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ORIGINAL ARTICLE

The comparison of the effectiveness of respiratory muscle exercises (RME) and incentive spirometry exercises (ISE) on improvement of lung function post mechanical ventilation: A literature review☆

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Abstract
Objectives: To compare the effectiveness of respiratory muscle exercise (RME) and incentive spirometry exercises (ISE) to improve lung function after mechanical ventilation.
Methods: This was a systematic literature review by searching through a database; PubMed, Cochrane, Science Direct, Google Scholar, and DOAJ.
Results: Nine articles were identified according to eligibility criteria, and all of them evaluated the effectiveness of breathing exercises with ISE. Such exercise has been significant in improving lung function; three articles that evaluate related to the direct title, namely RME with diaphragmatic breathing and ISE, the results are significant for improvement in lung function.
Conclusions: Several studies have concluded that breathing exercises (BE) by training diaphragmatic breathing muscles include RME and ISE, significantly improve lung function.

Introduction

Respiratory failure following extubation is a condition of respiratory failure in the post-extubation period due to the worsening condition of the organ, such as heart failure.[1] The condition of respiratory failure often occurs on the second-day post-extubation.[2] Failure to breathe with reintubation is a result of both hemodynamic instabilities or one of

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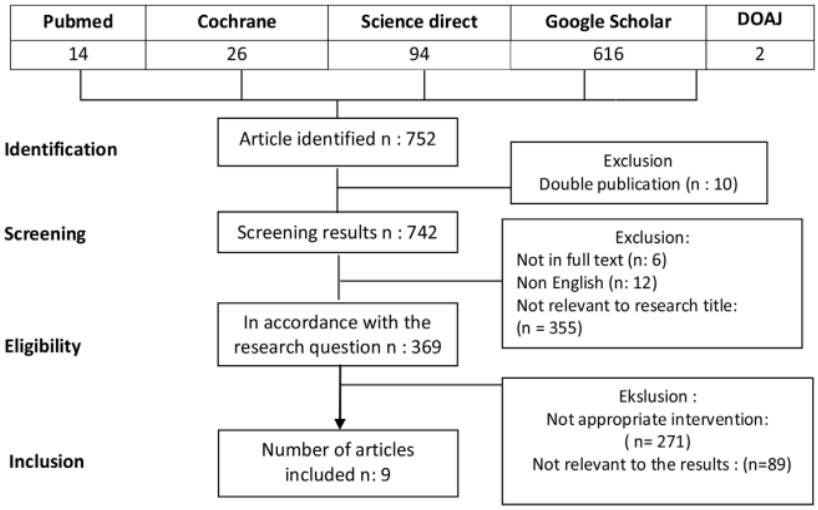

Figure 1 Flowcharts for selection and inclusion process study selection and inclusion.

several criteria for respiratory failure, such as; increased AGD PCO2 > 45 mmHg that accompanied by ineffective cough.[3] The prevalence of respiratory failure at reintubation was 93 (3.9%) of 2358 patients who were fitted with a ventilator.[4] The prevalence reported quite high. Thus, strict monitoring is needed, and the actions of nurses to evaluate respiratory muscle capability also to maintain respiratory function within the normal range. Breathing exercise (BE) is a breathing muscle training that has been proven through several previous studies to improve lung function.[5] However, the problem is not all forms of breathing exercises can be used in every area of nursing, especially critical care. respiratory muscle exercises (RME) and incentive spirometry exercises (ISE) have been proven to significantly improve respiratory muscle strength and pulmonary capacity function as well as patients with acute respiratory disorders, especially in patients treated in critical care.[6,7] Thus, this literature review aimed to compare the effectiveness of respiratory muscle exercise (RME) and incentive spirometry.

Methods

A systematic review conducted using the PRISMA 2009 checklist guideline. The selected article was analyzed using CASP skills.[8] The searching strategies was performed on the database PubMed, Cochrane, Science Direct, Google Scholar, and DOAJ. By using PICO (patient, intervention, and comparison), where P = post mechanical ventilation OR extubation I = respiratory muscle exercises OR inspiratory muscle training OR, C = *incentive spirometry*, T = lung function OR pulmonary function expiratory muscle. The total number of articles obtained is 752, and there are were two articles that double, 12 articles are non-English, 355 articles that are were not relevant, 271 articles are were not interventions, and 89 articles that have goals are were not relevant to the results (Fig. 1).

Results

Nine articles were identified according to eligibility criteria, and all of them evaluated the effectiveness of breathing exercises with ISE (Table 1).

