Review of literature on postoperative pulmonary complications

According to Polit and Hungler (1999) the task of reviewing research literature involves the task of reviewing research literature involves the identification, selection, critical analysis and written description of existing information on the topic. Related literature which was reviewed is discussed under the following headings.

Studies related to overview of the postoperative pulmonary complications.

Studies related to chest physiotherapy and incentive spirometry.

Studies related to overview of postoperative pulmonary complications

Soledad Chumillas (1998) posited that pulmonary function is commonly altered after surgery, particularly in patients who have had chest or upper abdominal surgery. The physiological changes observed are directly related to anaesthesia (general or regional) and to the type of incision and surgical technique employed, and are reflected by decreases in total pulmonary capacity and pulmonary volumes and by a parallel decrease in Pa02.

Yoder (2009) said that thoracic and upper abdominal surgery is associated with a reduction in vital capacity by 50% and in functional residual capacity by 30%. Diaphragmatic dysfunction, postoperative pain, and splinting make these changes. After upper abdominal surgery, patients shift to a breathing pattern with which ribcage excursions and abdominal expiratory muscle activities increase. Postoperative patients maintain adequate minute volume, but the tidal volume is very low and the respiratory rate increases. These abnormal breathing patterns, along with the residual effects of anesthesia

and postoperative analgesics, inhibit cough, impair mucociliary clearance, and contribute to the risk of postoperative pulmonary complications.

David Warner (2005) described that many factors responsible for PPCs are related to disruption of the normal activity of the respiratory muscles, disruption that begins with the induction of anaesthesia and that may continue into the postoperative period. The effects of anaesthesia can persist into the postoperative period, though via different mechanisms, as the effects of surgical trauma come into play. These are most pronounced following thoracic and abdominal surgery, and arise from at least three mechanisms. First, functional disruption of respiratory muscles by incisions, even after surgical repair, may impair their effectiveness. Postoperative pain may cause voluntary limitation of respiratory function. Finally, stimulation of the viscera, such as provided by mechanical traction on the gallbladder or esophageal dilation, markedly decreases phrenic motor neurone output and changes the activation of other respiratory muscles, in general acting to minimize diaphragmatic descent. Other factors that may contribute to PPCs include:

1) Reflex stimulation during surgery, and release of inflammatory mediators by drug administration, increasing airway resistance and limiting expiratory gas flow from the lung; if severe this can produce hyperinflation with risk of barotrauma and gas exchange abnormalities.

2) Impairment of normal mucociliary transport by anaesthetic gasses and endotracheal intubation which may delay clearance of pathogens and promote retained secretions

3)Impairment of lung inflammatory cell’s function by prolonged anaesthesia and surgery, which could increase susceptibility to postoperative infections

4) Impaired upper airway reflexes postoperatively, with may increase the risk of aspiration, and

5) Incomplete reversal of neuromuscular blockade.

Rochelle Wynne and Mari Botti (2004) postulated that the pathogenesis of postoperative pulmonary dysfunction is associated with anomalies in gas exchange, alterations in lung mechanics, or both. Abnormalities in gas exchange are evidenced by a widening of the alveolar-arterial oxygen gradient, increased micro vascular permeability in the lung, increased pulmonary vascular resistance, increased pulmonary shunt fraction, and intrapulmonary aggregation of leukocytes and platelets. Variations in the mechanical properties of the lung lead to reductions in vital capacity, functional residual capacity, and static and dynamic lung compliance.

Woerlee (2009) listed certain performance criteria for the respiratory system of a surgical patient. They are:

The lungs must have sufficient oxygen to oxygenate the blood.

The pulmonary circulation must eliminate carbon dioxide from the body to prevent carbon dioxide accumulation.

The client must be able to generate a productive cough, otherwise mucus accumulation will occur resulting in atelectasis and/or lung infection or pneumonia.

The client must be able to significantly increase their respiratory minute volume to compensate for factors such as increased postoperative metabolic rate, elevated body temperature, possible infections, pneumonia, etc. Poor performance in significantly raising and sustaining an elevated respiratory minute volume results in exhaustion and respiratory failure.

