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ORIGINAL ARTICLE

Clinical, Biochemical, and Physiological Predictors of Postoperative Pulmonary Complications After Major Thoracic and Abdominal Surgery: A Cross-Sectional Clinical Study

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ABSTRACT

Background: Pulmonary complications are a source of morbidity following major thoracic and abdominal surgery.
Objectives: To identify clinical, biochemical and physiological risk factors for postoperative pulmonary complications following major thoracic and abdominal surgery.
Methods: The study was a cross-sectional clinical study carried out in the Department of Anaesthesia, Ayub Teaching Hospital, Abbottabad, Pakistan, and the Department of General Surgery, Mohtarma Benazir Bhutto Shaheed Medical College, Mirpur, Pakistan, from June 2022 to June 2023. One hundred twenty (120) adult patients that were undergoing major thoracic or abdominal surgery under general anesthesia were included. Clinical features, biochemical data and physiological data, and postoperative pulmonary complications were documented. SPSS version 26 software was used for data analysis.
Results: Postoperative pulmonary complications occurred in 34 patients (28.3%). Complications patients were older, higher BMI, smoking history, COPD, diabetes mellitus, emergency surgery, longer operation time, more blood loss and more ICU admission. Biochemical parameters which were found to be raised were leucocyte count, NLR, CRP, serum lactate, creatinine, random blood sugar, low hemoglobin and hypoalbuminemia. Physiological predictors were included higher respiratory rate, lower SpO2, lower PaO2/FiO2 ratio, lower FEV1, and lower FVC. Multivariable analysis identified PaO_2/FiO_2 ratio <300, serum albumin <3.5 g/dL, ASA III–IV, COPD, FEV_1 <70%, length of surgery, smoking, raised CRP and Age >60 years as independent predictors.
Conclusion: Post op pulmonary complications were prevalent following major thoracic and abdominal surgery. Perioperative risk stratification might be better achieved with a combination of clinical, biochemical, and physiological assessment.
Keywords: Postoperative pulmonary complications; thoracic surgery; abdominal surgery; PaO_2/FiO_2 ratio; hypoalbuminemia; perioperative risk

INTRODUCTION

Pulmonary complications after major thoracic and abdominal surgery (postoperative pulmonary complications [PPCs]) continue to be one of the most frequent and clinically important complications after surgery.[1] These complications range from atelectasis and pneumonia, to respiratory failure, bronchospasm, pleural effusion, pulmonary edema, prolonged mechanical ventilation and reintubation.[2] PPCs have been reported in at least 5-40% of patients who undergo major surgery depending on the characteristics of patients, the surgical procedure and the diagnostic criteria used.[3] Their presence is linked to higher morbidity, prolonged intensive care unit (ICU) and hospital stay, higher healthcare costs, slow recovery following surgery, short- and long-term mortality.[4]

Thoracic and upper abdominal surgery is highly physiologic stress to the respiratory system.[5] The combined effect of surgical trauma, postoperative pain, dysfunction of the diaphragm, decreased cough reflex, decreased lung volumes, anesthesia-induced respiratory depression, and prolonged immobilization affects pulmonary mechanics and the effective clearance of airways.[6] Thoracic surgery adds insult to injury by the manipulation of the lungs, one-lung ventilation, and postoperative changes in ventilation–perfusion matching, making them especially vulnerable to respiratory problems.[7]

It is crucial that a patient's risk of developing PPCs is identified early in their treatment so that the perioperative management can be optimized and preventive measures can be taken.[8] The traditional risk assessment has been based primarily on demographic and clinical factors like old age, smoking, obesity, chronic obstructive pulmonary disease, diabetes mellitus, poor functional status, American Society of Anesthesiologists (ASA) physical status classification, emergency surgery and long surgical duration.[9] These are all involved in the risk stratification of peri-operative patients, but they may not be as useful as they are when used in isolation, as PPCs are a complex process of patient specific, surgical, anesthetic and inflammatory mechanisms.[10]

There is increasing evidence that biochemical parameters, such as markers of systemic inflammation, nutritional status and tissue damage, may be useful in predicting postoperative respiratory complications.[11] Increased inflammatory markers such as C-reactive protein (CRP), procalcitonin, leukocytes, neutrophil to lymphocyte ratio (NLR), and interleukin-6 (IL-6) have been linked to postoperative increased risks of infection, delayed recovery, and pulmonary function.[12] Similarly, low serum albumin, anemia, decreased renal function, and serum lactate levels may be an indicator of diminished physiological reserve and decreased tissue oxygenation, making them a risk factor for postoperative respiratory failure.[13]

