professional outcomes

Staff compliance

All levels of nurses in cardiothoracic surgical department, need to take turns to conduct the preadmission preoperation physical exercise training program and monthly follow up telephone calls to the targeted patients, are expected to follow the protocol. Their compliance with the guidelines is an indicator on whether they believe the intervention is effective or not.

Skills, knowledge and confidence

Through the staff training, nurses will be empowered to deliver effective preoperative teaching and monitor correct usage of Triflow (Laschinger, Nosko, Wilk & Finegan, 2014). Their level of skills, knowledge and confidence reflects whether they are competent enough in communicating the content of the intervention, which is one of the contributing factors to the success of the intervention (Arnold & Boggs, 2015).
System outcomes

Length of hospital stay

Studies results further proved that inspiratory muscle training promoted postoperative recovery as shown by the shorter duration of postoperative hospitalization in intervention group compared to the control group (Arthur et al., 2000; Hulzebos et al., 2006a; Hulzebos et al., 2006b and Rosenfeldt et al., 2011). Total length of hospital stay for patients receiving preoperative physical exercise was reduced by 3.21 days with 95% confidence interval -5.73 to -0.69 and a p-value of 0.01, showing the length of hospital stay can reflect the effectiveness of the program.

Utilization of and access to the innovation

The innovation is intended for all adult cardiac surgical patients. The cardiothoracic surgical nurses will approach the patients once they got scheduled for the surgery. Therefore the accessibility and utilization of the program can be guaranteed. Patients will continue the program when they think the exercise helps them, which make the program sustainable.
6.2 Deciding when and how often to take measurements

The time to measure outcomes depends on when the innovation will take effect.

Patient outcomes

Postoperative pulmonary complications

The number of patients who developed postoperative pulmonary complications including atelectasis and pneumonia is measured and compared between the intervention group and control group on the day of discharge.

Effective inspiratory muscle training

The evaluation form on Triflow use (Appendix 9) is distributed to patients at different preoperative and postoperative stages including a return demonstration on the day of the talk, verbalize the usage via telephone follow-ups; and during postoperative recovery period and rehabilitation.

Compliance and satisfaction

Questionnaire on monthly follow up telephone calls (Appendix 7) and the Short Form 36-item Health Survey Questionnaire (Appendix 11) are distributed to patients on the day of the talk and at the end of the whole program.
**Health care professional outcomes**

Staff compliance, their level of skills, knowledge and confidence are measured during the focus group intervention after the staff training session and at the end of the whole program.

**System outcomes**

**Length of hospital stay**

It is measured from the date of surgery scheduling to the date of discharge. Results are compared between both groups.
6.3 Determining the nature and number of participants to be involved

Eligibility criteria

All elective adult cardiac surgical patients would be recruited once they got scheduled after medical consultation and have to wait for at least 8 weeks, regardless of their risk of developing postoperative pulmonary complications.

Number of participants

In order to recruit a large enough sample to see genuine effect, the sample size is calculated based on the study design and the effect sizes of primary outcome. Al-Qubati, Damag & Noman (2013) found that about 15.08% patients suffered from postoperative pulmonary complications including atelectasis and pneumonia after open heart surgeries. According to the table of evidence extracted from the reviewed studies, the effect sizes of the prophylactic preoperative physical exercise for elective adult cardiac surgical patients on reducing postoperative pulmonary complications were between -13 to -2 (Hulzebos et al., 2006a; Hulzebos et al., 2006b & Carvalho et al., 2011). Applying this statistics, the median effect size on reducing postoperative pulmonary complications was taken to be -4.

Making use of the sample size calculator developed by Lenth (2012), the test for one
proportion was chosen. With the level of significance of 0.05, power of 80%, null value (P0) at 0.15 and actual value (P) at 0.1. The recommended sample size needed was then calculated as 139. Assure a drop-out rate of 10%, 155 patients should be recruited using the convenience sampling.
6.4 Data analysis

Patient outcomes

Postoperative pulmonary complications can be analyzed by significance testing which compares the difference between the numbers of patients who developed postoperative pulmonary complications in both groups. A two-tailed paired t-test can be performed.

The effectiveness of the inspiratory muscle training and correct usage of Triflow can be evaluated following the checklist in Appendix 9 during the preadmission preoperative physical exercise training program and during post operation assessment at different time points. Lung functions are measured by spirometry (Micro-Loop; PT Medical, Leek, the Netherlands) while the effectiveness of the inspiratory muscle strength is measured with a hand-held pressure gauge (Micro Medical MPM; PT Medical, Leek, the Netherlands). The validity and reliability of the above scales used are stated in the previous chapter. Significant testing and one sample t-test will be used for data analysis.

Data on patients’ compliance and satisfaction level can be collected through the questionnaires on monthly follow up telephone calls (Appendix 7) while the quality of
life can be assessed by Short Form 36-item Health Survey Questionnaire (Appendix 11). The scores will be obtained on the day of the talk and at the end of the whole program. Two-tailed paired t-test would be adopted for data analysis with the level of significance at 0.05.

