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Effect of Deep Breathing Exercises versus Incentive Spirometry on Pulmonary Complications among Geriatric Patients Undergoing Upper Abdominal Surgery

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Abstract: **Major gastric surgeries are among the most widespread operations in older adults' patients reached growing rates of postoperative mortality and morbidity. The surgical opening is often approaching the diaphragm with a serious consequence of pulmonary complications which presented with miscellaneous atypical presentations making both diagnosis and management a challenge. The prudent use of therapeutic lung expansion guides like incentive spirometry and deep breathing exercises become imperative to increase lung volume and prevent such life-threatening complications. Here comes the responsibility of gerontological nurses toward facilitating the use of these modalities and factors that decrease geriatric patients' awareness and hinder their education. Aim: The aim of the current study is to compare the effect of deep breathing exercises versus incentive spirometer on pulmonary complications among geriatric patients undergoing upper abdominal surgeries. Methods: Setting: This study was conducted at two surgical units affiliated to General Alexandria Main University Hospital, Egypt; specialized in upper abdominal surgeries. Subjects: A total of 60 male and female older adults hospitalized to undergo upper gastric surgeries, selected using the consecutive sampling technique, and divided into three groups: two experimental groups (interventional group) and one control group (routine hospital care). Data were collected through five tools: Mini Mental State Examination, Socio-demographic and health profile of the geriatric patients structured interview schedule, Katz activities of daily living scale (six activities of daily living according to three levels of dependency; fully independent, partially dependent, and totally dependent), ARISCAT Risk index (7-independent risk factors), and Melbourne Group Scale (MBG, 8-item checklist). Results: Lung expansion manipulations had statistical significant reduction on the outcrop of pulmonary complications following upper gastric surgeries in geriatric patients, as only 6.7% of those target patients in the study groups presented with these complications on the 6th postoperative day, compared to 60% of their counterparts in the control group.**

Conclusion: Application of either deep breathing exercises or incentive spirometer proved to be equally influential in diminishing the incidence of pulmonary complications denoting the period following upper gastric surgical operation for elderly subjects. The postoperative pulmonary complications for elderly who underwent these serious surgeries in the deep breathing exercise or incentive spirometer group proved to be lower than those in the matching group with a statistically significant difference between the groups. Recommendations: The pursuit of deep breathing exercises and/or use of incentive spirometer should be established as a routine interventional measure for older adult's patients undergo upper gastric surgeries in clinical settings. Developing of educational classes, posters, or brochures related to importance and steps of lung expansion modalities for both geriatric patients and gerontological nurses should be launched and stepped in the pre and post-operative period.

Keywords: **Deep breathing exercises, Geriatric patients, Gerontological nurses, Incentive spirometer, Lung expansion modalities, Postoperative pulmonary complications, Upper abdominal surgeries.**

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I. INTRODUCTION

Upper gastrointestinal operations are notified to be one of the most continual major surgical proceedings executed for geriatric patients. [1] Upper gastric surgery is sorted out as "any surgical procedure performed through an incision into the abdomen above or extending above the umbilicus. [2] In this type of surgery, the incision is sustained from the xiphoid area and terminating immediately on top of the umbilicus. Upper gastrointestinal interference encompasses the surgical procedures of the spleen, stomach, liver/biliary tree, pancreas, upper duodenum, and transverse colon. [3] So, it includes surgical intrusions as hepatic-biliary mutilation, splenectomy, gastric bypass, pancreatectomy and other interventions in the upper guts cavity performed by conventional laparotomy or laparoscopy. [2]

Geriatric patients are often viewed as high-risk surgical candidates as senescence is as a role linked with decreased functional reserve of the critical organ systems which result in decreased ability to cope with surgical stress. [4] A retrospective study in Estonia (2014) revealed that 24.1% of geriatric patients of those aged sixty-five years and over were undergoing upper gastrointestinal tract surgery. [5] Another recent study in China (2017), reported that 11% of elderly patients seventy years and more underwent hepatobiliary surgery. [6] In United States of America (2018), the overall annual rates of major upper abdominal surgeries, mainly liver and pancreatic resections, in older adult reached their eighth decade, have risen from 6.7% to 11.52% within five years. [7] In Saudi Arabia (2011), higher rate of this type of surgeries was observed among geriatric patients, where the elderly patients aged above 60 years underwent 36% of appendectomy surgeries which was a challenging surgical procedure for them. [8] Another study was proceeded in the Department of surgery, Faculty of Medicine, Alexandria University (2011), revealed that 118 geriatric patients underwent surgery for colon carcinoma during this year. [9]

Unfortunately, the older adults are at higher risk of acquiring postoperative complications. Approximately 35% of geriatric patients planned for upper abdominal surgeries suffered from postoperative complications and approximately 10% of them are at the 30- day mortality rate risk. [10] This may be due to age- related changes, decline of the physiological reserve and the tolerance for postoperative adverse –events, as well as increasing incidence of co-morbidities. [11,12] Consequently, it is more difficult for many older adults to recover in the wake of upper abdominal surgeries, regain independence or return home following discharge, and they often largely demand post-acute care services. [13]

Postoperative respiratory complications are the most common and serious sort of problems determined after upper abdominal surgeries. As, the closer an operation's incision is to the diaphragm, the more likely is the chance of achieving postoperative pulmonary complications. So, upper abdominal surgical procedures are tied up with a 20% incidental rate of postoperative pulmonary complications, whereas lower abdominal surgeries hold an incidence of 2 to 8%. [14] Upper abdominal operations initiate a series of pathological responses which potentially lead to the postoperative pulmonary complications for the older adults. [15] These pathological responses include depressed central nervous system, decreased diaphragm mobility, impaired muco-ciliary function, reduced cough efficacy, changes in the ventilation-perfusion ratio, increased respiratory rate, and reduced pulmonary volumes and capacities. [2, 16] Additionally, the risk for postoperative pulmonary complications duplicated with advanced age and its associated variations in the respiratory system, chronic obstructive pulmonary diseases, functional dependence, cigarette smoking, obesity, poor nutritional status, and emergency surgical procedure. [17,18] General anesthesia disturbs many aspects of respiratory function, and therefore, upper abdominal surgical procedures that necessitate general anesthesia have a higher proportion of risk for developing postoperative pulmonary complications than those necessitate regional anesthesia. [19,20] Long-acting neuromuscular blockers such as pancuronium might also compromises cough reflex and airway patency. [21] Narcotic medications for pain control may increase aspiration risk through slowing of gastrointestinal motility and in return, increase the susceptibility for pulmonary complications postoperatively by reducing the ventilatory response to hypoxia and hypercapnia. That is why, these medications should be avoided in geriatric patients. [22]