Physiological assessment is additionally crucial in the evaluation of perioperative risk.[14] The pulmonary function tests, arterial blood gas analysis, oxygen saturation, respiratory rate, and exercise capacity are objective measurements of the extent of cardiopulmonary reserve and ventilatory efficiency, which are useful preoperatively.[15] A decreased forced expiratory volume in one second (FEV_1), a decreased forced vital capacity (FVC), a decreased PaO_2/FiO_2 ratio, and impaired functional exercise tolerance each have been reported to be associated with an increased incidence of PPCs after major surgery.[16] However, none of the physiology parameters is universally a good predictor of postoperative pulmonary performance in various surgical cohorts.[17]

Recent developments in the field of perioperative medicine focus on the combination of various clinical, biochemical, and physiological parameters in order to generate a risk prediction

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model as opposed to the use of single parameters.[18] This multi-dimensional assessment can help to personalize perioperative optimization, improve targeting of respiratory interventions, optimize recovery plans, and allow for more effective critical care resource allocation.[19] Although there has been a growing interest in predictive modelling, there is still relatively limited evidence that has simultaneously evaluated these domains in patients subjected to both major thoracic and abdominal surgery, especially in routine clinical practice.[20]

The present study was thus conducted to examine the relationship of clinical characteristics, biochemical markers and physiological parameters to the development of postoperative pulmonary complications in major thoracic and abdominal surgery. This study aims to find independent factors associated with PPCs to better stratify the risk in the perioperative period and to facilitate early use of preventive measures that can decrease postoperative morbidity and enhance surgical outcomes.

MATERIALS AND METHODS

The study was cross-sectional and clinical in nature conducted in the Department of Anaesthesia, Ayub Teaching Hospital, Abbottabad, Pakistan, and the Department of General Surgery, Mohtarma Benazir Bhutto Shaheed Medical College, Mirpur, Pakistan for one year in June 2022 to June 2023. Adult patients who were undergoing major thoraco-abdominal surgical procedures under general anesthesia were included in the study. Major surgery was defined as surgery performed in the chest or abdomen (excluding neurosurgery) that involved general anesthesia with endotracheal intubation and hospitalization.

One hundred and twenty patients were studied. Both male and female patients aged 18 years or older who had complete preoperative clinical assessment and biochemical investigations and had complete physiologic records during the perioperative period were eligible for inclusion in the study if they underwent elective or emergency major thoracic or abdominal surgery. Patients having minor day-care procedures (surgery under local or regional anesthesia alone), those with active pre-operative pneumonia, incomplete records, or refusal to participate were excluded.

A structured proforma was used to collect data. Clinical parameters were age, gender, body mass index, smoking, comorbid conditions, American Society of Anesthesiologists physical status, type of surgery, elective or emergency surgery, duration of surgery, duration of anesthetic, estimated blood loss, blood transfusion, intensive care unit admission and length of stay.

Pre-operative biochemical parameters were hemoglobin, total leucocyte count, neutrophilic count, lymphocytic count, neutrophilic/lymphocytic ratio, serum albumin, serum creatinine, random blood glucose, C-reactive protein (CRP) and serum lactate (if available). These were recorded to measure anemia, systemic inflammation, nutrition, renal function, metabolic stress and tissue perfusion.

Physiological measurements were respiratory rate, oxygen saturation, arterial oxygenation, PaO_2/FiO_2 ratio (if an arterial blood gas analysis was performed), ventilation time, and requirement of ventilatory support with or without a ventilator. Pulmonary function parameters such as forced expiratory volume in one second (FEV1) and forced vital capacity (FVC) were measured if available.

Pre-operative assessment and optimization for all patients was done as per institutional protocols. General anesthesia was given with standard monitoring including ECG, non-invasive blood pressure, pulse oximetry, capnography and monitoring of urine output, as indicated, and temperature monitoring. Anesthesiologists used their favorite technique for induction and maintenance of anesthesia based on the patient's condition, surgical needs, and their preference. Post-op care consisted of oxygen therapy, analgesia, chest physiotherapy, incentive spirometry, early mobilisation and intensive care support, if clinically indicated.