**Health care professional outcomes**

Their level of skills, knowledge and confidence can be evaluated by a list of self-developed questions asked during the focus group interview as attached in Appendix 15. It assesses the competency, confidence and communication skills of nurses. The interview process will be audio-taped and transcribed for qualitative data analysis. The researchers will use codes to interpret the data and categorize similar words and phrases (Parahoo, 2006).

**System outcomes**

The length of hospital stay is determined by the estimated difference in medians between the admission and discharge dates. Independent t test with significant testing at level of 0.05 is used to compare the length of hospital stay between the intervention and control group.
6.5 Criteria for effectiveness of the guidelines

The main objective of the proposed innovation is to reduce the incidence of postoperative pulmonary complications. The preoperative physical exercise guidelines would be considered as effective when the following criteria are fulfilled.

**Patient outcomes**

For patient primary outcome, if the effect size decreases at least 4 in the risk of developing postoperative pulmonary compilations in target setting after receiving preoperative physical exercise training, it will be considered as an effective innovation. Different literature showed that the effect sizes of the prophylactic preoperative physical exercise on reducing postoperative pulmonary complications decreased between 2 and 13 (Hulzebos et al, 2006a; Hulzebos et al, 2006b & Carvalho et al, 2011).

In addition, when the inspiratory muscle strength shown to have +2.5 effect size after the training exercise and 80% patients complying with the program, the guidelines will be considered as effective in manifesting substantial clinical benefits.
**Health care professional outcomes**

Compliance with the program with at least 80% of the staff support the implementation improves the staff morale. Their level of skills, knowledge and confidence could be evaluated by a list of self-developed questions asked during the focus group interview. If positive feedback after qualitative data analysis is yielded, the innovation will be considered as effective.

**System outcomes**

The guidelines would be considered as effective when the length of hospital stay is reduced by 1 day, and benefiting a large enough proportion of cardiac surgical patients.
Conclusion

To conclude, actively engaging in practice according to evidence-based not only can improve patients’ outcomes, but also uphold the professional nursing standard and nurture the continual nursing development; which in turn improve staff recruitment as the department supports on-the-job training.

For health system as a whole, the healthcare professionals from all hospital levels strive to maximize resource allocation and hence quality and timely service could be provided to patients in need.
References


Bergmann, P., Huber, S., Machler, H., Liebl, E., Hinghofer-Szalkay, H., Rehak, P.


empowerment and perceived support for professional nursing practice on unit effectiveness and individual nurse well-being: A time-lagged study. *International journal of nursing studies, 51*(12), 1615-1623.


Queen Mary Hospital. (2013). Department of Cardiothoracic Surgery Cardiac Surgery Biennial Report 2012-2013. Hong Kong: Hospital Authority.


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**Appendix 1 – Search History Flow Chart**

<table>
<thead>
<tr>
<th>Electronic database</th>
<th>PubMed</th>
<th>Medline via EBSCO Host</th>
<th>CINAHL Plus</th>
<th>ProQuest</th>
<th>British Nursing Index</th>
</tr>
</thead>
<tbody>
<tr>
<td>Initial keyword search</td>
<td>323</td>
<td>670</td>
<td>377</td>
<td>22</td>
<td>12</td>
</tr>
<tr>
<td>After various combinations of keywords search</td>
<td>76</td>
<td>94</td>
<td>88</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>After screening titles and abstracts according to the inclusion and exclusion criteria</td>
<td>43</td>
<td>56</td>
<td>15</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>After reading full text of potential studies</td>
<td>5</td>
<td>6</td>
<td>6</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>After checking reference lists of identified studies for additional relevant articles</td>
<td>6</td>
<td>6</td>
<td>6</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>After eliminating duplicates</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>6</td>
</tr>
</tbody>
</table>
1404 articles identified through initial database searching

1358 excluded

46 full-text articles screened out and assessed for eligibility

6 studies included in critical appraisal after removing duplicates

40 full-text articles excluded:
- Not using physical exercise as preoperative intervention (n=26)
- Not targeting elective cardiac surgery patients (n=5)
- No relevant outcomes (n=4)
- No randomization (n=4)
- No control group (n=1)
## Appendix 2 – Table of evidence

