

# Using Different Respiratory Modalities for Preventing Pulmonary Complications among Patients Post-cardiac Surgeries: A Quasi-experimental Study

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## Abstract

**Background:** Using different respiratory modalities prevents pulmonary complications. **Aim:** Evaluate effect of different respiratory modalities among patients undergoing cardiac surgeries on postoperative pulmonary complications rate. **Methods:** Selective assigned of 150 patients divided into three equal groups undergoing cardiac surgeries from a cardiovascular hospital affiliated with Ain Shams University. Group A practiced deep breathing and coughing exercise as a respiratory model, Group B utilized incentive spirometry as another modality, while group C applied all modalities. Patient's interviewing questionnaire, practical observational checklists, and postoperative pulmonary complications assessment form were the used tools. A training program was performed for groups. **Results:** 22%, 14%, and 10% from groups A, B, and C developed postoperative pulmonary complications with 27.2% death among complicated in group A. Moreover; a significant difference between complications means scores among the groups  $p < 0.01$ . **Conclusion:** The combination of different respiratory modalities significantly reduces pulmonary complications post-cardiac surgery.

**Keywords:** Cardiac surgeries, Modalities, Postoperative, Pulmonary complications, Respiratory.

## 1. Introduction

Postoperative pulmonary complications (PPCs) are adverse changes occurring in the respiratory system resulting from; the reduction of the pulmonary reserve. It occurs in 8.0% with valve surgeries and 5.4% with coronary artery bypass graft (CABG) [1]. Approximately 7% of patients with normal preoperative lung function and 70% of patients with risk are affected PPCs [2]. Estimates suggest that more than 1 million PPCs occur annually in the United States, with 46 200 related deaths and 4.8 million additional hospitalization days [3].

Atelectasis is the common PPCs occurring in 3.86% after cardiopulmonary bypass (CPB), followed by 1.54% for respiratory failure and 0.58% for pneumonia [4] Another study revealed that; 41% of patients post cardiac surgeries develop pleural effusions [5] and bronchospasm is an unusual complication of open-heart surgery [6].

Different respiratory modalities are a routinely prescribed exercises employed with medical direction to treat, control, and care for patients with cardiopulmonary deficiencies [7] Specific deep breathing exercises (DBEs) include; pursed-lip and diaphragmatic breathing which helps in airway clearance and improves breathing efficiency. Incentive spirometry (IS) is a mechanical device that helps re-inflate collapsed lungs and re-enforce a pattern of breathing [8] Pre-operative patient training on modalities is the responsibility of medical staff to prepare them for cardiac surgery and ensure post-operative continuity [9].

Respiratory modalities are considered the major

component of patient care post-cardiac surgeries, but there is a lack of scientific clinical trials describing the most effective model for reducing PPCs among cardiac patients. Therefore, this study was conducted to evaluate effect of different respiratory modalities among patients undergoing cardiac surgeries on post-operative pulmonary complications rate through the following:

- Assessing the patients performance level (knowledge and practice) regarding different respiratory modalities.
- Developing and implementing training program based on the patients' needs.
- Evaluating the effect of using each respiratory modality training program on performance and post-operative pulmonary complications rate.

The study hypothesized that there were a significant difference in pulmonary complications (PCs) rate among post-op cardiac patients who practiced all different respiratory modalities (DBEs, coughing exercise and the use of IS) versus other groups.

## 2. Methods

Prospective, double-blind comparative study approved by two ethical and research committees; nursing research ethical committee, faculty of nursing, Ain Shams University, and ethical research committee affiliated to Ain Shams University Hospitals, Cairo, Egypt.

A quasi-experimental design with sequential assignment into three equal groups, 50 patients for each one with purposive sampling recruited from 2 cardiothoracic surgical wards and a postoperative intensive care unit

(ICU) at a cardiovascular hospital affiliated with Ain Shams University Which serves a large number of patients annually, where 1828 patients underwent cardiothoracic surgery in 2018.

**Sample size**

A target sample size was calculated based on the results of the previous study [10] Equal groups number, two-sided, and 50 patients in each group should be included to be able to detect a differences by power analysis (80%) and 5% significance level, chosen based on the following equation:

$$\frac{2(Z_{\alpha/2} + Z_{\beta})^2 P(1 - P)}{(P_1 - P_2)^2}$$

Z<sub>α</sub> = Standard normal deviate for α = 1.9600.