The main outcome was occurrence of postoperative PPCs during the postoperative stay in the hospital. Only pulmonary complications occurring after surgery were included in the definition of postoperative pulmonary complications, which included atelectasis, pneumonia, bronchospasm requiring treatment, pleural effusion requiring intervention, pulmonary edema, respiratory failure, prolonged oxygen requirement, need for non-invasive ventilation, reintubation or prolonged mechanical ventilation.

SPSS version 26 was used to analyze the data. Continuous variables were presented as mean ± standard deviation or median (interquartile range) based on data distribution, and categorical variables were presented as numbers and percentage. Patients were stratified into two groups based on postoperative pulmonary complications (PPC) being present or absent. The independent-samples t-test or Mann–Whitney U test was used for continuous variables, while the chi-square test or Fisher's exact test was used for categorical variables. Multivariate logistic regression analyses were performed to determine independent risk factors for postoperative pulmonary complications with variables that had significant or clinically important associations. Adjusted odds ratios (ORs) and 95% confidence intervals (CI) were calculated and a p-value of ≤0.05 was deemed statistically significant.

Appropriate institutional ethical review committees gave their approval. All patients or their legal attendant (if applicable) provided written informed consent. The confidentiality of patients was respected during the study, and all the data collected were used only for research.

RESULTS

A total of 120 patients were included in this current study. The average age of the patients was 55.8 ± 13.4 years. There were 72 males (60.0%) and 48 females (40.0%). 34 patients (28.3%) developed postoperative pulmonary complications and 86 patients (71.7%) were free of postoperative pulmonary complications. There were 23 male (31.9%) and 11 female (22.9%) patients with PPCs. Patients with PPCs had a higher mean age, BMI and were more likely to be current smokers. Emergency surgery, ASA III – IV and diabetes mellitus were also found to be significant in developing PPC. PPCs were more common in males, but gender was not significantly related to PPC occurrence. All baseline clinical characteristics are summarized in Table 1.

Patients with PPCs tended to have undergone more thoracic surgery, and those without PPCs, more abdominal surgery. Patients with PPCs had significantly longer surgical time, longer anesthesia time, higher blood loss, higher transfusion need, more ICU admission and longer hospital stay. The perioperative findings are as follows and listed in Table 2.

Biochemical results revealed that the hemoglobin and serum albumin were significantly lower in patients with PPCs than in patients without PPCs. However, total leukocyte count, neutrophil to lymphocyte ratio, serum creatinine, random blood glucose, serum C-reaction protein and serum lactate were significantly increased in the PPC group. The biochemical differences are exhibited in Table 3.

Physiological evaluation revealed that those patients who developed PPCs had significantly higher respiratory rate and lower pre-operative oxygen saturation. Additionally, they had lower PaO_2/FiO_2 ratio, lower FEV_1, and lower FVC than patients who did not develop PPCs. There were significantly more cases of postoperative oxygen requirement, need for non-invasive ventilation and reintubation in the PPC group. The physiological results are summarised in Table 4.

The most common pulmonary complication after surgery was need for prolonged oxygenation requirement, followed by atelectasis and the need for non-invasive ventilation. Other findings included pneumonia, respiratory failure, bronchospasm, therapeutic pleural drainage and relonged mechanical ventilation. The frequency of individual PPCs is shown in Table 5.

Multivariable logistic regression analysis showed that PaO_2/FiO_2 ratio <300, serum albumin <3.5 g/dL, ASA III or IV, FEV_1 <70% predicted, COPD, duration of surgery >180 minutes, current smoking, raised CRP and age >60 years were the strongest independent risk factors for PPCs. The independent predictors are listed on Table 6.