<table>
<thead>
<tr>
<th>Citation</th>
<th>Study type</th>
<th>Participants characteristics</th>
<th>Intervention</th>
<th>Comparison</th>
<th>Follow up</th>
<th>Outcome measure</th>
<th>Effect size*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Arthur et al, 2000</td>
<td>Randomized controlled trial</td>
<td>Patients waiting for at least 10 weeks for elective CABG from a cardiovascular surgery center in Canada. (n=249) - Low risk</td>
<td>Combination of individualized exercise training, education and social support - twice per week, 8 weeks in total Postoperative cardiac rehabilitation</td>
<td>Usual care (followed by primary care physicians, cardiologists, or surgeons)</td>
<td>- 1 week before surgery (baseline) - 6 – 8 weeks after surgery 6 months after surgery</td>
<td>Primary - Postoperative length of hospital stay</td>
<td>Primary: -1 &lt;br&gt; 95% CI -1.0 – 0.98, p=0.001</td>
</tr>
<tr>
<td>Hulzebos et al, 2006a</td>
<td>Randomized controlled trial</td>
<td>Patients waiting for 1 to 10 weeks for elective CABG from a University cardiac center in the Netherlands (n=279) - High risk</td>
<td>Individualized Inspiratory muscle training (IMT), incentive spirometry, education in active cycle expiration techniques - 7 times a week, 20 minutes each, for at least 2 weeks</td>
<td>Usual care received on the day before surgery (instruction on deep breathing maneuvers, coughing and early mobilization)</td>
<td>- Baseline - One day before surgery</td>
<td>Primary - Incidence of postoperative pulmonary complications (PPCs)</td>
<td>Primary: Pneumonia: -13 (p=0.01) &lt;br&gt; Atelectasis: -4 (p=0.02)</td>
</tr>
<tr>
<td>Citation</td>
<td>Study type</td>
<td>Participants characteristics</td>
<td>Intervention</td>
<td>Comparison</td>
<td>Follow up</td>
<td>Outcome measure</td>
<td>Effect size*</td>
</tr>
<tr>
<td>--------------------------</td>
<td>-----------------------</td>
<td>------------------------------</td>
<td>--------------------------------------------------</td>
<td>-------------------------------------------------------------</td>
<td>-----------------------------------------------</td>
<td>----------------------------------------------------------------------------------</td>
<td>-------------------------</td>
</tr>
</tbody>
</table>
| Hulzebos et al, 2006b    | Randomized controlled trial | Patients waiting for elective CABG from a University cardiac center in the Netherlands (n=26)  
- High risk | Inspiratory muscle training  
- 2 – 4 weeks before surgery  
- 7 times a week, 20 minutes each, for at least 2 weeks | Usual care (patient education about early mobilization, coughing with wound support), one day before surgery | - Baseline  
- One day before surgery | Primary  
- Inspiratory muscle strength  
Secondary  
- Postoperative pulmonary complications (e.g. bronchitis, atelectasis, pneumonia)  
- Length of hospital stay | +0.38 (p=0.001)  
Secondary  
Pneumonia: no different  
Atelectasis: -4 (p=0.02) |
| Ferreira et al, 2009     | Randomized controlled trial | Patients waiting for at least 2 weeks for myocardial revascularization or cardiac valve surgery from a University hospital in Sao Paulo, Brazil (n=30) | Inspiratory muscle training  
- 5 series of 10 calm and deep inspirations, thrice daily, for at least 2 weeks | General pre-surgery advice (e.g. not to smoke, deep inspiration exercise, daily walking) | - start of the program  
- day of hospital admission  
- 12, 24, 48, 72 hours post-operatively | Manovacuometry (peak inspiratory, MaxIP and expiratory pressures, MaxEP)  
Pulmonary function tests (spirometry: FEV1/FVC ratio**)  
Arterial gasometry (PO2) | +2.4 (p=0.008)  
Mechanical ventilation less than 48 hours: +1  
(p=1.000)  
All-cause death: +2  
(p=0.598) |
<table>
<thead>
<tr>
<th>Citation</th>
<th>Study type</th>
<th>Participants characteristics</th>
<th>Intervention</th>
<th>Comparison</th>
<th>Follow up</th>
<th>Outcome measure</th>
<th>Effect size*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Carvalho et al, 2011</td>
<td>Randomized controlled trial</td>
<td>Patients waiting for at least 2 weeks for elective CABG from a University hospital in Florianopolis, Brazil (n=32) - high risk</td>
<td>Inspiratory muscle training</td>
<td>Not specify</td>
<td>- Two weeks before surgery</td>
<td>- Functional capacity (FC)</td>
<td>Pneumonia: -2 (p&lt;0.05)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>- One day before surgery</td>
<td>- Respiratory muscle strength (RMS)</td>
<td>Atelectasis: -4 (p&lt;0.05)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>- Three days after surgery</td>
<td>- Postoperative pulmonary complications (e.g. pneumonia, atelectasis, pleural effusion)</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>- Seven days after surgery</td>
<td></td>
<td>6-min walk: +101.3m (p&lt;0.001)</td>
</tr>
<tr>
<td>Rosenfeldt et al, 2011</td>
<td>Randomized controlled trial</td>
<td>Patients waiting for at least 2 weeks elective CABG or valve surgery from a major public hospital in Melbourne, Australia (n=117)</td>
<td>Holistic program including physical conditioning and mental stress reduction - two 60-minute exercise sessions per week</td>
<td>Usual care</td>
<td>- Baseline</td>
<td>- QoL (quality of life: physical and mental)</td>
<td>Physical QoL: +1.3</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>- Preoperative (post-therapy) - 6 weeks after surgery</td>
<td>- LOS (length of hospital stay)</td>
<td>95%CI 0.89 – 1.72, p&lt;0.001</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>- Rate of post-operative AF (atrial fibrillation)</td>
<td>- No significant different between groups for LOS and post-op AF</td>
</tr>
</tbody>
</table>

*Effect size: differences in mean (intervention - control)

**FEV1/FVC ratio: forced expiratory volume to forced vital capacity ratio
## Appendix 3 - Internal Validity Assessment of the selected studies