Hypoxemia, atelectasis, and pneumonia are the well-known pulmonary complications widely linked with upper abdominal surgeries which increase the duration of hospital stay, treatment costs and significantly increasing postoperative mortality rate. [23,24] The incidence rate for postoperative atelectasis extended from 20% up to 69% and for postoperative pneumonia from 9% to 40% after upper gastric surgeries. [23] Postoperative pulmonary complications accounted for 24% of deaths within the first 6 days next to upper abdominal surgeries among the hospitalized geriatric patients. [25] The problem is that geriatric patients with postoperative complications in the respiratory system can be

presented asymptomatic or it may be manifested as dyspnea, rapid shallow breathing, diminished, weaken or absent of lung sounds, mild tachycardia, or hypoxemia. A change in cognition or delirium resulting from hypoxia can be one of the frontline signs of these complications in the older adults, making early detection a confront. [26]

The lung expansion techniques reported to be the mostly beneficial strategy for avoiding postoperative pulmonary complications for geriatric patients subjected to upper abdominal surgeries. These modalities include deep breathing exercises, incentive spirometry, intermittent positive pressure breathing and continuous positive airway pressure. [27,28] Deep breathing exercises promote better lung expansion, gas-exchange, and tissue perfusion. Incentive spirometry is also a machine that promotes deep breathing and helps to inflate collapsed alveoli, thus improving lung functions after these surgeries. [29] Preoperative deep breathing exercise practicing or incentive spirometry training is conveyed to be associated with an absolute risk reduction of 20% in postoperative pulmonary complications. These maneuvers are more effective if patient's teaching begins before surgery at least 24 to 48 hours preoperatively and should be continued for 3 to 5 days postoperatively. [30] Deep breathing exercises or incentive spirometry should be proposed for all geriatric patients nominated for upper abdominal surgeries because they are at higher risk for negative bronchopulmonary consequences. [31] The American College of Physicians Clinical Guidelines (2006) support the use of lung expansion modalities in aiming at maintaining patient airway and improving breathing pattern and gas exchange. [32]

The gerontological nurse should institute evidence-based practices to prevent postoperative respiratory tract complications that greatly presented, in association with, upper abdominal surgeries. Geriatric patients should be assessed and monitored closely preoperatively for nutritional, cognitive and functional status, likewise, the pulmonary functional status and existing bronchopulmonary disease such as chronic obstructive pulmonary disease. Additionally, gerontological nurse should encourage the geriatric patient to stop cigarette smoking for at least 8 weeks before these surgeries, as well as educate them about lung expansion exercises such as deep-breathing exercises and use of the incentive spirometry, early and frequent mobilization, and optimal pain management all have to be included as key components of the preoperative preventive strategies. [30,31]

Despite predictions that better modalities can positively influence the lung function of the Egyptian geriatric patients undergoing upper abdominal surgeries, there is a lack of evidence supporting this assumption. This study further gives gerontological nurses opportunities to more deliberately individualize nursing interventions and to provide more intensive interventions for geriatric patients to prevent these complications.

Aim of the study:

To determine the effect of deep breathing exercises versus the incentive spirometry on pulmonary complications among geriatric patients undergoing upper abdominal surgeries.

Hypothesis:

H1: Geriatric patients undergoing upper abdominal surgery who perform deep breathing exercises exhibit lower incidence of postoperative pulmonary complications than those who don't.

H2: Geriatric patients undergoing upper abdominal surgery who use incentive spirometry exhibit lower incidence of postoperative pulmonary complications than those who don't.

H3: Geriatric patients undergoing upper abdominal surgery who perform deep breathing exercises exhibit lower incidence of postoperative pulmonary complications than those who use incentive spirometry.

H4: Geriatric patients undergoing upper abdominal surgery who use incentive spirometry exhibit lower incidence of postoperative pulmonary complications than those who perform deep breathing exercises.

Operational definition:

For this study, **pulmonary complications** refer to the presence of either atelectasis or pneumonia during the first 6 postoperative days.

II. MATERIALS AND METHOD

Materials

I- Design:

A quasi-experimental research design was used in this study.

II- Settings:

The study was conducted in the Hepatic and Pancreatic surgical department (3 wards, with a total capacity of 28 beds), and the Gastrointestinal surgical department (5 wards, with a total capacity of 36 beds) specialized in upper abdominal surgeries and affiliated to the Alexandria Main University Hospital. According to statistical records of the admission department in the hospital, these departments collectively have an admission rate of about 40-50 geriatric patients undergoing upper abdominal surgeries during 3 months' period.

III- Subjects:

The study subjects comprised 60 geriatric patients admitted to the above-mentioned settings and fulfilling the following criteria; age 60 years and above, admitted for upper abdominal surgery, able to communicate, with no cognitive impairment, and accept to participate in the study. Geriatric patients with either cerebrovascular disease or decompensated cardiac problems or preoperative respiratory problems or postoperative peritonitis or planned for laparoscopic surgery were excluded from the study subjects.

The selected subjects were randomly assigned to three groups: two study groups and one control group. The study groups included 30 geriatric patients undergoing upper abdominal surgery and fulfilling the study criteria. These subjects were divided into two equal groups of 15 geriatric patients each. Group I received the deep breathing exercises and group II received the incentive spirometry therapy. As for group III (control group) included 30 geriatric patients and were left to the routine hospital care.

Sample size calculation:

The Epi info V 7.0 was used to estimate the sample size using the following parameters; population size=40 over three months, expected frequency=50%, acceptable error=10%, confidence coefficient= 95%. According to the Epi info V 7.0, the estimated sample size is 60 geriatric patients.

III- Tools:

Five tools were used for data collection.