Research that has been done explained that an increase in PImax occurred on day 15 by using TG ($p < 0.001$). Likewise, what happened in the ISG group experienced a significant increase ($p < 0.001$) compared to CG did not experience a significant increase ($p = 0.988$) toward PImax9.[9] Pulmonary function significantly improved with diaphragmatic breathing exercises and spirometry exercises incentive volume ($p < 0.02$) compared to breathing exercises in the spirometry exercise group incentive flow and control group ($p > 0.08$).[7] Besides, this study also concluded that fentanyl attached for lung function of patients is more significant if with spirometry incentive training ($p = 0.01$) and can also reduce the incidence and severity of fentanyl-induced cough (FIC) when compared to the group without exercise ($p = 0.03$).[10] Significant increase in FVC proven after doing ITG and RMTG breathing exercises ($p < 0.002$ and $p < 0.02$) compared to the control group ($p > 0.80$). Besides, seeing FEV1 experienced a significant increase after breathing exercises ITG and RMTG ($p < 0.001$ and $p < 0.04$) compared to the control group ($p > 0.48$).[11] The same thing is obtained after breathing exercises using IS that significantly increase pulmonary ventilation (ΔEELVVT after surgery in patients without lung disease) with *p*-value <0.01 same result with the case with PEP training that can improve pulmonary ventilation (ΔEELI) with a value of $p < 0.01$.[12] Research using IS, and aerobic diaphragm resistance training has a beneficial effect on increasing pulmonary PEFR parameter values ($p < 0.001$).[13] Deep breathing exercises (DBE) and incentive spirometers (IS) are useful in physical therapy interventions to reduce pain and increase PEFR lung volume ($p < 0.001$), especially in postoperative patients on day 7.[14,15] Both of these interventions significantly improve PEFR lung function when done

Table 1 Synthesis grid articles related to the effectiveness of respiratory muscle exercise (RME) and incentive spirometry exercises (ISE) to improve lung function after mechanical ventilation.

Researcher	Purpose	Method	Result
Paiva et al. (2015)[9]	Evaluate the effectiveness of both IMT interventions with threshold (TG) and IMT use incentive spirometry (IS) in increasing PImax.	RCT, ANOVA test, number of samples were 40 respondents, consists of 3 groups namely the control group, the IMT-threshold group, and the IMT-incentive spirometry group	From the results of the study conclude that there is a significant increase in PImax on the 15th day with using TG ($p < 0.001$). Likewise furthermore, the ISG group experienced a significant increase ($p < 0.001$) toward the PI max, while for the CG group there was no significant ($p = 0.988$) increase in PI max
Alaparthi et al. (2016)[7]	Evaluate the effects of diaphragmatic breathing exercises, spirometry incentives and volume spirometry incentives on lung function (FVC/FEV1/PEFR) and diaphragm in patients who will undergo laparoscopic abdominal surgery	RCT, ANOVA test, a total of 260 respondents, Consists of 4 groups viz. diaphragmatic respiratory groups, a spirometry incentive group, spirometry volume incentive group, and control group	The study concluded that lung function and excursion significantly increased FVC ($p < 0.03$) and diaphragmatic excursion ($p < 0.001$). The same thing happened in breathing exercises using the volume incentive spirometer FVC ($p < 0.03$) and diaphragm excursion ($p < 0.0$
Goyal, Bhargava, and Baj (2017)[10]	Knowing the effectiveness of providing incentive spirometry exercises during fentanyl administration to reduce the incidence of fentanyl induced cough (FIC)	A prospective, randomized, controlled study, analyzed -test, Pearson Chi-square test for categorical variables. incidence and severity of FIC compared using the Fisher and Mann–Whitney exact test, number of samples were 200 respondents which consist of 2 groups; the control group (fentanyl) spirometry incentive group and fentanyl	From the results of the study concluded that patients with fentanyl medication and spirometry incentive training were more significant ($p = 0.01$) reduce the incidence and severity of Fentanyl-induced cough (FIC) when compared to the group without exercise ($p = 0.03$)
Kim, Lee, Kim, and Kim (2015)[11]	Evaluate the effects of respiratory muscle training(RMT) combined with abdominal drawing in maneuver (ADIM) on decreased activity and respiratory muscle function in patients with post-stroke hemiplegia	RCT, one-way analysis of variance (ANOVA), 37 respondents, consisting of 3 groups the RMT group, the ITG group, and the control group (CG), respectively	From the results of the study concluded that there was a significant increase in FVC after doing ITG and RMTG breathing exercises ($p < 0.002$ and $p < (0.02)$ compared to the control group ($p > 0.80$), Likewise moreover, in FEV1 has increased significantly after breathing exercises ITG and RMTG ($p < 0.001$ and $p < 0.04$) compared to the control group ($p > 0.48$).