<table>
<thead>
<tr>
<th>Study</th>
<th>Clearly focused question</th>
<th>Random allocation</th>
<th>Adequate concealment</th>
<th>Treatment allocation: blinding</th>
<th>Groups comparable</th>
<th>Only difference is treatment</th>
<th>Valid measurement of outcomes</th>
<th>Drop-out rate</th>
<th>Intention to treat analysis</th>
<th>Comparable results from all sites</th>
</tr>
</thead>
<tbody>
<tr>
<td>Arthur et al, 2000</td>
<td>+++</td>
<td>+++</td>
<td>+++</td>
<td>+</td>
<td>+++</td>
<td>+++</td>
<td>+++</td>
<td></td>
<td></td>
<td>Intervention group: 12.2% Control group: 18.7%</td>
</tr>
<tr>
<td>Hulzebos et al 2006a</td>
<td>+++</td>
<td>+++</td>
<td>+++</td>
<td>+</td>
<td>+++</td>
<td>+++</td>
<td>+++</td>
<td>0</td>
<td>+++</td>
<td></td>
</tr>
<tr>
<td>Hulzebos et al 2006b</td>
<td>+++</td>
<td>+++</td>
<td>NR</td>
<td>+</td>
<td>+++</td>
<td>+++</td>
<td>+++</td>
<td>0</td>
<td>+++</td>
<td></td>
</tr>
<tr>
<td>Ferreira et al, 2009</td>
<td>+++</td>
<td>+</td>
<td>NR</td>
<td>NR</td>
<td>+++</td>
<td>+++</td>
<td>+++</td>
<td></td>
<td></td>
<td>Intervention group: 3.3%</td>
</tr>
<tr>
<td>Carvalho et al, 2011</td>
<td>+++</td>
<td>+</td>
<td>NR</td>
<td>NR</td>
<td>+++</td>
<td>+++</td>
<td>+++</td>
<td>0</td>
<td>+++</td>
<td></td>
</tr>
<tr>
<td>Rosenfeldt et al, 2011</td>
<td>+++</td>
<td>+++</td>
<td>NR</td>
<td>NR</td>
<td>+++</td>
<td>+++</td>
<td>+++</td>
<td>0</td>
<td>+++</td>
<td></td>
</tr>
</tbody>
</table>

Well covered (+++); adequately Covered (++); Poorly Covered (+); Not Covered (–); Not Reported (NR); Not Applicable (NA)
## Overall Quality Assessment of the selected studies

<table>
<thead>
<tr>
<th>Study</th>
<th>Bias minimized</th>
<th>Direction of bias</th>
<th>Effect due to intervention</th>
<th>Results applicable to target group</th>
<th>Overall quality Rating</th>
</tr>
</thead>
<tbody>
<tr>
<td>Arthur et al, 2000</td>
<td>++</td>
<td>High risk of performance bias (blinding)</td>
<td>Yes</td>
<td>Yes</td>
<td>++ High</td>
</tr>
<tr>
<td>Hulzebos et al, 2006a</td>
<td>++</td>
<td>High risk of performance bias; Unclear risk of selection bias (allocation concealment) as it did not report in the study</td>
<td>Yes</td>
<td>Yes</td>
<td>++ High</td>
</tr>
<tr>
<td>Hulzebos et al, 2006b</td>
<td>++</td>
<td>High risk of performance bias</td>
<td>Yes</td>
<td>Yes</td>
<td>++ High</td>
</tr>
<tr>
<td>Ferreira et al, 2009</td>
<td>+</td>
<td>High risk of performance bias; Unclear risk of selection bias (random sequence and allocation concealment); Unclear risk of detection bias (outcome assessment blinding); Unclear risk of reporting bias</td>
<td>Yes</td>
<td>Yes</td>
<td>+ Fair</td>
</tr>
<tr>
<td>Carvalho et al, 2011</td>
<td>+</td>
<td>High risk of performance bias; Unclear risk of selection bias (random sequence and allocation concealment); Unclear risk of detection bias (outcome assessment blinding); Unclear risk of attrition bias</td>
<td>Yes</td>
<td>Yes</td>
<td>+ Fair</td>
</tr>
<tr>
<td>Rosenfeldt et al, 2011</td>
<td>++</td>
<td>High risk of performance bias</td>
<td>Yes</td>
<td>Yes</td>
<td>+ Fair</td>
</tr>
</tbody>
</table>
### Appendix 4 - Components and frequency of preoperative physical exercise training program of the 6 selected studies