Tool I: - Mini Mental State Examination (MMSE)

The MMSE was developed by Folstein et al. (1975) [33]. It is a reliable scale designed to assess the elder's cognitive function. It was translated into Arabic language by El Husseini S. (2008) [34] and approved to be valid and reliable scale, with a reliability coefficient of (r=0.96). It consists of 11- questions that investigate five aspects of cognitive function; memory, orientation to time and place, attention and calculation, naming, repetition and language, praxis and copying of a design. This tool was used to exclude geriatric patients with mild or severe cognitive impairment. The minimum total score of Mini Mental State Examination is zero, while the maximum total score is 30. Scoring is based on the number of correct items and categorized in the following manner; score of 24-30 indicates normal cognitive function, score of 18-23 indicates mild cognitive impairment, and score of 0-17 indicates severe cognitive impairment.

Tool II: - Socio-demographic and health profile for the geriatric patients undergoing upper abdominal surgery structured interview schedule.

This tool was developed by the researcher and consisted of four parts:

Part I: The socio-demographic characteristics of the study subjects such as age, sex, marital status, educational level, job before retirement and income.

Part II: The health profile of the geriatric patients

- Past and present medical data such as history of chronic diseases such as diabetes mellitus, hypertension, gastrointestinal or hepatic disease, intake of medication.
- Past and present surgical data such as previous surgery during the last year, current surgical diagnosis.
- Laboratory investigations within the last month such as albumin level and hemoglobin level.

Part III: Assessment of the preoperative respiratory status of the geriatric patients through measurement of pulse oximeter oxygen saturation, assessment for history of obstructive sleep apnea and risk factors precipitating to postoperative pulmonary complications such as smoking, exposure to environmental or occupational pollution.

Part IV: Calculation of body mass index:

- Body mass index (BMI): weight in kilogram divided by height in meter^2, where ≤ 22 Kg/ m^2 reflects underweight, 22to 27 Kg/ m^2 reflects normal weight, ≥ 27 Kg/ m^2 reflects overweight, and ≥ 27 Kg/ m^2 reflects obesity.

Tool III: - Katz activities of daily living scale

It was developed by Katz and Akpom (1976), [35] as a measurement of the client's ability to perform ADLs independently. It was translated into Arabic and proved to be valid and reliable (r= 0.83) scale by a study done in Alexandria by El Sayed E. (2007). [36] The scale measures the ability of the client to perform six main activities of daily living namely; morning care, toileting, feeding, dressing, bathing, transfers and ambulation. Geriatric patients are scored in each of the six activities of daily living according to three levels of dependency; (fully independent, partially dependent, and totally dependent). The total score of the scale is 18 points, with a score of 6 points indicates full independent elder i.e. able to perform task without assistance, score from 7 to 12 points indicates partially dependent elder i.e. able to perform task with some help assistance, and score from 13 to 18 points indicates a totally dependent elder i.e. unable to perform task even with assistance.

Tool VI: - ARISCAT risk index

The ARISCAT risk index was developed by Canet et al. in (2010). [37] This index was used for assessing the overall risk for developing postoperative pulmonary complications for surgical patients. This index consists of 7 independent risk factors to be assessed after the surgery with point values are assigned to each factor according to patient's condition. The risk factors with different Likert scales for each, include advanced age (above 50 years), low preoperative oxygen saturation (less than 96%), presence of respiratory infection within the last month (e.g. bronchitis), preoperative anemia (Hb equal to or less than 10mg/dl), upper abdominal surgical incision, duration of surgery (two hours or more), type of operation (emergency surgery) and each had certain score. The minimum total score of the ARISCAT risk index is zero while the maximum total score is 123. Based on the total score, the patient's risk for developing postoperative pulmonary complications is stratified as follows; score from 0 to 25 points denotes low-risk group, score from 26 to 44 points denotes intermediate-risk group, score of 45 to 123 points denotes high-risk group.

Tool V: - Melbourne Group Scale

Melbourne Group Scale (MGS) was developed by Scholes et al. in (1999)[38] as a diagnostic checklist tool consisting of eight items that helps to identify patients who have postoperative pulmonary complications following upper abdominal surgeries, when they are presenting with four or more of the following eight dichotomous criteria which are categorized as clinical and diagnostic criteria. **The clinical criteria** include Abnormal breath sounds on auscultation which differ from preoperative assessment, purulent sputum differing from preoperative status, oxygen saturations <90% on room air, raised temperature >38C on more than one consecutive postoperative day. Those four indicators of infection were detected by physical examination on the 1st, 3rd& 6th day postoperative. **The diagnostic criteria** include raised white blood cell count (>11.23109/l), chest x-ray findings of atelectasis or consolidation, physician diagnosis of pneumonia, presence of infection on sputum culture. These indicators were collected from reviewing of patient's chart in the same previously mentioned postoperative days.

METHOD

I. Preparatory phase:

1- Obtaining approvals

An official letter was issued from the Faculty of Nursing, Alexandria University and forwarded to the director of the Alexandria Main University Hospital in order to obtain his approval to carry out the study. Head of the Hepatic and Pancreatic surgical department, and Gastrointestinal surgical department were informed about the purpose of the study, the date and the time of data collection in order to obtain their permission to meet the study subjects.

2- Literature review

A thorough review of literature related to lung expansion modalities used to prevent pulmonary complications after upper abdominal surgeries were done by the researcher. Researches concerning the topic of the study were helpful in designing the data collection tools.

3- Preparation of study tools:

The Arabic version of tool I: The Mini Mental State Examination was used to identify the geriatric patients with intact cognitive function to be included in the study subjects.

Tool II: the socio-demographic and health profile for the geriatric patients undergoing upper abdominal surgery structured interview schedule was developed by the researcher based on thorough review of relevant literature.

Tools validity:

The preliminary forms of tool IV (ARISCAT) and V (Melbourne) were translated into Arabic language and presented to a panel of experts for content validity. The jury panel consists of five professors of Gerontological Nursing, Medical-surgical Nursing and critical Care Nursing from Faculty of Nursing, Alexandria University. According to their opinion, the recommended modifications were performed.