Table 1 (*Continued*)

Researcher	Purpose	Method	Result
Reychler et al. (2019)[12]	Evaluate the effects of positive expiratory pressure (PEP) and incentive spirometry (IS) in increasing lung ventilation (ΔEELVVT) in patients after surgery	Randomized crossover study, the normality of the distribution is verified by the Kolmogorov–Smirnov test, and Wilcoxon marked rank test. Resting phase compared to ANOVA, The number of samples is 10 with two groups, namely IS and PEP	Research result concluded breathing exercises with IS were significant in improving pulmonary ventilation (ΔEELVVT after surgery in patients without pulmonary disease with value $p < 0.001$, as well as PEP exercises, can improve pulmonary ventilation (ΔEELI) with value $p < .001$
Aweto, Aiyegbusi, and Olaniyan (2017)[13]	The compare the effects of spirometry incentives and diaphragm resistance training on FEV1 parameters, FVC, cardiopulmonary PEFR selected in patients with asthma	Paired *t*-test, Analysis of variance (ANOVA) used to compare differences, 42 respondents, which consists of 3 groups; group A by receiving aerobic exercise and spirometry incentives, group B received aerobic exercise and diaphragm resistance training, and group C (control group) only accept aerobic exercise	this research shows that the use of spirometry incentives significantly can increase FEV1 $p < 0.001$, FVC $p < 0.012$, PEFR $p < 0.001$, as well as aerobic diaphragm resistance exercises, have a beneficial effect in increasing selected lung parameters FEV1, FVC, PEFR that is $p < 0.001$
Pm & Mc (2018)[14]	Evaluate the effect of deep breathing exercises (DBE) and incentive spirometer after abdominal surgery on pain and lung function (PEFR)	Purposive sampling with 40 respondents, all respondents received training viz. (DBE) and (IS)	The results of (DBE) research and (IS) effective in physical therapy interventions to reduce pain and increase lung volume. DBE and IS are significant in increasing PEFR ($p < 0.001$) increase lung capacity and volume on the 7th postoperative day
Ali, Shabaan, Diab, Fehro, and Eid (2018)[15]	Evaluate the effects of diaphragmatic breathing exercises and the incentive of spirometer flow in increasing PERF in patients with upper abdominal surgery	The *t*-test is used to compare each of the 3 data groups studied. Chi-square test is used to compare groups of numerical data studied, 120 respondents, consists of 3 groups namely diagfragma respiration group, spirometry incentive group and diaphragmatic respiratory group with spirometry flow incentives	The results concluded that diaphragmatic breathing exercises significantly improved PEFR lung function when done with spirometry incentive exercises ($p < 0.001$) compared to just doing one of them ($p < 0.05$)
Rafaqat et al. (2016)[16]	To compare the effectiveness of balloon blowing (BB) exercises and spirometry incentives improve lung function in patients with chest intubation after trauma	RCT, to see the effect between the two interventions using inferential statistics, paired *t*-test. 120 respondents, consisting of 3 groups namely diaphragmatic respiratory groups, the spirometry incentive group and the diaphragm breathing group with the IS and the (BB) group	There was no significant difference between balloon blowing exercises and IS for an increase in FVC ($p > 0.6$). Both groups that were tested had a *p* value of 0.00, so both groups are said to be significantly effective in improving lung function

performed with spirometry incentive exercises ($p < 0.001$) compared to just doing one of them ($p < 0.05$).[15] Other studies also prove that there is no significant difference in the balloon blowing exercises and spirometry incentives in improving lung function. However, spirometry incentive training is more suitable for patients with limited physical activity.[16]

Discussion

The results of the review above confirm that diaphragmatic breathing exercises can significantly improve lung function FVC/PEFR $p < 0.001$, as well as incentive spirometry exercises, which can significantly increase lung volume FVC/FEV1 $p < 0.01$. This form of BE is mainly to strengthen inspiring muscles, and this is recommended for patients who experience decreased lung function, as a post-op patient, because of the effect of giving sedation drugs and long duration of surgery that can weaken respiratory muscles.[7,11,12,14] The intervention can be measured by using spirometry or a simple peak flow meter.[9,10]

Conclusion

From the results of the above review, it can be concluded that diaphragmatic BE and spirometry incentive exercises have the same benefits and advantages in improving lung function. With this BE is expected to help improve lung function in patients with post mechanical ventilation to reduce the number of reintubation incidents.

Conflict of interest

The authors declare no conflict of interest.

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