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Risk factors of postoperative invasive ventilator support in laparotomy patients

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Abstract

A medical ventilator is a machine designed to move breathable air in and out of the lungs, to provide breathing for a patient who is physically unable to breathe, or breathing insufficiently. The early history of mechanical ventilation begins with various versions of what was eventually called the iron lung, a form of non-invasive negative pressure ventilator widely used during the polio epidemics of Copenhagen, Denmark, in 1952. Whenever a patient is posted for laparotomy, a detailed clinical history followed by clinical examination and routine lab investigations will be done. If needed special investigations also will be done. Patient is categorized according to ASA classification and NYHA classification whenever applicable. After laparotomy details, of surgery were also collected. Surgery was elective for 143 patients and emergency for 48 patients. 25% of surgeries were emergency. 8 out of 48 emergency surgery patients required ventilatory support (16.6%). 8 out of 14 ventilator patients were emergency surgery patients (57%). From this emergency surgery is found to be an important risk factor for post-operative invasive ventilation with an odds ratio of 4.567 and P value of 0.008.

Keywords: postoperative invasive ventilator support, laparotomy, risk factors

Introduction

The last 200 years have seen enormous improvements in the management of patients undergoing surgery. This has been due to key discoveries in anaesthesia, antibiotics, aseptic practices, understanding of human physiology, x-ray to name a few. There have also been important organizational changes including the development of postoperative recovery rooms and critical care units. Surgical mortality has fallen while range of invasive surgical procedures has expanded. Operations are undertaken on patients who would have formally been deemed unsuitable because of serious comorbidities, age or physiological derangement. A good percentage of these high risk patients surviving surgeries will require admission to a critical care unit and ventilator support ^[1].

A medical ventilator is a machine designed to move breathable air in and out of the lungs, to provide breathing for a patient who is physically unable to breathe, or breathing insufficiently. The early history of mechanical ventilation begins with various versions of what was eventually called the iron lung, a form of non-invasive negative pressure ventilator widely used during the polio epidemics of Copenhagen, Denmark, in 1952 ^[2].

In 1949, John Haven Emerson developed a mechanical assister for anaesthesia with the cooperation of the anaesthesia department at Harvard University. Mechanical ventilators began to be used increasingly in anaesthesia and intensive care during the 1950s. Their development was stimulated both by the need to treat polio patients and the increasing use of muscle relaxants during anaesthesia ^[3].

Fast forwarding to current time, modern ventilators are sophisticated computers with various programs of ventilation suited for individual patients whose respiratory needs vary considerably. Extensive search for studies related to risk factors for postoperative invasive ventilation support in post laparotomy patients were made in PubMed, Medline and Cochrane. Several articles have mentioned the risk factors for postoperative mortality and morbidity, postoperative respiratory failure, common postoperative complications and most common type of postoperative organ support received. Several studies were conducted on post upper abdominal surgery and colon surgery patient's developing pulmonary complications. Whether these patients required invasive ventilator support or not is not clear from these studies ^[4].

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Indications for invasive ventilation may not always be due a primary pulmonary pathology. None of these articles mentions about the risk factors in laparotomy patients that ultimately lead to post-operative invasive ventilator support.

Methodology

All patients undergoing laparotomy under the department of general surgery, for a period of two years and fulfilling the inclusion criteria were enrolled for the study. Informed written consent was taken from patients or close relatives. For this study census method also called complete enumeration survey method of data collection is used. In census method each and every person fulfilling inclusion criteria is taken and selected for data collection.

Whenever a patient is posted for laparotomy, a detailed clinical history followed by clinical examination and routine lab investigations will be done. If needed special investigations also will be done. Patient is categorized according to ASA classification and NYHA classification whenever applicable. After laparotomy details, of surgery were also collected.

Detailed clinical history about co-morbid factors like diabetes, Hypertension, Coronary artery disease, cerebrovascular accident, pulmonary disease, and Kidney disease is taken. Clinical examination include recording of vitals, Respiratory system, cardiovascular system, Central nervous system and GIT. For the purpose of analysis patients are grouped into below 60 yrs and above or equal to 60yrs and odds ratio of each group is calculated. Frequency of comorbidity in the study population is calculated and odds ratio for post-operative invasive ventilation is calculated. From temperature, heart rate, respiratory rate, total leukocyte count a composite SIRS score is calculated. A score of two or more, if present, then the patient is considered to have SIRS. Number of patients with SIRS and odds ratio for SIRS patients to have post- operative ventilation is calculated.