Reliability:

Tool IV (ARISCAT) and V (Melbourne) were tested for their reliability using intra-rater test (Cohen's Kappa) reliability test. These tools were applied to 10 geriatric patients undergoing upper abdominal surgery selected from the Hepatic and Pancreatic, and Gastrointestinal surgical department (these patients were not included in the study subjects). The reliability for ARISCAT (tool IV) was (r= 0.771) and for Melbourne (tool V) was (r=0.814).

Pilot study:

This was carried out on ten newly admitted geriatric patients undergoing upper abdominal surgeries selected from both study surgical departments. The pilot served to assess the clarity of the questionnaire as well as the applicability of the study tools. The geriatric patients included in the pilot study were excluded from the study subjects. Accordingly, the necessary modifications in the study tools were done and the sheets were put into the final form.

4- Developing the educational program:

After a thorough review of related literature, the researcher designed an educational program of lung expansion modalities namely deep breathing exercises and incentive spirometer use for geriatric patients undergoing upper abdominal surgery. The program covered items related to age-related changes of the respiratory system, benefits of lung expansion modalities either deep breathing exercise or incentive spirometer use, simple instructions and illustrations for each step of the deep breathing exercise/ incentive spirometer use as well as the schedule of performing the exercises.

Methods of teaching during different sessions:

During conducting the sessions, the researcher used different teaching methods such as:

- Discussion on individual basis using pictures in the illustrative booklet.
- Demonstration and re-demonstration of deep breathing exercise/ incentive spirometer use.

An illustrative booklet was developed by the researcher to be used in teaching the geriatric patients undergoing upper abdominal surgeries. This booklet helps to guide geriatric patients in demonstrating deep breathing exercises and incentive spirometer use.

Implementation phase:

5- Sampling:

- Based on the weekly schedule of the outpatient clinics, Thursday is the day scheduled for the Hepatic and Pancreatic surgical department (department A) and Sunday for the Gastrointestinal surgical department (department B) where cases requiring upper abdominal surgical intervention are admitted to these departments on the scheduled day of the clinics. In

order to meet the newly admitted geriatric patients and to identify those fulfilling the study criteria, the researcher used to go to the study settings the next day following the schedule of the outpatient clinic either on Friday or Monday respectively for the two surgical departments (department A and B).

- Eligible geriatric patients were interviewed individually to assess their cognitive status using Mini Mental State Examination (MMSE) (tool I). Those with no cognitive impairment were included in the study and assigned either to study group (I or II) or control group (III) using **consecutive sampling technique as follows:**

- In the first week of data collection on the previously mentioned days, two of the newly admitted eligible geriatric patients from department A were assigned to group I (deep breathing exercise) and two from department B were assigned to group II (incentive spirometer therapy).

- In the second week of data collection and in order to prevent contamination between participants of the study and control groups, two of newly admitted eligible geriatric patients from each surgical department (A and B) were assigned to group III (control group). These geriatric patients were left to the hospital routine care.

- In the third week of data collection, two of newly admitted eligible geriatric patients from department B were assigned to group I (deep breathing exercise) and two from department A to group II (incentive spirometer use). This switch was done because the type of upper abdominal surgeries was different in the two surgical departments.

- In the fourth week of data collection, two geriatric patients from each study surgical department were enrolled in group III (control group).

- This process was repeated successively until completing the selection of the total number of study subjects i.e.15 geriatric patients in each of study group (I and II), and 30 geriatric patients in the control group.

6- Baseline assessment:

Every study subject meeting the eligible criteria was interviewed individually to collect the baseline information about socio-demographic and health profile using (tool II). As well as, the functional status of the geriatric patients was assessed using (tool III).

7- Applying the educational program:

The program was implemented individually in 6 sessions; three sessions preoperatively i.e. before the planned surgery (on 1st, 2nd, and 3rd day after hospital admission), and the other three sessions after the surgery (on 1st, 3rd, and 6th day postoperative).

A) Preoperative sessions:

First session: this session took place during the first 24 hours of geriatric patient's admission to the hospital. At the beginning of the session, the researcher introduced herself and explained the general objective of the program to gain the cooperation of the geriatric patient and take his approval to participate in the study. This session took 30 minutes. This session covered items related to:

- Age-related changes in the respiratory system.

- Importance of either deep breathing exercise for group I or incentive spirometer use for group II in preventing postoperative pulmonary complications.

- Demonstration of deep breathing exercise' technique for group I or incentive spirometer use for group II by the researcher.

- The geriatric patient was given an instructional booklet with illustrative pictures to clarify the steps and remind him of the correct technique.

Second and third sessions: were conducted on the 2nd and 3rd day of hospital admission. These sessions included:

- Re-emphasizing the importance of deep breathing exercise for group I or of incentive spirometer use for group II and check the patient's practice of the exercise during the previous day.

- Emphasizing the importance of performing the exercises 4 times daily.
- Give positive feedback to maintain geriatric patient's motivation to perform the exercise after recovery from anesthesia. Each of these sessions took about 30 minutes.

B) Postoperative sessions: included three sessions

First session: this session was conducted 24 hours after surgery when the geriatric patient was able to perform either the deep breathing exercise or incentive spirometer use, during this session the researcher:

- Revised and emphasized instruction given in the preoperative period about deep breathing exercise for elders in group I or incentive spirometer use for those in group II and ask the patient to continue practicing the exercise under the supervision of the researcher.
- Assessment of the overall risk for developing postoperative pulmonary complications for geriatric patients after 24 hours of the surgery using ARISCAT index (tool VI). This was done by the researcher.
- Assess the presence of postoperative pulmonary complications namely; atelectasis and pneumonia 24 hours after upper abdominal surgery using Melbourne Group Scale (MGS) (tool V). This session took around 30 minutes.

Second and third sessions: these sessions were conducted in the morning shift of the 3rd and 6th postoperative day. These sessions included:

- Encouraging and motivating geriatric patients to practice the exercise to decrease the incidence of postoperative pulmonary complications.
- Assess the presence of postoperative pulmonary complications after upper abdominal surgery using Melbourne Group Scale (MGS) (tool V). Each of these sessions took 30 minutes.
- At the end of each session, a brief summary was given by the researcher, emphasizing the most important points. Also, at the beginning of the next session, the researcher revised what was taught in the previous session to make sure the patient understands and follows the given instructions.