Z<sub>β</sub> = Standard normal deviate for β = 0.8416.

(Z<sub>α</sub> + Z<sub>β</sub>)<sup>2</sup> = 7.84.

p = 0.44 + 0.182.

(p1-p2)<sup>2</sup> = -0.066

The N thus calculated is rounded up to the next highest integer to give the group size.

$$n = \left(\frac{2 \times 7.84 \times 0.21}{0.066}\right) = 49.8 \approx 50.$$

The study was conducted 3 days/ week from January to December 2021. All patients met the following criteria ; Adult patient with pre-operative ejection fraction > 50%, undergoing first median sternotomy for CABG, mitral or aortic valve replacement with total bypass time ≤ 150 minutes, post-operative vitally stable, with no history of angina at rest, or any pulmonary or neurological disorders that may affect the respiratory system and mechanically ventilated < 24hrs. Informed consent was taken by all patients.

The groups distributed as the following:

- Group (A): Practiced DBE, 3 sets of pursed lip followed by 5 sets of diaphragmatic breath then 3 sets of coughing exercise / 1hr as a respiratory modality.
- Group (B): Utilized the IS, 5 sets / 1hr as other respiratory modality.
- Group (C): Applied all respiratory modalities.

A pilot study carried on 30 patients (20%) of the study subjects to test feasibility, simplicity and applicability of the study tools and the pilot patients were excluded from the sample.

**Equation:**

$$\alpha = \frac{N \cdot \bar{r}}{1 + (N - 1) \cdot \bar{r}}$$

The patients in each of the three groups were divided into 3-5 patients / week and filled the data collecting tools 1 and 2 within 45 minutes then received training program containing; 2 theoretical sessions lasting 1hr for each one and 2 practical sessions lasting 1hr for groups (A & B) and 2hrs for (C) interspersed with 5-10 min break were

applied in the previous mentioned setting. The program associated with written instructional booklet in simple Arabic language.

After that, the patients in the groups practiced the different respiratory modalities from 8AM to 7pm in the two days preceding the surgery and the two days following it (the 2<sup>nd</sup> and 3<sup>rd</sup> postoperative day). The nurses follow-up paper document was developed and discussed by the researcher to all assigned nurses in the selected setting to follow patients practice after their training program content. Effect of program performance was evaluated through; pre-program, post-program and during the follow-up at 2<sup>nd</sup> postoperative day while PPCs were assessed on the 4<sup>th</sup> day.

**Tools**

**Patients interviewing questionnaire** developed tool [11, 12] contains ; patient’s demographics, clinical data, and knowledge. Total (147) questions (35) multiple-choice questions (MCQ) and (112) closed-ended; one grade was given for each correct answer with a total satisfactory level ≥ 75%.

**Patients practice observational check-lists** modified tool involves; pursed-lip breathing, diaphragmatic breathing, coughing exercise, and using of IS. Each tool contains (8) items categorizing into "done correctly" or "not done". One grade was given for each correct step with a total adequacy level ≥ 80 %.

Patients post-operative pulmonary complications assessment form is a developed tool [15-17] which was used to monitor (5) PCs; atelectasis, pleural effusion, pneumonia, bronchospasm and ARF and its related death. Each complication was monitored for its related subjective and objective criteria which were confirmed or diagnosed by the physician. The tool was filled by the researcher in 10-15 mins. The item was categorized into " yes" or " No". One score was given for each item the patient suffered from and zero was given for each item the patient didn’t suffer from. Total mean score of each complication in groups A, B, and C was calculated.

The tools validity was done through; 7 medical surgical and critical nursing experts. It ranged from (71.5%) to (100%) for face and content and (9.6) to (9.9) for self-validity and Cronbach alpha reliability values ranged from (0.93) to (0.98).

**Statistics**

IBM SPSS (version 26) was used to analyze the data. Quantitative variables are presented in  $\bar{x} \pm SD$ . Qualitative variables were presented in frequency and percentage. Shapiro-Wilk and Kolmogorov-Smirnov tests were used to determine the normality of data, then the non-parametric Chi-square, Post Hoc Mann-Whitney after Kruskal Wallis tests were used to compare the groups.