Postoperative pulmonary complications account for a substantial portion of the risks related to surgery and anaesthesia and are a source of postoperative morbidity, mortality and longer hospital stays. The current basis for our understanding of the nature of Postoperative pulmonary complications is weak; only a small number of high quality studies are available, a uniform definition has not emerged, and studies have focused on specific patients and kinds of surgeries. Current evidence suggests that risk factors for Postoperative pulmonary complications are related to the patient’s health status and the particular anaesthetic and surgical procedures chosen. Age, pre-existing respiratory and cardiac diseases, the use of general anaesthesia and overall surgical insult are the most significant factors associated with complications. Election of anaesthetic technique, postoperative analgesia and chest physiotherapy seem to be the preventive measures that are best supported by evidence. (J. Canet, V. Mazo, 2010)

J. C. Hall ., et. al (1991)evaluated the relationship between postoperative pulmonary complications and various putative risk factors in a prospective longitudinal study of 1000 patients undergoing abdominal surgery. Transient subclinical events were studied by defining postoperative pulmonary complications as positive clinical findings in combination with either positive sputum microbiology, unexplained pyrexia, or positive chest

roentgenographic findings. The overall incidence of postoperative pulmonary complications was 23. 2%(232/1000). These findings supplies clinicians and clinical nurse with a simple means of identifying patients who are at high risk of postoperative pulmonary complications after abdominal surgery.

Postoperative pulmonary complications contribute significantly to the overall perioperative morbidity and mortality. Pulmonary complications occur significantly more often in patients undergoing elective surgery of the thorax and abdomen. These include atelectasis, infections including bronchitis and pneumonia, respiratory failure and bronchospasm. Sharma (2000).

The study findings of Brooks-Brunn (1995) revealed that atelectasis and infectious complications account for the majority of reported pulmonary complications. Risk factors were thought to exaggerate pulmonary function deterioration, which occurred both during and after surgical procedures. 18 risk factors were reviewed regarding their Pathophysiology, impact on preoperative, intra operative and postoperative pulmonary function in this study. Identification of risk factor and prediction of postoperative pulmonary complications are important. Preoperative assessment and identification of patients at risk for postoperative pulmonary complications can guide our respiratory care to prevent or minimize these complications.

Postoperative pulmonary complications were investigated in a total of 41 paediatric recipients who underwent orthotopic liver transplantation. Atelectasis was seen in 40 cases (98%) of the 41 recipients, and occurred in the left lower lobe in 28 cases (68%), and in the right upper lobe in 25 cases (61%). Radiographic pulmonary edema occurred on 23 occasions in 18

recipients (45%). Five recipients experienced two episodes of pulmonary edema during their ICU stay. Pleural effusions were observed in 21 cases (52%), of which 18 had right sided effusion and 3 had bilateral effusions. Pneumothorax occurred in 3 cases. Pyothorax, hemothorax, bronchial asthma and subglottic granulation occurred in one case each. The present study demonstrated that postoperative pulmonary complications are frequently observed in paediatric recipients undergoing orthotopic liver transplantation. (Toshihide et. al., 1994).

Kanat et al., (2007) studied the risk factors for postoperative pulmonary complications in upper abdominal surgery. They concluded that pulmonary complications are the most frequent causes of postoperative morbidity and mortality in upper abdominal surgery. A prospective study on 60 consecutive patients was conducted who underwent elective upper abdominal surgery in general surgical unit. Each patient’s preoperative pulmonary status was assessed by an experienced chest physician using clinical examination, chest radiographs, spirometry, blood analysis, anaesthetical risks, surgical indications, operation time, incision type, duration of nasogastric catheter and mobilization time. Complications were observed in 35 patients (58. 3%). The most complications were pneumonia followed by pneumonitis, atelectasis, bronchitis, pulmonary emboli and acute respiratory failure. They recommend a detailed pulmonary examinations and spirometry in patients who will undergo upper abdominal surgery by chest physicians to identify the patients at high risk for postoperative pulmonary complications, to manage respiratory problems of the patients before surgery and also to help

surgeons to take early measures in such patients before a most likely postoperative pulmonary complications occurrence.

Serojo et al., (2007) in a prospective cohort study, studied risk factors for pulmonary complications after emergency abdominal surgery. Pertinent data were collected through interview and chart review and their association with the occurrence of postoperative pulmonary complications were analyzed. 286 consecutive children were included and 75 (28. 2%) developed postoperative pulmonary complications. Pulmonary complications are frequent among children undergoing abdominal surgery and lead to increased length of hospital stay and death rate.

Kilpadi , et al., (1999) in a prospective study of respiratory complications, conducted a study for a period of six months with total samples of 584 patients, who underwent elective or emergency surgery. He found that 81 of them had 13. 9% of respiratory complications, 68% had pneumonia and others included pleural effusion, empyema and exacerbation of asthma.