For group III (control group):

Geriatric patients in the control group were assessed individually on admission using tool II to assess their socio-demographic and health profile and tool III to assess their functional status preoperatively. Geriatric patients in the control group received the routine hospital care provided for all patients undergoing upper abdominal surgery. No instructions or booklet were given to these geriatric patients. On the first postoperative day, the researcher used ARISCAT Risk Index (tool IV) to assess the geriatric patient's risk for developing postoperative pulmonary complications. As well as, this group was followed by the researcher three times postoperatively; on the first, third and sixth postoperative days to assess the presence of postoperative pulmonary complications using Melbourne Group Scale (tool V).

- The data collection started on the first of January 2019 to the end of June 2019.

8- Evaluation phase:

The researcher assessed the respiratory status for each geriatric patient in the study and control groups after upper abdominal surgery three times; on the first, third, and sixth postoperative day using Melbourne Group Scale (tool V) to evaluate the effect of the program on the incidence of postoperative pulmonary complications. Comparison was done between the three groups using proper statistical analysis to identify which intervention is the most effective in preventing postoperative pulmonary complications for geriatric patients undergoing upper abdominal surgeries.

Ethical considerations:

An informed oral consent was obtained from each study subject included in this study after being informed about the purpose of the study. The desire of the study subjects to withdraw from the study at any time was respected. Geriatric patients were assured that all data taken by the researcher will be used only for the purpose of the study and will not be available for others. Anonymity and privacy of the study subjects was maintained and confidentiality of the collected data was assured.

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Limitations of the study:

During the different phases of the study, thirteen geriatric patients (six in the study and seven in the control group) did not complete the study. The main reasons were preoperative respiratory infections, uncontrolled diabetes or hypertension and intraoperative peritonitis. These geriatric patients were replaced by others in order to maintain the sample size.

Statistical analysis of the data

After data were collected, they were coded and transformed into specially designed forms to be suitable for computer feeding. All entered data were verified for any errors. Statistical Package of Social Science "SPSS "software version 20.0 was used for analysis of data. Statistical significance was considered at the level of P at $p \leq 0.05$.

The following statistical measures were used:

A- Descriptive statistics:

- **Number and percentage:** used for describing and summarizing the qualitative data.
- **Arithmetic mean (x), standard deviation:** used for describing central tendency and dispersion for quantitative data.

B- Analytical statistics:

- **Pearson 's Chi square test:** used to test the association / relationship between qualitative variables, if more than 20% of the cells have expected value ≥ 5
- **Mont Carlo Exact test:** it is alternative for the Pearson 's Chi square test, used if more than 20% of the cells have expected values <5
- **Fisher's Exact test:** it is alternative for the Pearson 's Chi square test, used if the expected value of one or more cells =0
- **Univariate Regression test:** used to test the relation between postoperative pulmonary complications and other independent variables. Only the variables that have P-values lower than 0.10 in the analysis, considered to be associated with postoperative pulmonary complications. Odds ratios (OR) and 95% confidence intervals (95% CIs) were used to estimate the association between postoperative pulmonary complications and other variables.

III. RESULTS

Fig. 1. shows the level of risk for developing postoperative pulmonary complication of the study and control subjects. It was evident that 10% of the geriatric patients in the study group, compared to 13.3% of those in the control group were stratified as at low risk for developing postoperative pulmonary complications. 53.3% of elders in the study group, compared to 40% of the control group were classified as at intermediate- risk for developing postoperative pulmonary complications. High-risk group constituted 36.6% of cases in the study group and 46.7% of those in the control group. The mean score for elders in the study group was 37.3 ± 8.674, compared to 41.1 ± 12.947 for those in the control group. No statistically significant difference was found among the study and control groups regarding degree of risk for developing postoperative pulmonary complication. (P= 0.096)

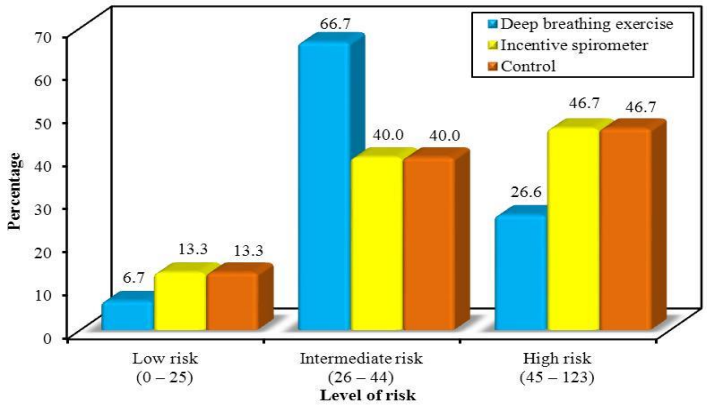

Fig. 1: Distribution of the study and control subjects according to their level of risk for developing postoperative pulmonary complications

Table (I) shows comparison between the study and control groups according to presence of postoperative pulmonary complications in the first six postoperative days based on Melbourne scale. It appears that none of the geriatric patients in both the study and control groups had respiratory complications on the 1st postoperative day. While on the 3rd postoperative day, 6.7% of elderly in the incentive spirometer group, compared to 20% of those in the routine care group developed postoperative pulmonary complications, with no significant difference between the three groups. Whereas, 6.7% of patients in each of the study groups, compared to 60% in the routine care group had postoperative pulmonary complications on the 6th postoperative day. A statistically significant difference was found between deep breathing exercise and routine care group (P= 0.000), and between incentive spirometer and routine care group (P= 0.000). Whereas, no significant difference was found between deep breathing and incentive spirometer groups.

Table (I) Comparison between the study and control groups according to presence of postoperative pulmonary complications based on Melbourne scale.