Table 1: Baseline clinical characteristics according to postoperative pulmonary complication status

Variable	Total (n = 120)	PPC present (n = 34)	PPC absent (n = 86)	p-value
Age, years	55.8 ± 13.4	62.6 ± 11.8	53.1 ± 13.1	<0.001
Male gender	72 (60.0%)	23 (67.6%)	49 (57.0%)	0.28
Female gender	48 (40.0%)	11 (32.4%)	37 (43.0%)	0.28
BMI, kg/m²	27.1 ± 4.6	28.8 ± 4.9	26.4 ± 4.3	0.009
Current smoker	42 (35.0%)	19 (55.9%)	23 (26.7%)	0.003
COPD	24 (20.0%)	13 (38.2%)	11 (12.8%)	0.002
Diabetes mellitus	36 (30.0%)	15 (44.1%)	21 (24.4%)	0.033
ASA III–IV	46 (38.3%)	22 (64.7%)	24 (27.9%)	<0.001
Emergency surgery	38 (31.7%)	17 (50.0%)	21 (24.4%)	0.006

Table 2: Surgical and perioperative characteristics according to postoperative pulmonary complication status

Variable	Total (n = 120)	PPC present (n = 34)	PPC absent (n = 86)	p-value
Thoracic surgery	46 (38.3%)	18 (52.9%)	28 (32.6%)	0.038
Abdominal surgery	74 (61.7%)	16 (47.1%)	58 (67.4%)	0.038
Duration of surgery, min	168.5 ± 49.2	198.4 ± 52.6	156.7 ± 42.9	<0.001
Duration of anesthesia, min	196.3 ± 55.8	228.1 ± 58.7	183.7 ± 48.5	<0.001
Blood loss, mL	485 ± 235	635 ± 264	426 ± 194	<0.001
Blood transfusion	31 (25.8%)	15 (44.1%)	16 (18.6%)	0.004
ICU admission	39 (32.5%)	23 (67.6%)	16 (18.6%)	<0.001
Hospital stay, days	7.8 ± 3.4	11.2 ± 3.8	6.5 ± 2.1	<0.001

Table 3: Biochemical parameters according to postoperative pulmonary complication status

Variable	PPC present (n = 34)	PPC absent (n = 86)	p-value
Hemoglobin, g/dL	10.9 ± 1.6	12.1 ± 1.5	<0.001
Total leukocyte count, ×10⁹/L	12.8 ± 3.4	9.7 ± 2.6	<0.001
Neutrophil-to-lymphocyte ratio	5.6 ± 2.1	3.4 ± 1.5	<0.001
Serum albumin, g/dL	3.1 ± 0.5	3.7 ± 0.4	<0.001
Serum creatinine, mg/dL	1.28 ± 0.41	1.04 ± 0.29	0.001
Random blood glucose, mg/dL	174.6 ± 48.3	143.2 ± 39.6	<0.001
C-reactive protein, mg/L	42.5 ± 18.7	24.8 ± 12.6	<0.001
Serum lactate, mmol/L	2.4 ± 0.8	1.6 ± 0.5	<0.001

Table 4. Physiological parameters according to postoperative pulmonary complication status

Variable	PPC present (n = 34)	PPC absent (n = 86)	p-value
Respiratory rate, breaths/min	22.8 ± 4.1	18.6 ± 3.2	<0.001
Preoperative SpO_2, %	93.8 ± 3.2	96.7 ± 2.1	<0.001
PaO_2/FiO_2 ratio	286.4 ± 58.7	354.2 ± 62.5	<0.001
FEV_1, % predicted	68.5 ± 14.2	81.6 ± 13.8	<0.001
FVC, % predicted	72.4 ± 15.1	84.3 ± 12.9	<0.001
Postoperative oxygen requirement	29 (85.3%)	34 (39.5%)	<0.001
Non-invasive ventilation	11 (32.4%)	4 (4.7%)	<0.001
Reintubation	5 (14.7%)	1 (1.2%)	0.002

Table 5. Frequency of postoperative pulmonary complications

Complication	Frequency, n (%)
Prolonged oxygen requirement	25 (20.8%)
Atelectasis	15 (12.5%)
Non-invasive ventilation	15 (12.5%)
Pneumonia	10 (8.3%)
Respiratory failure	8 (6.7%)
Bronchospasm	7 (5.8%)
Pleural effusion requiring treatment	6 (5.0%)
Reintubation	6 (5.0%)
Prolonged mechanical ventilation	5 (4.2%)

Table 6. Multivariable logistic regression analysis for independent predictors of postoperative pulmonary complications