Felardo et al., (2002) investigated the postoperative pulmonary complications after upper abdominal surgery. Two hundred and eighty three patients were followed from pre to postoperative period. A protocol including a questionnaire, physical examination, thoracic radiogram and spirometry was used during preoperative period. Sixty nine (24. 4%) patients had pulmonary complications in 87 events registered. Pneumonia was the most frequent event 34% (30/87) followed by atelectasis 24% (21/87), broncho constriction 17% (15/87), acute respiratory failure 13% (11/87), prolonged mechanical ventilation 9% (8/87) and bronchial infection 2% (2/87).

Pulmonary complications occurs more frequently than cardiac complications. The complication rates for upper abdominal and thoracic surgery are the highest. A better understanding of the risk factors associated with postoperative pulmonary complications is essential to develop strategies for reducing these complications. In any individual patient the benefit from a surgical procedure should be weighed against the risks it imposes. When possible, stabilization of respiratory status is advisable before surgery. (Muhammed Aslam, Syed Hussain, 2005).

Decline in pulmonary function after major abdominal surgery is thought to be identified in daily assessment by observation of breathing and pain intensity. Measurement of pulmonary function is usually not included in the assessment of the patient in postoperative period. The aim of this study was to investigate the relationship between clinical observation of breathing and decline in pulmonary function and pain. Eighty nine patients admitted for elective major, mild and upper abdominal surgery, participated in the study. Clinical observation of breathing covered the following parameters like abdominal expansion, side expansion, high thoracic expansion, paradoxical breathing, symmetry of thorax expansion, ability to huff and signs of mucus retention. Pain intensity was assessed at rest and during breathing exercises and during coughing using a visual analogue scale. Peak expiratory flow rate were performed on the preoperative day and for seven postoperative day. A poor correlation is found between clinical observation of breathing and pulmonary function after abdominal surgery. (Johannes vandeleor et al ., 2003).

Fung et al., (2010) compared postoperative respiratory complications in obese and nonobese children following surgery for sleep-disordered breathing. All obese children who had undergone adenotonsillectomy for sleep-disordered breathing from 2002 to 2007 were compared with age- and gender-matched controls. Length of hospital stay and the incidence, severity, and location of respiratory complications were compared. Forty-nine obese children were identified (20: 29, female: male). Overall, 37 obese children (75. 5%) and 13 controls (26. 5%) incurred complications (P = 0. 000). Ten obese patients and two controls incurred major events (P = 0. 012); 36 obese children had minor complications versus 12 controls (P = 0. 000). Obese children had significantly more upper airway obstruction (19 vs. 4, P = 0. 0003), particularly during the immediate postoperative period. The mean hospital stay was significantly longer for the obese group (18 vs. 8 hours, P = 0. 000, mean difference of 10 hours). He concluded that Obesity in children significantly increases the risk of respiratory complications following surgery for sleep-disordered breathing.

Sixty patients were studied to determine the incidence of postoperative pulmonary complications and the value of preoperative spirometry in producing pulmonary complications after upper abdominal surgery. On the day before the operation and for 15 days after the operation, each patient’s respiratory status was assessed by clinical examinations, chest x-ray, spirometry and blood gas analysis. A chest physician and surgeon monitored patients for pulmonary complications independently. In this study postoperative pulmonary complications developed in 21(35%) patients (pneumonia in 10 patient, bronchitis in 9 patients, atelectasis in 1 patient,

pulmonary embolism in 1 patient) of 31 patients with abnormal preoperative spirometry, 14 patients showed normal preoperative spirometry, 7 patients showed complications. It was concluded that postoperative pulmonary complications was still a serious cause of postoperative morbidity. (Kocabas et al., 1996).

Study conducted by Ephgrave et al., (1993) revealed that postoperative pneumonia was a major complication that had been linked to micro aspiration of pathogens originating in the gastrointestinal tract. 140 patients who had undergone major surgeries were selected. Postoperative pneumonia is present in 26 (18. 6%) of 140 patients. Postoperative pneumonia is a morbid postoperative complications associated with presence of gastric bacteria during operation and transmission of gastric bacteria to the pulmonary tree after surgery.

Studies related to chest physiotherapy and incentive spirometry

Chest physiotherapy is an important therapy in the treatment of respiratory illness. It is very important to carry out this procedure in children for the purpose of loosening secretions from the lungs.