<table>
<thead>
<tr>
<th>Study</th>
<th>Components</th>
<th>Frequency of preoperative physical exercise</th>
</tr>
</thead>
<tbody>
<tr>
<td>Arthur et al., 2000</td>
<td>Holistic program (physical including IMT and psychological components)</td>
<td>2 times/week</td>
</tr>
<tr>
<td>Hulzebos et al., 2006a</td>
<td>Inspiratory muscle training (IMT)</td>
<td>7 times/week, 20 minutes each</td>
</tr>
<tr>
<td>Hulzebos et al., 2006b</td>
<td>Inspiratory muscle training (IMT)</td>
<td>7 times/week, 20 minutes each</td>
</tr>
<tr>
<td>Ferreira et al., 2009</td>
<td>Inspiratory muscle training (IMT)</td>
<td>7 times/week, 3 sessions/day</td>
</tr>
<tr>
<td>Carvalho et al., 2011</td>
<td>Inspiratory muscle training (IMT)</td>
<td>Did not mention</td>
</tr>
<tr>
<td>Rosenfeldt et al., 2011</td>
<td>Holistic program (physical including IMT and psychological components)</td>
<td>2 times/week, 60 minutes each</td>
</tr>
</tbody>
</table>
### Appendix 5 - Timeline for intervention implementation and evaluation

<table>
<thead>
<tr>
<th>Event</th>
<th>Week 2</th>
<th>Week 7</th>
<th>Week 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Proposal</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Get administrative support</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Promote to frontline healthcare professionals</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Provide training for nurses in cardiothoracic surgical department</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Host preadmission preoperative physical exercise training program to the targeted patients</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pilot test</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Evaluation plan</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
## Appendix 6 – Calculations on cost-benefit ratio

### Material Cost

<table>
<thead>
<tr>
<th>Items</th>
<th>Cost (HKD)</th>
<th>Quantity</th>
<th>Details</th>
<th>Source</th>
</tr>
</thead>
<tbody>
<tr>
<td>Incentive spirometer (Triflow)</td>
<td>$26 \times 30 = $780</td>
<td>30</td>
<td>- Staff training</td>
<td>Patient Co-op Shop</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>- Demonstration to patients</td>
<td></td>
</tr>
<tr>
<td>Copies of Triflow instruction and evaluation form</td>
<td>$0.5 \times 1000 = $500</td>
<td>1000</td>
<td>- Staff training</td>
<td>Photocopying machine</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>- Distribute to patients during preadmission preoperation</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>- Physical exercise training program</td>
<td></td>
</tr>
</tbody>
</table>

### Non-material Cost

<table>
<thead>
<tr>
<th>Details</th>
<th>Responsibilities</th>
<th>Cost (HKD)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Manpower</td>
<td>- Staff training x 3 sessions</td>
<td>- $200 hourly rate x 30RNs x 3 sessions = $18000</td>
</tr>
<tr>
<td></td>
<td>- Preadmission preoperation physical exercise training program</td>
<td>- $200 hourly rate x 2-hour session = $400/patient/session</td>
</tr>
<tr>
<td></td>
<td>- Monthly follow up telephone calls</td>
<td>- $200 hourly rate x 15-minute call = $50/patient/call</td>
</tr>
<tr>
<td>- Nurses</td>
<td></td>
<td></td>
</tr>
<tr>
<td>- Physiotherapists</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Total estimated expenses per patient** (200 target patients each year):$780/200 + $500/200 + $18000/200 + $400 + $50

≈$547/patient
Benefits of implementing preoperative physical exercise training program

<table>
<thead>
<tr>
<th>Items</th>
<th>Saved money per patient/ day</th>
</tr>
</thead>
<tbody>
<tr>
<td>Decreased medical expenses</td>
<td>$3290</td>
</tr>
<tr>
<td>Decreased length of stay (decreased hospital charges)</td>
<td>$1200 - $100</td>
</tr>
</tbody>
</table>

Total potential benefits per patient: $3290 + $1200 - $100

= $4390

NET GAIN = total potential benefits – total estimated expenses

= $4390 - $547

= $3843

Cost-benefit ratio = $4390/$547

= 8.03

References:
Food and Health Bureau, 2010
Appendix 7
Guidelines on questions to be asked for monthly follow up phone calls from nurses

Patient’s name: ______________________ Phone call duration: ______________________
Operation name: ______________________ Operation Date: ______________________
Main concerns: ______________________
Desired outcomes: ______________________

1. Have you encountered any troubles concerning the preoperative physical exercise training program?

2. Regarding your problem, how do you want us, as nurses, to help?

3. Do you have anything want to ask regarding the surgery?

4. Please feel free to express your fears and expectations for the program and the surgery.

Follow up issues: ______________________
Date of next follow up phone call: ______________________
Signature: ______________________ Date & Time: ______________________
### Appendix 8

**Key to evidence statements and grades of recommendations**

#### Levels of evidence (SIGN, 2013)

<table>
<thead>
<tr>
<th>Level of evidence</th>
<th>Evidence statements</th>
</tr>
</thead>
<tbody>
<tr>
<td>1++</td>
<td>High quality meta-analyses, systematic reviews of RCTs, or RCTs with a very low risk of bias</td>
</tr>
<tr>
<td>1+</td>
<td>Well conducted meta-analyses, systematic reviews, or RCTs with a low risk of bias</td>
</tr>
<tr>
<td>1-</td>
<td>Meta-analyses, systematic reviews, or RCTs with a high risk of bias</td>
</tr>
<tr>
<td>2++</td>
<td>High quality systematic reviews of case control or cohort studies</td>
</tr>
<tr>
<td></td>
<td>High quality case control or cohort studies with a very low risk of confounding or bias and a high probability that the relationship is causal</td>
</tr>
<tr>
<td>2+</td>
<td>Well conducted case control or cohort studies with a low risk of confounding or bias and a moderate probability that the relationship is causal</td>
</tr>
<tr>
<td>2-</td>
<td>Case control or cohort studies with a high risk of confounding or bias and a significant risk that the relationship is not causal</td>
</tr>
<tr>
<td>3</td>
<td>Non-analytic studies, e.g. case reports, case series</td>
</tr>
<tr>
<td>4</td>
<td>Expert opinion</td>
</tr>
</tbody>
</table>