All the data collected are entered into a semi structured questionnaire after getting consent from the participant. After the completion of data collection, it will be properly coded and will be entered in Microsoft excel data sheet.

Results

Table 1: Association of socio-demographic variables to post-laparotomy ventilator support

Variable	Ventilator support		Odds Ratio	P value
	Yes	No		
Gender				
Male	10 (71.4%)	119 (67.2%)	1.218	1.000
Female	4 (28.6%)	58 (32.8%)		
Age				
Equal to or more than 60 yrs	8 (57.1%)	91 (51.4%)	1.260	0.785
Less than 60 yrs	6 (42.9%)	86 (48.6%)		

Table 2: Association of co-morbidities to post-laparotomy ventilator support

Variable	Ventilator support		Odds Ratio	P value
	Yes	No		
Chronic Obstructive Pulmonary Disease				
Yes	7 (50%)	33 (18.6%)	4.36	0.01
No	7 (50%)	144 (81.4%)		

All the other co-morbidities like CVA, diabetes, hypertension, CAD were absent in those who required ventilator support. So odds ratio was not calculated for them.

Table 3: Association of SIRS, Hemo/Pneumothorax and ASA category with Post-laparotomy Ventilatory Support.

Variable	Ventilator support		Odds Ratio	P value
	Yes	No		
SIRS				
Yes	8(57.1%)	48 (27.1%)	3.58	0.029
No	6 (42.9%)	129(72.9%)		
Hemo/pneumo thorax				
Yes	4(28.6%)	0	18.7	0.00
No	10(71.4%)	177 (100%)		
ASA classification				
Greater than class III Class I and II	14(100%)0	31(71.5%) 146(82.5%)	1.45	0.000

Table 4: Association of type of surgery with post laparotomy ventilator support.

Variable	Ventilator support		Odds Ratio	P value
	Yes	No		
Time from onset of symptoms to surgery				
Less than 30 days	8(57.1%)	134(75.7%)	0.42	0.199
More than 30 days	6(42.9%)	43(24.3%)		
Emergency /Elective surgery				
Emergency	8(57.1%)	40 (22.6%)	4.567	0.008
Elective	6 (42.9%)	137(77.4%)		
Damage control/ definitive surgery				
Damage control	8(57.1%)	27(15.32%)	7.407	0.001
Definitive	6(42.9%)	150 (84.72%)		
Duration of surgery				
More than 2.5 hrs	6(42.9%)	69(39%)	1.17	0.78
Less than 2.5 hrs	8(57.1%)	108(61%)		

Table 5: Association between operative findings and post laparotomy ventilator support.

Variable	Ventilator support		Odds Ratio	P value
	Yes	No		
Operative finding: Tumor				
Present	6(42.9%)	95(53.7%)	0.608	0.580
Absent	8(57.1%)	82(46.3%)		
Operative finding: Intra-abdominal sepsis				
Present	4(28.6%)	33(18.6%)	0.746	0.479
Absent	10 (71.4%)	144(81.4%)		
Operative finding: Hemoperitoneum				
Present	4(28.6%)	10(5.6%)	6.944	0.012
Absent	10(71.4%)	167 (94.4%)		

Discussion

Surgery was elective for 143 patients and emergency for 48 patients. 25% of surgeries were emergency. 8 out of 48 emergency surgery patient required ventilatory support (16.6%). 8 out of 14 ventilator patients were emergency surgery patients (57%). From this emergency surgery is found to be an important risk factor for post-operative invasive ventilation with an odds ratio of 4.567 and P value of 0.008.

Definitive surgery was performed for 156 patients and damage control surgery for 35 patients. 8 out of 35 damage control surgery patients required post-operative ventilatory support (22.8%). 57% of ventilatory patients were damage control surgery patients. Damage control surgery is also found to be an important risk factor for postoperative invasive ventilation, probably because both the emergency and damage control surgery patients were the same ones. Odds ratio was 7.407 and P value 0.001.