Predictor	Adjusted OR	95% CI	p-value
Age >60 years	2.31	1.08–4.95	0.031
Current smoking	2.74	1.19–6.32	0.018
COPD	3.18	1.26–8.03	0.014
ASA III–IV	3.52	1.47–8.44	0.005
Duration of surgery >180 min	2.96	1.24–7.08	0.015
Serum albumin <3.5 g/dL	3.89	1.61–9.39	0.003
CRP >30 mg/L	2.68	1.12–6.43	0.027
PaO_2/FiO_2 ratio <300	4.21	1.71–10.38	0.002
FEV_1 <70% predicted	3.36	1.34–8.41	0.010

DISCUSSION

This is a cross-sectional clinical study in which postoperative pulmonary complications were reported in 28.3% of patients undergoing major thoracic and abdominal surgery.[1] PPCs were related to old age, high BMI, current smoking, COPD, diabetes mellitus, ASA III–IV, emergency surgery, long operative and anesthesia time, amount of blood loss, need for transfusion, need for ICU, and longer hospital stay. [2]

This may be attributed to the fact that PPCs were more prevalent in older patients, which may be associated with diminished respiratory reserve, diminished cough reflex, diminished mucociliary clearance, and increased presence of comorbid illness.[3] Smoking and COPD also contribute to the postoperative risk of respiratory complications via airway inflammation, retention of bronchial secretions, bronchospasm and defects in gas exchange.[4] Likewise, ASA III-IV indicates decreased physiologic reserve and increased operability risk.[5]

Significant relationships between biochemical markers and PPC development were observed.[6] Leukocyte count, neutrophil-to-lymphocyte ratio, CRP, serum lactate, creatinine and random blood glucose were higher and hemoglobin and serum albumin were lower in patients with PPCs.[7] These observations indicate that systemic inflammation, nutritional status, anaemia, metabolic stress and decreased physiological reserve may be associated with postoperative respiratory morbidity.[8]

Physiological variables were particularly important predictors.[9] Preoperative SpO_2, PaO_2/FiO_2 ratio, FEV_1, and FVC levels were significantly associated with PPCs.[10] PaO_2/FiO_2 ratio <300 and FEV_1 <70% predicted were independent factors on the multivariable analysis, reinforcing the utility of objective respiratory evaluation to identify high-risk patients prior to surgery.[11]

The association of PPCs with ICU admission, postoperative oxygen need, non-invasive ventilation, reintubation and longer hospital stay underscores the clinical impact of these complications.[12] Timely prevention can be achieved through early identification of high-risk patients and smoking cessation, bronchodilator optimization, chest physiotherapy, incentive spirometry, sufficient pain management, early mobility, lung-protective ventilation and enhanced postoperative care. [13]

This study has some limitations.[14] The cross-sectional nature of the design restricts causal interpretation and data from two institutions may decrease the generalizability of the findings.[15] Not all patients in routine practice will have pulmonary function tests and arterial blood gas parameters.[16] There is a need for larger prospective multicenter studies to validate these predictors and

create reliable prediction models of postoperative pulmonary complications.[17]

CONCLUSION

Major thoracic and abdominal surgery was associated with a high prevalence of postoperative pulmonary complications. Important predictors were advanced age, smoking, COPD, higher ASA status, longer surgery duration, higher inflammatory markers, hypoalbuminemia, and lower PaO_2/FiO_2 ratio. The use of combined clinical, biochemical and physiological assessment could enhance peri-operative risk stratification and could be used to direct preventive measures to minimise post-operative respiratory morbidity.