#### Grades of Recommendations (SIGN, 2013)

<table>
<thead>
<tr>
<th>Grade</th>
<th>Statements</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>At least one meta-analysis, systematic review, or RCT rated as 1++, and directly applicable to the target population; or A body of evidence consisting principally of studies rated as 1+, directly applicable to the target population, and demonstrating overall consistency of results</td>
</tr>
<tr>
<td>B</td>
<td>A body of evidence including studies rated as 2++, directly applicable to the target population, and demonstrating overall consistency of results; or Extrapolated evidence from studies rated as 1++ or 1+</td>
</tr>
<tr>
<td>C</td>
<td>A body of evidence including studies rated as 2+, directly applicable to the target population and demonstrating overall consistency of results; or Extrapolated evidence from studies rated as 2++</td>
</tr>
<tr>
<td>D</td>
<td>Evidence level 3 or 4; or Extrapolated evidence from studies rated as 2+</td>
</tr>
</tbody>
</table>
Appendix 9
Instruction and checklist for Triflow incentive spirometer use

Aims:
- To facilitate inspiratory muscle training
- To sustain deep breaths
- To maximize lung expansion

Desired Outcomes:
Patient being able to inhale at a predetermined flow and sustain the inflation for at least 5 seconds

Instructions:
1. Hold the spirometer upright → exhale normally → place the lips tightly around the mouthpiece

2. (a). Slow sustained maximal inspiration (SMI):
   Slow inhalation to raise only the ball in the first chamber, while the balls in other chambers remain at rest

   (b). High flow rate:
   Sufficient inhalation flow rate to raise the first and second balls, while the ball in the third chamber remain at rest

3. At maximum inhalation → remove mouthpiece → a breath-hold → normal exhalation

4. Relax after each prolonged deep breath → rest and normal breathing

5. Repeat the exercise as per the regimen from healthcare professionals

References:
**Evaluation:**

**Preadmission preoperation physical exercise training program**

Assessment date: ___________________ Telephone follow up date: ___________________

Exercise regimen: ______________________________________________________________

<table>
<thead>
<tr>
<th>Time Steps</th>
<th>Return demonstration by patient</th>
<th>Telephone follow up</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Troubles encountered: ______________________________________________________________

**Post operation assessment**

Date and name of operation: ________________________________

Post operation day: ____________________________

Exercise regimen: ______________________________________________________________

<table>
<thead>
<tr>
<th>Time Steps</th>
<th>Post op day 1</th>
<th>Rehabilitation and follow up</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Continue exercise regimen: YES / NO

Adjustment and modification: ____________________________________________________
Appendix 10
Guidelines on deep breathing and coughing exercise

Aims:
- To promote more effective coughing and lung expansion
- To clear the lungs, bronchi and trachea of secretions

Desired Outcomes:
Patient being able to perform correct and effective deep breathing and controlled coughing techniques

Instructions:
A. Pursed lip breathing
   1. Inhale slowly through the nose
   2. Pause
   3. Part the lips just enough to let a steady stream of air out when exhale

   N.B. - Keep the lips pursed, inhale: exhale time = 1:2
       - Do not force air out, do not relax the cheeks

B. Diaphragmatic breathing
   1. Sit or lie in a comfortable position, place one hand on the abdomen above the belly button, inhale slowly through the nose
   2. Feel the abdomen rise slowly when inhaling. Let the air out through pursed lips. The upper part of the chest should stay relaxed

   N.B. Try diaphragmatic breathing while standing and walking after mastering diaphragmatic breathing techniques on sitting and lying

C. Coughing technique
   1. Sit comfortably with feet resting on the ground, then lean slightly forward
   2. Take three deep diaphragmatic breaths before coughing
   3. Take a deep breath, hold it for three seconds, tighten the abdominal muscles and cough twice. The first cough loosens the sputum while the second cough move the sputum high up in the throat.

   N.B. Spit the sputum onto tissue paper and check the color.
**Frequency:**
Do the deep breathing and coughing exercise consistently for one minute and rest for two minutes. Gradually increase the exercise periods to ten minutes.

**Reference:**

## Appendix 11
Short Form 36-item Health Survey on Questionnaire quality of life

1. In general, would you say your health is:

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Excellent</td>
<td>1</td>
</tr>
<tr>
<td>Very good</td>
<td>2</td>
</tr>
<tr>
<td>Good</td>
<td>3</td>
</tr>
<tr>
<td>Fair</td>
<td>4</td>
</tr>
<tr>
<td>Poor</td>
<td>5</td>
</tr>
</tbody>
</table>

2. **Compared to one year ago**, how would you rate your health in general **now**?