Postoperative pulmonary complications	Deep breathing exercise group (n= 15)		Incentive spirometer group (n= 15)		Routine care group (n= 30)		Test of sig.
	No	%	No	%	No	%	
1st postoperative day							FET-------
No	15	100.0	15	100.0	30	100.0	
Yes	0	0.0	0	0.0	0	0.0	
3rd postoperative day							FET $_1$= 3.462 P_1= 0.157
No	15	100.0	14	100.0	24	80.0	
Yes	0	0.0	1	0.0	6	20.0	FET_2= 3.462 P_2= 0.157 FET_3=--------
6th postoperative day							FET_1= 14.464 P $_1$= 0.000
No	14	93.3	14	93.3	12	40.0	
Yes	1	6.7	1	6.7	18	60.0	FET_2= 14.464 P_2= 0.000 FET_3= 0.000 P $_3$= 1.000

FET1= Fisher exact test between group 1 and group 3

FET2= Fisher exact test between group 2 and group 3

FET3= Fisher exact test between group 1 and group 2

Table (II) shows the comparison between the study and control groups regarding to the clinical criteria of postoperative pulmonary complications during the 1st, 3rd, 6th postoperative day using Melbourne scale. Regarding to new abnormal breath sounds on chest auscultation, it was evident that 6.7% of elders in deep breathing exercise group, compared to 33.3% of those in routine care group had this criterion on the 3rd postoperative day. 6.7% of geriatric patients in each of the study groups, compared to 60% in routine care group on the 6th postoperative day, with a significant difference on the 3rd and 6th postoperative day (P= 0.002, 0.000 respectively).

With regards to SpO2 value postoperatively, it was reported that 73.3%, 80%, 76.7% of elderly in the deep breathing, incentive spirometer, and routine care groups respectively had Spo2 ≤90% on the 1st postoperative day. On the 3rd postoperative day, 6.7% of elderly in each of the deep breathing and incentive spirometer groups, compared to 60% of those in the routine care group had Spo2 ≤90%. While on the 6th postoperative day, only 60% of elderly in the routine care group had this criterion, with significant difference between the groups on the 3rd and 6th postoperative day.

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Table (II) Comparison between the study and control groups according to presence of clinical criteria of postoperative pulmonary complications on Melbourne scale.

Clinical criteria	Deep breathing exercise group (n= 15)		Incentive spirometer group (n= 15)		Routine care group (n= 30)		Test of sig.
	No	%	No	%	No	%	
New abnormal breath sounds							
1st postoperative day	0	0.0	0	0.0	0	0.0	FET--------
3rd postoperative day	1	6.7	1	6.7	10	33.3	X2= 9.504 P= 0.002
6th postoperative day	1	6.7	1	6.7	18	60.0	X2= 23.787 P= 0.0000
$Spo_2 \leq 90\%$							
1st postoperative day	11	73.3	12	80.0	23	76.7	$X^2 = 0.98$ P= 1.000
3rd postoperative day	1	6.7	1	6.7	18	60.0	$X^2 = 17.733$ P= 0.000
6th postoperative day	0	0.0	0	0.0	18	60.0	$X^2 = 18.542$ P= 0.000

Table (III) shows the duration of hospital stay for the study and control subjects. It appears from the table that the hospital stay for geriatric patients in the study groups ranged from 11 to 14 days with a mean of 11.89±0.523 days, compared to hospital stay ranged from 11 to 42 days with a mean of 20.6±6.80 days for those in the control group. A statistically significant difference was found among the study and control groups regarding duration of hospital stay (p= 0.048).

Table (III) Distribution of the study and control subjects according to duration of hospital stay.

Item	Study subjects						Group (3) Control (n= 30)		Test of sig.
	Group (1) Deep breathing exercise (n= 15)		Group (2) Incentive spirometer (n= 15)		Total of study subjects (n=30)				
	No	%	No	%	No	%	No	%	
Duration of hospital stay in days									
11 days	4	26.7	4	26.7	8	26.7	2	6.7	
12 days	9	60.0	9	60.0	18	60.0	6	20.0	
13 days	1	6.7	2	13.3	3	10.0	3	10.0	
14 days	1	6.7	0	0.0	1	3.3	3	10.0	X^2 =4.6364 P=0.0489
More than 14 days	0	0.0	0	0.0	0	0.0	16	53.3	
Mean±SD	11.93±0.638		11.86±0.409		11.89±0.712		20.6±6.88		

X^2 = Pearson chi-square test **Statistically significant difference at ≤ 0.05**

Table (IV) shows the univariate analysis of factors associated with postoperative pulmonary complications in upper abdominal surgery. It appears that increased risk of postoperative pulmonary complications is associated with age above 70 years (OR= 1.525, P= 0.000), male gender (OR= 2.683, P= 0.10), history of smoking (OR= 6.397, P= 0.002). As well as, Body Mass Index above 30KG/m2 (OR= 3.111, P= 0.000), partially functional dependency (OR= 3.017, P= 0.000), duration of surgery more than 3 hours (OR= 5.00, P= 0.014) were found to significantly influence the development of postoperative pulmonary complications.

Table (IV) Univariate analyses of factors associated with postoperative pulmonary complications following upper abdominal surgery.

Factors	OR	95% CI	P-value
Age above 70 years	1.525	1.231-1.888	0.000
Male gender	2.683	0.907-7.943	0.010
History of smoking	6.397	1.963-2.841	0.002
Body mass index (BMI) greater than 30Kg/m2	3.111	0.907-7.943	0.000
Albumin level less than 3.2 mg/dl	0.535	0.178-1.603	0.264
Hemoglobin level less than 10mg/dl	0.584	0.407-0.838	0.426
Partially functional dependency	3.017	2.494-7.744	0.000
Duration of surgery more than 3 hours	5.000	0.000-1.384	0.014

OR= Odds ratio CI= confidence interval Statistically significant difference at ≤ 0.01

IV. DISCUSSION

The frequency of elective upper abdominal surgeries for elderly patients has been increased in the recent years, which raises the question of how best to prevent their complications in aging researches. [39,40] Elderly surgical patients are thought to be at increased risk for the development of postoperative pulmonary complications with a ramification of slower recovery, higher mortality rate, longer length of hospital stays, alterations in pulmonary functions, and doubled hospital cost. [41,42]

The current study has provided some promise in reducing the incidence of pulmonary complications following upper abdominal surgeries through gaining nursing knowledge and necessitation of appropriate practice. It succeeded in proving that performing either deep breathing exercises or using incentive spirometer are equally effective in reduction of such significant complications among the geriatric patients, with no documented significant difference between the two modalities in their efficacy. This result may be related to the effective application of the proposed program preoperatively through three consecutive sessions. Each geriatric patient was interviewed before the operation on the 1st, 2nd, and 3rd day of hospital admission. During these sessions, researchers demonstrate technique of exercise and encourage geriatric patients to repeat each exercise 15 times, 4 times daily in addition to close supervision and monitoring of geriatric patients while practicing these exercises. As well as, geriatric patients were followed by the researchers on the 1st, 3rd and 6th postoperative day to ensure proper performance and compliance to perform exercises according to their schedule.