**3. Result**

**Table 1: Comparison between three groups regarding their characteristics.**

Variables	G (A)		G (B)		G (C)		χ <sup>2</sup>	P -value
	N	%	N	%	N	%		
Age: (years), $\bar{x} \pm SD$	55.2	±9.0	55.3	±9.2	57.5	± 8.4	2.533	0.865
Male	29	58	36	72	0.337	66	2.178	0.337
Female	21	42	14	28	17	34		
Education:								

Not read and write	7	14	6	12	6	12	5.601	0.469
Read and write	9	18	9	18	15	30		
Secondary education	24	48	24	48	15	30		
High education	10	20	11	22	14	28	1.735	0.420
Smoker:	19	38	15	30	13	26		
Ex-smoker:	12	24	14	28	16	32	0.794	0.672
Body mass index (kg/M <sup>-2</sup> ), $\bar{x} \pm SD$	30.50±4.93		29.96±5.74		30.41±4.92		5.408	0.493
Type of surgery*:								
Coronary artery bypass graft	25	50	31	62	26	52	1.668	0.434
Aortic valve replacement	12	24	9	18	10	20	0.569	0.752
Mitral valve replacement	17	34	16	32	19	38	0.412	0.814
$\bar{x} \pm SD$ : mean $\pm$ stander deviation; *more variable; chi square test; and non-significant= $P > 0.05$ . No significant difference between three groups regarding their characteristics $P > 0.05$ . (Table 1).								

**Table 2: Comparison of total satisfactory knowledge for patients in each group.**

Variable	G (A)			G (B)			G (C)		
	$\chi^2 P 1$	$\chi^2 P 2$	$\chi^2 P 3$	$\chi^2 P 1$	$\chi^2 P 2$	$\chi^2 P 3$	$\chi^2 P 1$	$\chi^2 P 2$	$\chi^2 P 3$
Total satisfactory knowledge	29.26	52.59	59.59	31.56	46.31	54.59	23.07	36.94	43.75
	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000

*P 1*: pre- posttest; *P 2*: pre - follow-up test; *P 3* pre, post and follow-up test; Chi Square test and significance =  $P \leq 0.01$ .  
A statistically significant difference in total satisfactory level of knowledge for patients in each group (pre-test, post-test and follow-up) ( $P \leq 0.01$ ). (Table 2).

**Table 3: Comparison of total adequate practices for patients in each group.**

Variable	G (A)			G (B)			G(C)		
	$\chi^2 P 1$	$\chi^2 P 2$	$\chi^2 P 3$	$\chi^2 P 1$	$\chi^2 P 2$	$\chi^2 P 3$	$\chi^2 P 1$	$\chi^2 P 2$	$\chi^2 P 3$
Total adequate practices	31.56	58.60	65.87	11.40	33.76	33.81	19.39	32.18	37.435
	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000

*P 1*: pre- posttest; *P 2*: pre - follow-up test; *P 3* pre, post and follow-up tests; Chi Square test and significance =  $P \leq 0.01$ .  
A statistically significant difference in total adequate level of practices for patients in each group (pre-test, post-test and follow-up) ( $P \leq 0.01$ ). (Table 3).

**Table 4: Distribution of patients in different groups regarding postoperative pulmonary complications.**

Postoperative pulmonary complications	G (A)		G (B)		G(C)	
	N.	%	N.	%	N.	%
Atelectasis	9	18	4	8	3	6
	3#	33.3				
Pleural effusion	7	14	4	8	3	6
	3#	42.8				
Pneumonia	2	4	4	8	1	2
Bronchospasm	3	6	3	6	1	2
Acute respiratory failure	5	10	2	4	1	2
	3#	60				

N: number; %: percentage and # death.