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Much better now than one year ago</td>
<td>1</td>
</tr>
<tr>
<td>Somewhat better now than one year ago</td>
<td>2</td>
</tr>
<tr>
<td>About the same</td>
<td>3</td>
</tr>
<tr>
<td>Somewhat worse now than one year ago</td>
<td>4</td>
</tr>
<tr>
<td>Much worse now than one year ago</td>
<td>5</td>
</tr>
</tbody>
</table>
The following items are about activities you might do during a typical day. Does your health now limit you in these activities? If so, how much?

(Circle One Number on Each Line)

<table>
<thead>
<tr>
<th>Activity</th>
<th>Yes, limited a lot</th>
<th>Yes, limited a little</th>
<th>No, not limited at all</th>
</tr>
</thead>
<tbody>
<tr>
<td>3. Vigorous activities, such as running, lifting heavy objects, participating in strenuous sports</td>
<td>[1]</td>
<td>[2]</td>
<td>[3]</td>
</tr>
<tr>
<td>4. Moderate activities, such as moving a table, pushing a vacuum cleaner, bowling, or playing golf</td>
<td>[1]</td>
<td>[2]</td>
<td>[3]</td>
</tr>
<tr>
<td>5. Lifting or carrying groceries</td>
<td>[1]</td>
<td>[2]</td>
<td>[3]</td>
</tr>
<tr>
<td>6. Climbing several flights of stairs</td>
<td>[1]</td>
<td>[2]</td>
<td>[3]</td>
</tr>
<tr>
<td>7. Climbing one flight of stairs</td>
<td>[1]</td>
<td>[2]</td>
<td>[3]</td>
</tr>
<tr>
<td>8. Bending, kneeling, or stooping</td>
<td>[1]</td>
<td>[2]</td>
<td>[3]</td>
</tr>
<tr>
<td>9. Walking more than a mile</td>
<td>[1]</td>
<td>[2]</td>
<td>[3]</td>
</tr>
<tr>
<td>10. Walking several blocks</td>
<td>[1]</td>
<td>[2]</td>
<td>[3]</td>
</tr>
<tr>
<td>11. Walking one block</td>
<td>[1]</td>
<td>[2]</td>
<td>[3]</td>
</tr>
<tr>
<td>12. Bathing or dressing yourself</td>
<td>[1]</td>
<td>[2]</td>
<td>[3]</td>
</tr>
</tbody>
</table>
During the **past 4 weeks**, have you had any of the following problems with your work or other regular daily activities **as a result of your physical health**?

(Circle One Number on Each Line)

<table>
<thead>
<tr>
<th></th>
<th>Yes</th>
<th>No</th>
</tr>
</thead>
<tbody>
<tr>
<td>13. Cut down the amount of time you spent on work or other activities</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>14. <strong>Accomplished less</strong> than you would like</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>15. Were limited in the <strong>kind</strong> of work or other activities</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>16. Had <strong>difficulty</strong> performing the work or other activities (for example, it took extra effort)</td>
<td>1</td>
<td>2</td>
</tr>
</tbody>
</table>

During the **past 4 weeks**, have you had any of the following problems with your work or other regular daily activities **as a result of any emotional problems** (such as feeling depressed or anxious)?

(Circle One Number on Each Line)

<table>
<thead>
<tr>
<th></th>
<th>Yes</th>
<th>No</th>
</tr>
</thead>
<tbody>
<tr>
<td>17. Cut down the <strong>amount of time</strong> you spent on work or other activities</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>18. <strong>Accomplished less</strong> than you would like</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>19. Didn't do work or other activities as <strong>carefully</strong> as usual</td>
<td>1</td>
<td>2</td>
</tr>
</tbody>
</table>
20. During the past 4 weeks, to what extent has your physical health or emotional problems interfered with your normal social activities with family, friends, neighbors, or groups? (Circle One Number)

<table>
<thead>
<tr>
<th>Not at all</th>
<th>1</th>
</tr>
</thead>
<tbody>
<tr>
<td>Slightly</td>
<td>2</td>
</tr>
<tr>
<td>Moderately</td>
<td>3</td>
</tr>
<tr>
<td>Quite a bit</td>
<td>4</td>
</tr>
<tr>
<td>Extremely</td>
<td>5</td>
</tr>
</tbody>
</table>

21. How much bodily pain have you had during the past 4 weeks?

(Circle One Number)

<table>
<thead>
<tr>
<th>None</th>
<th>1</th>
</tr>
</thead>
<tbody>
<tr>
<td>Very mild</td>
<td>2</td>
</tr>
<tr>
<td>Mild</td>
<td>3</td>
</tr>
<tr>
<td>Moderate</td>
<td>4</td>
</tr>
<tr>
<td>Severe</td>
<td>5</td>
</tr>
<tr>
<td>Very severe</td>
<td>6</td>
</tr>
</tbody>
</table>

22. During the past 4 weeks, how much did pain interfere with your normal work (including both work outside the home and housework)? (Circle One Number)

<table>
<thead>
<tr>
<th>Not at all</th>
<th>1</th>
</tr>
</thead>
<tbody>
<tr>
<td>A little bit</td>
<td>2</td>
</tr>
<tr>
<td>Moderately</td>
<td>3</td>
</tr>
<tr>
<td>Quite a bit</td>
<td>4</td>
</tr>
<tr>
<td>Extremely</td>
<td>5</td>
</tr>
</tbody>
</table>
These questions are about how you feel and how things have been with you during the past 4 weeks. For each question, please give the one answer that comes closest to the way you have been feeling.