The advantages of these pulmonary exercises were evident in many literatures [43,44] to be simple, inexpensive strategies that could be easily understood and remembered by elderly patients, caregivers and families, free from side effects, and plainly instructed and formulated to be compliance with, in addition to the positive effect of these exercise on the pulmonary function which make them more successful in management of respiratory complications among elderly patients submitted to upper abdominal surgeries. Gore C. (2007), found in his study, that preoperative nursing instructions which incorporated educational classes regarding deep breathing exercises/ incentive spirometer use were more effective in reducing postoperative chest complications than waiting after the operation to give these instructions and explained that the patient's awareness would be compromised after surgery which hinder his/ her ability to comprehend instructions and lead to delayed initiation of these exercises, and consequently increase risk for pulmonary problems after surgery. [45] The recent work of Boden et al. (2018) also highlighted that preoperative training on deep breathing exercises was associated with a 20% absolute risk drooping of postoperative bronchopulmonary deteriorations. [46]

Another vital finding displayed by the present study is that geriatric patients who received health education regarding the applied pulmonary expansion manipulations reported lower incidence of pulmonary retrogradation in the postoperative period (less than 10%) when compared to controls because of their assured and definite effect on lung volumes. In this regard, a Brazilian study done by Grams S et al. (2012), and another Australian study done by Patman S et al. (2017) demonstrated that deep breathing exercises increase respiratory muscle strength, functional residual capacity, and forced vital capacity of the lung on the first six postoperative days after upper guts operations. [47,48] In this context also, Tayson F et al. (2015) reported that, the addition of visual feedback in incentive spirometer is thought to increase geriatric patients' motivation to repeat actively the steps of this exercise which lessen the presence of lung dysfunction manifestations. [49] In Saudi Arabia and India respectively, the study of El-Marakby A et al. (2013) and Kamble K

&Vardhan V. (2019) denoted that the utilization of incentive spirometer is the most probable indicator for the strength of inspiratory muscles for the purpose of diminishing chest problems for patients assigned for upper abdominal surgeries.[50,51] On the other hand, routine hospital care doesn't include any structured educational program for geriatric patients planned for abdominal surgeries neither pre nor postoperatively, which just includes administering the prescribed medical treatment that exposed the non-experimental group to a higher rate of complications.

The present study has been developed to help geriatric participants better prevent or reduce postoperative pulmonary complications through many mechanisms of improvement. The proposed modalities, as relevant by our study, upgraded PaO2 levels and cleared breathing sounds on chest auscultation after their deterioration on the 3rd and 6th day postoperative in the treatment group compared to the lower rate in the parallel group, and these results were with a highly statistical significant difference. The positive role these exercises play in improving the pulmonary function and oxygen hemoglobin saturation levels after abdominal operations was noted. Diaphragmatic breathing exercise was able to improve pulmonary mechanics and lead to beneficial effect on forced vital capacity (FVC) and pulse oximeter oxygen saturation (PaO2) post abdominal surgery. Nevertheless, other several studies [52,53,54)] documented the effective role of these exercises in maintaining chest clearance from sputum, correcting abnormal blood gases, decrease length of hospital stay, and improve quality of life accordingly.

Added a helpful assumption, a study performed at Zagazig, Egypt, by Shawky j, et al. 2016 reported that starting the respiratory physiotherapy program two weeks before the abdominal surgeries would be largely contributed to progressed inspiratory muscle strength and better elaboration in paO2 value. It was proved that decrease in PaO2 value in the first and second postoperative day for the treatment group with incentive spirometer after gastric surgery was less than the deterioration in PaO2 value in the control group. [55] Silva Y& Rickard M (2013) further mentioned an auxiliary outcome of those preoperative respiratory physical therapies before abdominal surgeries in mobilizing the bronchial secretion from lung periphery to more proximal branch. Thus, they aid in the expectoration of the sputum which enhancing pulmonary hygiene and preventing accumulation of crackles in the chest. [56]

The current study supplementary illustrated that cholecystectomy was the most common upper abdominal surgical operation performed among the study and control groups, followed by gastrectomy. The authenticated rate of gallstones in the gallbladder and cholecystitis increases with old age by 13–50%. Aging is usually associated with decreased contraction ability of the gallbladder, increased cholesterol and phospholipid content of the bile, and increased biliary tract diameter. [57,58] A Turkish study executed by Cam P et al. (2018), and an Egyptian one proceeded in El Minia, by Abu Baker A. et al in the same year, revealed that cholecystectomy was the most common abdominal surgical procedures among geriatric patients. [59,60]

Further finding revealed by the current study, is a significant relation between age and occurrence of postoperative pulmonary complications after upper abdominal surgeries. With increasing age above 70 years, the incidence of these complications raises. Age-related changes in the respiratory system that increasing risk of these complications, include reduced pulmonary elastic recoil, decrease in chest wall compliance and respiratory muscle strength, decrease in static lung volume and reduction in paO2 value. [61] Additionally, diminished immune function is common with advanced age, prone older adults to respiratory infection and postoperative pneumonia. [62] Otherwise, they are also more likely to suffer from multiple chronic illnesses, increased risk for postoperative chest complications, which established by the scientific work of Kodra et al. (2016) and Mavros M et al. (2014). [63,64]

Several randomized controlled trials of early post-anesthetic chest physiotherapy training protocols on elderly patients undergoing upper abdominal surgeries have confirmed that the occurrence of postoperative lung complications was strongly linked to age, gender, pollution, body mass index, dependency levels, and duration of surgery and hospital stay.[17,18,24] Praveen B & Ajmal I (2019), who studied gender differences in presence of pulmonary complications, found that male gender has been cited as the most commonly predictor risk factor that may susceptible geriatric patients to these complications than females [65] , which similarly reflected by the current study. No doubts, sex differences in complication experiences could have its impact in this context. Geriatric males differed in breathing pattern than females as men tend to breath more with their diaphragm and women more with their thorax, thus when the movement of the diaphragm are compromised after upper abdominal surgeries, the males have more difficulty to expand the lungs. Add to that, smoking habits that differentiate between them. [66]