Regarding PPCs; Atelectasis occurred in 18%, 8%, and 6% of patients in groups A, B, and C with 33.3% death of the affected in G (A), 14%, 8%, and 6% were having pleural effusion with 42.8% death of complicated patients in G

(A), 4%, 8%, and 2% developed pneumonia, 6%, 6% and 2% had bronchospasm while ARF presented in 10%, 4% and 2% with 60% death of suffered patients in G (A). (Table 4)

**Table 5: Comparison between the patients in different groups regarding postoperative pulmonary complications means scores.**

Parameters	G (A)		G (B)		G (C)		Kruskal Wallis test	P -value
	$\bar{x}$	SD	$\bar{x}$	SD	$\bar{x}$	SD		
Atelectasis	4.5600	4.47743	3.3000	3.81324	2.2800	3.55734	15.324**	0.000
Pleural effusion	4.6600	4.11870	3.2200	3.33375	2.3800	2.88479	15.184**	0.001
Pneumonia	4.0800	3.33711	3.2800	3.35663	2.0800	2.91260	14.641**	0.001
Bronchospasm	4.6400	2.40544	3.7600	2.45415	2.8800	2.37022	16.043**	0.000
ARF	5.2800	4.23320	3.8800	3.64574	2.8800	2.90418	14.925**	0.0001

G: group;  $\bar{x} \pm SD$ : mean  $\pm$  stander deviation; ARF: acute respiratory failure; and significance =  $P \leq 0.01$ .

The three groups were different in PPCs means scores at  $P$  (0.000, 0.001, and 0.0001) respectively. (Table 5)

**Table 6: Post Hoc comparison of patients in different groups**

Parameters	G (A) : G (B)	G (B) : G (C)	G (A) : G (C)
	P -value	P -value	P -value
Atelectasis	0.088	0.015**	0.000
Pleural effusion	0.029*	0.045*	0.000
Pneumonia	0.167	0.008**	0.000
Bronchospasm	0.058	0.028*	0.000
ARF	0.052*	0.113	0.000

Groups A and B were different in occurring of pleural effusion and ARF  $P$  (0.029 & 0.052). Other differences were found in the development of atelectasis, pleural effusion, pneumonia, and bronchospasm between groups B and C at  $P$  (0.015, 0.045, 0.008 and 0.028). Furthermore; there was a difference between groups (A and C) in all PPCs where  $P$  (0.000). Table (6).

#### 4. Discussion

This study shows that; the combination of DBEs, coughing exercise, and IS are the most effective respiratory model for preventing/reducing the PPCs among patients undergoing cardiac surgeries. It is believed to be the first study to evaluate efficacy of using different respiratory modalities to estimate which one of the three different groups of patients undergoing cardiac surgeries had no PPCs after conducting training program sessions because of limited scientific clinical trials in this field. The current study was based on a previous comparative study in upper abdominal surgery [18] and other systemic review related prevention of PPCs after heart surgery [10].

The study revealed, a significant difference in total satisfactory level of knowledge for patients in each group; pre-test, post-test and follow-up test  $P$  (0.000), reflected the positive effect of the training program, high readiness, and engagement in the sessions. This is in line with Sallam et al. [19] who noticed; an increase in overall patients knowledge from pre-test to post-test.

Concerning total adequacy level of patients practices, there was a significant difference in total adequate level of practices for patients in each group which the patients practices were enhanced in post-test and follow-up tests than pre-test  $P$  (0.000). This reflects the patients' desire for applying different breathing modalities in a correct manner. This is in line with Rodrigues who noticed; a significant difference between patients' performance in pre-test and post-test regarding breathing exercises.

Fortunately, this study displayed that; less than one-fifth of groups A, B, and C suffered from post-operative atelectasis, pleural effusion, pneumonia, bronchospasm, and ARF. Following the present study, a previous comparative study showed that; less than one-fifth of the intervention group was affected by PPCs after breathing exercise application opposite three-fifths of the control group [20]. However, such study was conducted in upper abdominal surgeries.

In relation to mortality, the current study revealed that; more than one-third of patients who developed atelectasis, more than two-fifths of patients with pleural effusion, and three-fifths of ARF patients in G (A) died opposite no mortality among groups (B and C). This contradicted with a study that reported in their review that; the percentage of death resulting from PPCs ranged from less than one-fifth to one third.

There was a statistical significant difference between groups A, B, and C regarding overall PPCs after practicing the different respiratory modalities  $P < (0.001)$  which indicates; that there were one or more models are more effective in preventing the PPCs. This contradicted with a

study that showed comparative results and noticed that; no statistical significant difference between pulmonary function among patients groups who applied three respiratory physical therapy techniques  $P > (0.05)$ .