Study by McCoy CC, *et al.* [5] found emergency operations accounted for 14.6% of the approximately general surgery procedures. Post-operative complications included surgical site infection had the highest incidence (6.7%). The second most common complication was pneumonia (5.7%). Stroke, major bleeding, myocardial infarction, and pneumonia exhibited the strongest associations with postoperative death.

127 patients had midline incisions, 20 patients had subcostal incision, 25 patients with paramedian incisions and 19 transverse incisions. After recoding to vertical and transverse incisions 152 patients had vertical incisions and 39 patients had transverse incisions. All the patients with postoperative invasive ventilation had vertical laparotomy incisions. Odds ratio could not be calculated in this case.

According to Brown SR, *et al.* [6] both analgesia use and pulmonary compromise may be reduced with a transverse or oblique incision but this does not seem to be significant clinically as complication rates and recovery times are the same as with midline incision. The methodological and clinical diversity and the potential for bias in the included studies also mean that the results in favour of a transverse or oblique incision, particularly with regard to analgesic use, should be treated with caution. The optimal incision for abdominal surgery still remains the preference of the surgeon.

Based on the duration of surgery patients are divided into two groups, surgery for more than 2.5 hrs and surgery duration less than 2.5 hrs. 75 patients (39.2%) had surgery for more than 2.5 hrs. Based on my study, surgery for more than 2.5 hrs is not a risk factor for post-operative invasive ventilation. Odds ratio is found to be 1.17 and a P value of 0.78.

Several studies have shown that the duration of surgery is independently associated with increased infectious complications and increased length of hospital stay. Study by May Hua, *et al.* found ASA class, the presence of preoperative

sepsis and total operative time were independently associated with risk of post-operative invasive ventilation [7].

Operative findings include hemoperitoneum in 14 patients, intra-abdominal sepsis in 37, tumor/mass in 101, inflammation in 32 patients. For patients who require post-operative invasive ventilation intraoperative findings include hemoperitoneum 4 patients, intra-abdominal sepsis 4 patients and tumor in 6 patients. Of the 14 patients with hemoperitoneum, 4 patients had associated hemo/pneumothorax. Finding of hemoperitoneum is associated with increased risk of post-operative invasive ventilation, odds ratio of 6.944 and P value of 0.012.

This may due to the fact that 28% of patients with hemoperitoneum had hemothorax or pneumothorax. From this study operative finding of tumor or intra-abdominal sepsis is not an important risk factor for post-operative invasive ventilation. In case of intra-abdominal tumor Odds ratio was 0.608 and P value of 0.580 for post-operative invasive ventilation. In case of intra-abdominal sepsis odds ratio was 0.746 and P value 0.479.

Colin L. Verdant, *et al.* in their study says persistence or recurrence of intra-abdominal sepsis is a serious threat in the postoperative course of acutely ill patients requiring urgent laparotomy. The prognosis of such patients is quite uncertain, with mortality rates reaching more than 50% in some series. In case of abdominal tumours, C. E. Cauley, *et al.* says patients with disseminated cancer are highly morbid and many patients die soon after surgery 8.

Mean days of hospital stay for a laparotomy patient is 10 days with a standard deviation of 4.1 days. A minimum days of hospital stay is 4 and maximum days of hospital stay is 27. In case of patients who required post-operative invasive ventilation the mean duration of hospital stay was 17 days with a SD of 3.8 days.

Conclusion

Post-operative invasive ventilatory support requirement significantly increases the duration of hospital stay and also increases the cost of medical treatment. As these patients are critically ill their mortality and morbidity are significantly high, by identifying pre-operative risk factors for laparotomy patients requiring post-operative invasive ventilatory support we would be better able to predict and manage the post-operative period. The risk factors found during this study were presence of hemo/pneumothorax, higher ASA grade, COPD, SIRS on admission, hemoperitoneum, emergency surgery, damage control surgery. Pre-operative optimisation of these risk factors whenever possible should be done, in situations when this is not possible adequate resources for post-operative care should be available.

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