Morran, et al., (1993) has done a randomized controlled trial on physiotherapy for postoperative pulmonary complications. A sample size of 102 patients undergoing cholecystectomy were assigned to control group and study group. The patients in the control group did not receive chest physiotherapy, while patients in the study group received chest physiotherapy. The study proved that without chest physiotherapy 21

patients developed atelectasis and 19 patients developed chest infections whereas with chest physiotherapy 15 patients developed atelectasis and 7 developed chest infection and 40 patients developed no complication. The author concluded that routine prophylactic chest physiotherapy significantly decreased frequency of chest infection (p <0. 02).

Lie, C et al., (1999) had written that postoperative pulmonary complications play a significant role in the postoperative morbidity after abdominal surgery. To prevent this, an array of methods, such as chest physiotherapy, incentive spirometry or mask treatment with positive airway pressure are used. He stated that the available controlled studies indicate that none of these treatment modalities reduced the occurrence of postoperative atelectasis but only chest physiotherapy is able to reduce the development of postoperative pneumonia. He recommend chest physiotherapy as prophylactic treatment after abdominal surgery.

Manzano et al., (2008) conducted randomized clinical trial on chest physiotherapy during immediate postoperative period among patients undergoing upper abdominal surgery in the post-anesthesia care unit of a public university hospital. 31 patients were randomly assigned to control (n= 16) and chest physiotherapy (n= 15) groups. The chest physiotherapy group received treatment at the post-anaesthesia care unit, while the control did not. The control groups presented decreased spirometry values in contrast the chest physiotherapy group presented improved oxygen-hemoglobin saturation during the immediate postoperative period (p <0. 03). He concluded that chest physiotherapy was very effective in improving the 0xy-hemoglobin saturation during the immediate postoperative period. Breathing

exercises could be adopted at post-anaesthesia care units with benefits for patients.

Fagevikolsen, et al.,(2005), conducted a randomized controlled study to evaluate the clinical benefit and physiological effects of prophylactic chest physiotherapy in open major abdominal surgery. A group of 174 patients received chest physiotherapy including breathing with pursed lips, huffing and coughing, and information about the importance of early mobilization. In addition high-risk patients were given resistance training on inspiration and expiration with a mask. The resistance used during inspiration was −5 cmH2O and that during expiration +10 cmH2O. The control group (194 patients) received no information or treatment unless a pulmonary complication occurred. The result showed that oxygen saturation on postoperative days 1-3 was significantly greater in the treatment group. Treated patients were mobilized significantly earlier. No difference was noted in peak expiratory flow rate or forced vital capacity. Postoperative pulmonary complications occurred in 6 per cent of patients in the treatment group and in 27 per cent of controls (P <0·001). In high-risk patients the numbers with pulmonary complications were six of 40 and 20 of 39 respectively. Pulmonary complications were particularly common in patients with morbid obesity. This study showed that, preoperative chest physiotherapy reduced the incidence of postoperative pulmonary complications and improved mobilization and oxygen saturation after major abdominal surgery.

Warren and Grim Wood (1996) conducted a study on postoperative pulmonary complications in patients who underwent cholecystectomy. In this study 194 patients were included. Postoperative pulmonary complications

such as atelectasis and pneumonia developed in 42 patients. Patients receiving physiotherapy had substantially fewer pulmonary complications complications. So from this study, we can conclude that, patients receiving chest physiotherapy are prone to develop fewer pulmonary complications.

The effectiveness of incentive spirometry versus chest physiotherapy for prevention of postoperative pulmonary complications was investigated after abdominal surgery. The researcher entered 876 patients into a clinical trial aimed at preventing pulmonary complications after abdominal surgery. Patients either received conventional chest physiotherapy or were encouraged to perform maximal inspiratory manoeuvres for 5 min during each hour while awake, using an incentive spirometer. The incidence of pulmonary complications did not differ significantly between the groups: incentive spirometry 68 of 431 (15·8%, 95% Cl 14·0-17·6%), and chest physiotherapy 68 of 445 (15·3%, Cl 13·6-17·0%). Nor was there a difference between the groups in the incidence of positive clinical signs, pyrexia, abnormal chest radiographs, pathogens in sputum, respiratory failure (PO2 < 60 mm Hg), or length of stay in hospital. They concluded that prophylactic incentive spirometry and chest physiotherapy are of equivalent clinical efficacy in the general management of patients undergoing abdominal surgery. (Hall et al., 1996).

Spirometry is one of the most common pulmonary lung function tests and it also a lung expansion technique. It is used to test for a variety of lung problems and to determine the effectiveness of treatment. The patient takes a deep breath and breaths out with force into a spirometer to the best of

their ability. The spirometer measures both the amount of air expelled and how quickly the air was expelled from the lungs.