Post-hoc comparisons of patients in different groups revealed that; a significant difference between groups A and B regarding the development of pleural effusion and ARF  $P \leq (0.05)$ . Other significant differences between groups B and C regard all PPCs occurrence; except ARF  $P > 0.05$ . Moreover, there were a significant difference between groups A and C regards overall PPCs  $P$  (0.000), revealing that the respiratory model applied by group C was the most effective one than other modalities used. This is supported by Ali et al. [18] who did a comparative study and found that; DBE and flow IS were recommended than each one alone in the prevention of PCs. However, this study was conducted in upper abdominal surgery.

#### 5. Limitations of study

Unavailability of the used respiratory modality (IS) in the selected study setting. No policy for storing patient personal IS modality.

#### 6. Conclusion

The use of different respiratory modalities had statistically significant effect on reducing PPCs among patients post cardiac surgeries.

#### Abbreviations

PPCs: Postoperative pulmonary complications; CABG: Coronary artery bypasses graft; CPB: Cardiopulmonary bypass; DBEs: deep breathing exercises; IS: Incentive spirometry; ICU: Intensive care unit; MCQ: multiple choice questions.

#### 7. Availability of data and materials

The datasets used and/or analyzed during this study are available from the corresponding author on reasonable request.

#### 8. Competing interests

The authors declare that they have no competing interests

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#### 10. Author contribution

All authors contributed to study conception and design. The manuscript was written, read, and approved by all authors.

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## 12. Disclosure statement

The authors report no conflict of interest.