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REFERENCES

1. Admass BA, Ego BY, Tawye HY, Ahmed SA. Post-operative pulmonary complications after thoracic and upper abdominal procedures at referral hospitals in Amhara region, Ethiopia: a multi-center study. Front Surg. 2023;10:1177647.
2. Lagier D, Zeng C, Fernandez-Bustamante A, Melo MF. Perioperative pulmonary atelectasis-part II: clinical implications. Anesthesiology. 2022;136(1):206.
3. Entriken C, Pritts TA. Perioperative pulmonary support of the elderly. Curr Geriatr Rep. 2021;10(4):167-174.
4. Gebeyehu G, Eshetu A, Aweke S. Incidence and associated factors of postoperative pulmonary complications after abdominal surgery in the public hospital, Addis Ababa, Ethiopia. Anesthesiol Res Pract. 2022;2022:8223903.
5. Best TD, Mercaldo SF, Bryan DS, Marquardt JP, Wrobel MM, Bridge CP, et al. Multilevel body composition analysis on chest computed tomography predicts hospital length of stay and complications after lobectomy for lung cancer: a multicenter study. Ann Surg. 2022;275(5):e708-e715.
6. Kakavas S, Karayiannis D, Bouloubasi Z, Poulia KA, Kompogiorgas S, Konstantinou D, et al. Global leadership initiative on malnutrition criteria predict pulmonary complications and 90-day mortality after major abdominal surgery in cancer patients. Nutrients. 2020;12(12):3726.
7. van der Kroft G, van Dijk DP, Rensen SS, Van Tiel FH, de Greef B, West M, et al. Low thoracic muscle radiation attenuation is associated with postoperative pneumonia following partial hepatectomy for colorectal metastasis. HPB. 2020;22(7):1011-1019.
8. Hong SW, Lee SA, Kim SH. Prediction of postoperative pulmonary complications in older patients undergoing lobectomy for lung cancer based on skeletal muscle mass. J Thorac Dis. 2023;15(3):1063.
9. Zhang X, Deng C, Wan Q, Zhao R, Han L, Wang X. Impact of sarcopenia on postoperative pulmonary complications after gastric cancer surgery: a retrospective cohort study. Front Surg. 2023;9:1013665.
10. Chen J, Peng LH, Min S. Implementation of perioperative breathing exercises and its effect on postoperative pulmonary complications and long-term prognosis in elderly patients undergoing laparoscopic colorectal surgery: a randomized controlled trial. Clin Rehabil. 2022;36(9):1229-1243.
11. Li MHG, Bolshinsky V, Ismail H, Burbury K, Ho KM, Amin B, et al. A cross-sectional survey of Australian anesthetists' and surgeons' perceptions of preoperative risk stratification and prehabilitation. Can J Anaesth. 2019;66(4):388-405.
12. Jones K, Gordon-Weeks A, Coleman C, Silva M. Radiologically determined sarcopenia predicts morbidity and mortality following abdominal surgery: a systematic review and meta-analysis. World J Surg. 2017;41(9):2266-2279.
13. De Hert S, Staender S, Fritsch G, Hinkelbein J, Afshari A, Bettelli G, et al. Pre-operative evaluation of adults undergoing elective noncardiac surgery: updated guideline from the European Society of Anaesthesiology. Eur J Anaesthesiol. 2018;35(6):407-465.
14. Emile SH, Elgamal M, Elshobaky A, Shalaby M, Fadaly A, AbdelMawla A, et al. Identifying patients at high risk of having pulmonary dysfunction before laparoscopic bariatric surgery and its impact on postoperative pulmonary complications. J Laparoendosc Adv Surg Tech A. 2019;29(11):1456-1461.
15. Lalhruaizela S, Lalrinpuia B, Gupta D. Serum albumin is a predictor for postoperative morbidity and mortality in gastrointestinal surgeries. J Clin Diagn Res. 2020;14(5).
16. Newton DH, Kim C, Lee N, Wolfe L, Pfeifer J, Amendola M. Sarcopenia predicts poor long-term survival in patients undergoing endovascular aortic aneurysm repair. J Vasc Surg. 2018;67(2):453-459.
17. Elliott JA, Doyle SL, Murphy CF, King S, Guinan EM, Beddy P, et al. Sarcopenia: prevalence, and impact on operative and oncologic outcomes in the multimodal management of locally advanced esophageal cancer. Ann Surg. 2017;266(5):822-830.
18. Elnour AA, Babkir S, Al-Kubaissi KA. The predictors of postoperative delirium at surgical units in Sudan: a multicenter, cross-sectional, prospective study. Pharm Pract. 2022;20(3):2705.
19. Kitahara S, Abe M, Kono C, Sakuma N, Ishii D, Kawasaki T, et al. Prognostic impact of the cross-sectional area of the erector spinae muscle in patients with pleuroparenchymal fibroelastosis. Sci Rep. 2023;13(1):17289.
20. Weldu MG, Berhane H, Berhe N, Haile K, Sibhatu Y, Gidey T, et al. Magnitude and determinant factors of surgical site infection in Suhul hospital Tigrai, northern Ethiopia: a cross-sectional study. Surg Infect. 2018;19(7):684-690.

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