Controversy exists with the routine use of aids to lung expansion in the prevention of pulmonary complications after abdominal surgery. The researcher prospectively randomized 172 patients into 1 of 4 groups: the control group (44 patients) received no respiratory treatment, the IPPB group (45 patients) received intermittent positive pressure breathing therapy for 15 min 4 times daily, the IS group (42 patients) were treated with incentive spirometry 4 times daily, and the DBE group (41 patients) carried out deep breathing exercises under supervision for 15 min 4 times daily. Postoperative pulmonary complications were defined as the development of 3 or more of 6 new findings: cough, phlegm, dyspnea, chest pain, temperature greater than 38 degrees C, pulse rate more than 100 beats/min. The frequency of development of pulmonary complications was 48% in the control group, 22% in the IPPB group (p less than 0. 05), 21% in the IS group (p less than 0. 05), and 22% in the DBE group (p less than 0. 05). Side effects of respiratory treatment were observed only in the IPPB group (18%; p less than 0. 05). This difference was not observed for the other two treatment groups. (Celli et al., 1984).

An ineffective cough leads on to retention of secretions, decreased lung compliance and atelectasis. The collapsed regions of lungs that are not reinflated can get infected. Incentive spirometry is a commonly used, effective and inexpensive bronchial hygiene tool for lung expansion. A lung expansion technique is one that increases lung volume above that of usual unassisted inspiration. Lung expansion techniques are indicated to prevent

atelectasis or pneumonia in patient who cannot or will not perform periodic hyperinflation, like postoperative patients with thoracic or abdominal surgery, patients with obstructive pulmonary disease, neuromuscular or chest wall disorders. (Naveen Malhotra et al., 2007).

Prevention of respiratory complications after abdominal surgery was investigated by conducting a randomised clinical trial by a comparison of a global policy of incentive spirometry with a regimen consisting of deep breathing exercises for low risk patients and incentive spirometry plus physiotherapy for high risk patients. Stratified randomised trial was undertaken in an general surgical service of an urban teaching hospital. c456 patients undergoing abdominal surgery were included. The researcher defined respiratory complications as clinical features consistent with collapse or consolidation, a temperature above 38°C, plus either confirmatory chest radiology or positive results on sputum microbiology. He also recorded the time that staff devoted to prophylactic respiratory therapy. There was good baseline equivalence between the groups. The incidence of respiratory complications was 15% (35/231) for patients in the incentive spirometry group and 12% (28/225) for patients in the mixed therapy group (P= 0. 40; 95% confidence interval -3. 6% to 9. 0%). It required similar amounts of staff time to provide incentive spirometry and deep breathing exercises for low risk patients. The inclusion of chest physiotherapy for high risk patients, however, resulted in the utilisation of an extra 30 minutes of staff time per patient. He concluded that when the use of resources is taken into account, the most efficient regimen of prophylaxis against respiratory complications

after abdominal surgery is deep breathing exercises for low risk patients and incentive spirometry for high risk patients. (Hall et al., 1996).

Pankaj Kundra et al., (2010) conducted a study that was designed to compare the effects of preoperative and postoperative incentive spirometry on lung functions after laproscopic cholecystectomy in 50 patients. Patients were randomized into a control group(n= 25) and a study group (n= 25). Patients in study group were instructed to carry out incentive spirometry before the surgery 15 times, every fourth hourly, for 1 week whereas in control group, incentive spirometry was carried out during the postoperative period. Lung functions were recorded at the time of preanesthetic assessment, on the day before the surgery, postoperatively at 6, 24 and 48 hours, and at discharge. Significant improvement in the lung functions was seen after preoperative incentive spirometry (study group, p <0. 05). The lung functions were significantly reduced till discharge in both the groups. However, lung functions were better preserved in study group at all times when compared with control group p <0. 05. He concluded that, lung functions are better preserved with preoperative than postoperative incentive spirometry.

Chest physiotherapy aims to decrease the occurrence of the postoperative pulmonary complications and hasten recovery. Breathing exercises aimed at maximising inspiratory effort are the most beneficial for the patients. In a non-randomised pilot study of 263 patients, it has been found that the addition of the incentive spirometer, as part of an intensive postoperative physiotherapy programme, decreased the occurrence of pulmonary complications (6vs 17%, p= 0. 01) and length of stay on the surgical figh

dependency unit (3. 1 vs 4 days p= 0. 03). The two groups were comparable when age, sex and the need for emergency surgery postoperative analgesia were compared.(Westwood et al., 2007)