## References

1. Pramanik M, Sarkar A, Gupta A, Chattopadhyay M. Postoperative pulmonary complications in robot-assisted uro-oncological surgeries: Our experience in a tertiary cancer care centre. *Indian Journal of Anaesthesia*. 2020;64(3):238. <https://doi.org/10.4103%2Fija.ija.527.19>
2. Hess D, MacIntyre N, Mishoe S. *Respiratory care: principles and practice*. Jones & Bartlett Learning, 2011. Available from: <https://books.google.com.pk/books?hl=en&lr=&id=BwMRh5BSKkC&oi=fnd&pg=PP4&dq=2.+%09Hess.+D,+MacIntyre,+NR.+%26+Galvin+WF>.
3. Fernandez-Bustamante A, Frenzl G, Sprung J, Kor DJ, Subramaniam B, Ruiz RM, Lee J-W, Henderson WG, Moss A, Mehdiratta N. Postoperative pulmonary complications, early mortality, and hospital stay following noncardiothoracic surgery: a multicenter study by the perioperative research network investigators. *JAMA surgery*. 2017;152(2):157-66. <https://doi.org/10.1001/jamasurg.2016.4065>
4. Naveed A, Azam H, Murtaza HG, Ahmad RA, Baig MAR. Incidence and risk factors of pulmonary complications after cardiopulmonary bypass. *Pakistan journal of medical sciences*. 2017;33(4):993. <https://doi.org/10.12669%2Fpjms.334.12846>
5. Bejar D, Triki M, Abouda M, Yengui F, Melki B, Rejeb H, Meiz NB, Antit S, Herbeg B, Bousabbeh E. Pleural effusions after cardiac surgery: Etiology and outcomes. *Eur Respiratory Soc*; 2016.
6. Lin Z, Chen D, Li Q. Severe Bronchospasm During Aortic Surgery for Type A Aortic Dissection. *Authorea Preprints*. 2020. <https://doi.org/10.1532/hsf.3529>
7. Cook A, Smith L, Anderson C, Ewing N, Gammack A, Pecover M, Sime N, Galley HF. The effect of Preoperative threshold inspiratory muscle training in adults undergoing cardiac surgery on postoperative hospital stay: A systematic review. *Physiotherapy Theory and Practice*. 2022:1-14. <https://doi.org/10.1080/09593985.2022.2025548>
8. Sweity EM, Alkaissi AA, Othman W, Salahat A. Preoperative incentive spirometry for preventing postoperative pulmonary complications in patients undergoing coronary artery bypass graft surgery: a prospective, randomized controlled trial. *Journal of Cardiothoracic Surgery*. 2021;16(1):1-11. <https://doi.org/10.1186/s13019-021-01628-2>
9. Hawkey MC, Lauck SB. *Valvular Heart Disease: A Guide for Cardiovascular Nurses and Allied Health Professionals*. Springer Nature, 2022. Available from: <https://books.google.com.pk/books?hl=en&lr=&id=6.1R.EAAAQBAJ&oi=fnd&pg=PR5&dq=9.+%09Lauck+SB,+Smit h+A>.
10. Karanfil ET, Møller AM. Preoperative inspiratory muscle training prevents pulmonary complications after cardiac surgery—a systematic review. *Dan Med J*. 2018;65(3):A5450. Available from: [https://ugeskriftet.dk/files/scientific\\_article\\_files/2018-08/a5450.pdf](https://ugeskriftet.dk/files/scientific_article_files/2018-08/a5450.pdf)
11. Mitchell A, Bacon C, Moran R. Reliability and determinants of Self-Evaluation of Breathing Questionnaire (SEBQ) score: a symptoms-based measure of dysfunctional breathing. *Applied psychophysiology and biofeedback*. 2016;41(1):111-20. <https://doi.org/10.1007/s10484-015-9316-7>
12. Miskovic A, Lumb A. Postoperative pulmonary complications. *BJA: British Journal of Anaesthesia*. 2017;118(3):317-34. <https://doi.org/10.1093/bja/aex002>
13. Townsend K. *Fundamental Concepts and Skills for the Patient Care Technician-E-Book*. Elsevier Health Sciences, 2022. Available from: <https://books.google.com.pk/books?hl=en&lr=&id=wBl2EAAAQBAJ&oi=fnd&pg=PP1&dq=Little+KT>.
14. Perry AG, Potter PA, Ostendorf W, Cobbett S. *Canadian Clinical Nursing Skills and Techniques E-Book*. Elsevier Health Sciences, 2019. Available from: <https://books.google.com.pk/books?hl=en&lr=&id=CsGZDwAAQBAJ&oi=fnd&pg=PP1&dq=Wright-Boon+CJ,+Ozog+N>.
15. Akhtar A, Macfarlane RJ, Waseem M. Pre-operative assessment and post-operative care in elective shoulder surgery. *Open Orthop J*. 2013;7:316-22. <https://doi.org/10.2174/1874325001307010316>
16. Al-Qubati FAA, Damag A, Noman T. Incidence and outcome of pulmonary complications after open cardiac surgery, Thowra Hospital, Cardiac center, Sana'a, Yemen. *Egyptian Journal of Chest Diseases and Tuberculosis*. 2013;62(4):775-80. <https://doi.org/10.1016/j.ejcdt.2013.08.008>
17. Mazo V, Sabate S, Canet J, Gallart L, De Abreu MG, Belda J, Langeron O, Hoelt A, Pelosi P. Prospective external validation of a predictive score for postoperative pulmonary complications. *Anesthesiology*. 2014;121(2):219-31. <https://doi.org/10.1097/ALN.0000000000000334>
18. Ali SB, Shabaan EG-E, Diab TM, Fehro A, Eid RM. Synergistic Effect of Flow Incentive Spirometer and Diaphragmatic Breathing Exercise for Patients with Upper Abdominal Surgery. Available from: <https://www.researchgate.net/publication/326557078>
19. Sallam GKS, Abdalla KF, Mahmoud SF. Effect of an Educational Program for Patients Post Coronary Artery Bypass Surgery on the Compliance with Symptoms Management Strategies. *Indian Journal of Forensic Medicine & Toxicology*. 2021;15(4). Available from: <https://web.s.ebscohost.com/abstract?direct=true&profile=ehost&scope=site&authtype=crawler&jrnl=09739122&AN=153355917>
20. Sorour DM, Khalil MIM, Sharaan MA, El Geneidy MM. Effect of Deep Breathing Exercises versus Incentive Spirometry on Pulmonary Complications among Geriatric Patients Undergoing Upper Abdominal Surgery. *International Journal of Novel Research in Healthcare and Nursing*. 2019;6(3):537-55. Available from:

<https://www.noveltyjournals.com/upload/paper/Effect%20of%20Deep%20Breathing%20Exercises-2058.pdf>

21. Вітомський В. Comparison of three respiratory physical therapy techniques and their impact on pulmonary function restoration among cardiac surgery patients in hospital settings. Запорізький медичний журнал. 2021;23(4):531-5.  
<https://doi.org/10.14739/2310-1210.2021.4.226538>