There was a statistically significant relationship between smoking history that correlated with pulmonary complications, which displayed by the present study findings. Musallam M., et al. (2013) discussed that prolonged exposure of the airways to cigarette toxins leads to broncho-constriction, reduced mucociliary clearance, thickening of the mucus-secreting membrane, dilated distal airways, and destruction of alveolar walls and macrophages. These structural and functional changes occur secondary to smoking result in the alveolar spaces filling with exudate and an additional insult to pulmonary function after abdominal surgery. [67]

Prasad M, et al. (2019) found that obesity (BMI above 30) was one of the ingredient factors for postoperative pulmonary complications following open upper abdominal surgeries. [68] The present study supported such phenomenon that the more BMI a patient has, the more likely he/she is to experience complications post-surgery, as high significant relationship between elders' BMI level and elders' susceptibility to respiratory complications, was detected. Obesity adversely affects respiratory muscle function, reduced total lung capacity, functional residual capacity, and vital capacity. As well as, it leads to increased work of breathing secondary to chest wall resistance, upper airway resistance, and need to eliminate more carbon-dioxide. These changes lead to ventilation-perfusion mismatch, hypoxemia and consequently increase risk for postoperative chest complications. [69,70]

In addition, preoperative functional dependency was reported to be significantly associated with increased incidence of postoperative lung complications in the present study, resulted from negative impact of functional decline on pulmonary function. Similar findings were reported by Garbuzenko D. (2016) who observed that complications reduction following early postoperative chest physiotherapy was significantly associated with immobility reduction and added that, the prolonged bed rest is accompanied with reduce pulmonary function and tissue oxygenation. [42] Haines J., et al. (2013) noted, in support, that patients were three times more likely to have pulmonary complications for each day they did not mobilize away from the bedside after abdominal surgeries. [71]

Duration of surgery more than 3 hours significantly related to increased occurrence of postoperative pulmonary problems in the present study. Ajmal I. (2019) confirmed that the rate of postoperative pulmonary malfunctions was 40% for the abdominal surgeries that last more than 3hrs, compared to 23% for abdominal surgeries last less than such duration. [65] With scientific conviction, anesthetic agents disrupt the respiratory function, impair central regulation of breathing and result in uncoordinated neural messaging, and consequently leading to hypoventilation and atelectasis shortly after induction of anesthesia. The resultant hypoxemia persists postoperatively and is compounded by ongoing disruption of respiratory muscles and limited respiratory expansion due to pain related to abdominal surgical incision. As well as, longer abdominal operations entail greater manipulation of abdominal viscera, which in turn causes a greater inhibition of the diaphragm movement postoperatively. [72]

As for the duration of hospital stay, the present study noticed that the mean value of the study subjects stayed in the hospital was 11.89±0.712, whereas it amounted to 20.6±6.88 for the control group, with a significant difference between the two different groups. Improved postoperative respiratory functions and decreased incidence of respiratory complications in both the incentive spirometry and deep breathing exercise groups were behind such promised and committed result. Building on Shander A et al. (2011), length of hospital stay was prolonged for those patients who developed postoperative lung complications to 18 days versus 8 days for patients without these complications after abdominal surgeries. [73]

In conclusion, nursing interventions supported lung expansion strategies give good ground that educational classes conducted in-inpatient units in clinical settings performing upper abdominal surgeries for geriatric patients, were succeeded in building knowledge and practicing early post-anesthetic chest physiotherapy techniques that achieve a positive impact on geriatric patients' pulmonary complications reduction.

V. CONCLUSION

Based on the outcomes of the present study, it can be deduced that either application of deep breathing exercises or utilizing incentive spirometer proved to be evenly effective in reducing the incidence of postoperative chest complications for geriatric subjects who underwent upper abdominal operations. Over and above, the occurrence of these complications for the predetermined groups performing any type of the two previously prescribed modalities proved to be significantly lower than those in the matching group "routine hospital care group". Training with pulmonary exercises also confirmed

to have a significant positive effect on geriatric patients' respiratory functions including a reduction in adventitious breathing sounds on chest auscultation, improving pulse oximeter oxygen saturation (PaO2) value postoperatively, as well as a shortening length of hospital stay among subjects in the intervention groups than those in the parallel group.

VI. RECOMMENDATIONS

Based on the presented findings of the current research, the following recommendations are proposed:

1- Nursing assessment of respiratory status for every geriatric patient undergoing upper abdominal surgery should be an integral part of the comprehensive assessment. As well as, nurses should be able to differentiate between the abnormal and normal symptomatology occurring during aging process regarding the respiratory functions.

2- Development of a valid and reliable tool specific for geriatric patients to early identify high-risk group before upper abdominal surgeries who are more susceptible to develop postoperative pulmonary complications, as well as a tool to precautionary recognize the atypical presentations of these complications in the older adults for proper prevention and management.

3- Conducting a training program for gerontological nurses in the various upper abdominal surgical departments about the lung expansion modalities and about other preventive strategies to be included in the preoperative instructions given to the geriatric patient undergoing this surgery.

4- Developing a simplified and illustrated Arabic brochures or posters in in-patient departments by trained qualified gerontological nurses to be distributed for all newly admitted geriatric patients to upper abdominal surgical departments preoperatively.

5- Designing the written educational materials to have special characters suited the older adults learning and overcome barriers hinder such effective understanding and practicing as susceptible sensory impairment, mild cognitive decline, and possible associated comorbidities.

6- Conducting periodic up-to-date teaching programs using special educational methodology for all geriatric patients admitted to the surgical department including information related to importance and steps/techniques of lung expansion modalities. These programs should be a part of routine hospital management.

Recommended future researches:

Comparative studies which focus on comparing the effectiveness of combination of deep breathing exercises and incentive spirometer versus using each one alone, is needed to be established in gerontological nursing research.

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