How much of the time during the past 4 weeks . . .

(Circle One Number on Each Line)

<table>
<thead>
<tr>
<th>Question</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
</tr>
</thead>
<tbody>
<tr>
<td>23. Did you feel full of pep?</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>24. Have you been a very nervous person?</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>25. Have you felt so down in the dumps that nothing could cheer you up?</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>26. Have you felt calm and peaceful?</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>27. Did you have a lot of energy?</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>28. Have you felt downhearted and blue?</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>29. Did you feel worn out?</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>30. Have you been a happy person?</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>31. Did you feel tired?</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
32. During the **past 4 weeks**, how much of the time has your physical health or emotional problems interfered with your social activities (like visiting with friends, relatives, etc.)?

(Circle One Number)

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>All of the time</td>
<td>1</td>
</tr>
<tr>
<td>Most of the time</td>
<td>2</td>
</tr>
<tr>
<td>Some of the time</td>
<td>3</td>
</tr>
<tr>
<td>A little of the time</td>
<td>4</td>
</tr>
<tr>
<td>None of the time</td>
<td>5</td>
</tr>
</tbody>
</table>

How TRUE or FALSE is **each** of the following statements for you.

(Circle One Number on Each Line)

<table>
<thead>
<tr>
<th>Statement</th>
<th>Definitely True</th>
<th>Mostly True</th>
<th>Don't Know</th>
<th>Mostly False</th>
<th>Definitely False</th>
</tr>
</thead>
<tbody>
<tr>
<td>33. I seem to get sick a little easier than other people</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>34. I am as healthy as anybody I know</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>35. I expect my health to get worse</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>36. My health is excellent</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
</tbody>
</table>

Reference

## Appendix 12

**Timeline for intervention development, implementation and evaluation**

<table>
<thead>
<tr>
<th>Event</th>
<th>Month</th>
</tr>
</thead>
<tbody>
<tr>
<td>Literature review</td>
<td>1-4</td>
</tr>
<tr>
<td>Formulating guidelines</td>
<td>5-6</td>
</tr>
<tr>
<td>Proposal</td>
<td>7</td>
</tr>
<tr>
<td>Get administrative support</td>
<td>8-11</td>
</tr>
<tr>
<td>Promote to frontline healthcare professionals</td>
<td>12-14</td>
</tr>
<tr>
<td>Provide training for nurses in cardiothoracic surgical department</td>
<td>15-21</td>
</tr>
<tr>
<td>Pilot test</td>
<td>22-24</td>
</tr>
<tr>
<td>Refine guidelines</td>
<td></td>
</tr>
<tr>
<td>Implementation</td>
<td></td>
</tr>
<tr>
<td>Evaluation</td>
<td></td>
</tr>
</tbody>
</table>
Appendix 13 - flow chart for communication plan

1. Proposer
   - Identify needs & provide evidence
   - Vigorous research
   - Refinement

2. CTSD nurses
   - Gather Information
   - Considered appropriate
   - Not agree

3. Ward Manager
   - Not agree

4. DOM (CTSD)
   - Not agree
   - Not agree

5. COS
   - Not agree

6. Nurses
   - Surgeons
   - Physiotherapists
   - Not agree

7. Communicate with targeted patients and their relatives

8. Endorse the proposed plan
Appendix 14 – Questionnaire on evaluating patients’ outcomes

Date of program start: ________________________________
Duration of the training: ______________________________
Name of Operation: _________________________________
Post-operation day: _________________________________

1. Have you encountered any problems or difficulties during the physical training exercise?

2. Do you it easy to follow the instructions on Triflow incentive spirometer?

3. Do you think the length of preoperative training starting from the date of surgery scheduling to the day of operation is sufficient enough?

4. Do you find it useful in promoting your post-operative recovery?

5. Will you continue the Triflow incentive spirometry training exercise after discharge?

6. What would you like be included in the current physical exercise training program?
Appendix 15 – Questions on staff performance (focus group interview)

1. Do you find the staff training session informative enough and prepare you for the training program to the patients?

2. Are you competent enough to host the preadmission preoperative physical exercise training program to the targeted cardiac surgical patients?

3. Are you confident enough in delivering the instructions on Triflow use to patients and assess whether the patients perform satisfactorily or not?

4. Are you comfortable to communicate with patients regarding their difficulties encountered and provide advice accordingly during both training session and monthly telephone follow up?

5. What are the problems or difficulties you encountered during the program?

6. Do you have any thing that you would like to change regarding this program?

7. Are you interested in conducting similar preadmission preoperative physical exercise training program in the future?