A Proposed Pediatric Risk Stratification Method (PediaRiSM) for Post Operative Pulmonary Complication for Cardiothoracic Surgery

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Background --- Pulmonary complications are the most common form of posoperative morbidity experienced by a pediatric patient undergoing surgery, particularly cardiothoracic surgery. There has been no preoperative risk stratification method available to evaluate pediatric patients. This study aimed to propose a risk stratification method for post-operative pulmonary outcomes among pediatric patients undergoing cardiothoracic surgery.

Methods **---** We retrospectively reviewed medical records of 506 children aged 6 to 19 years old who underwent cardiothoracic surgery from June 2003 to 2008. Preoperative risk factors extracted included age, gender, cardiothoracic anomalies, nutritional status, and co-morbidities. Laboratory data included complete blood count, 2D echocardiogram, chest radiograph, pulmonary function tests and blood gas analysis. These parameters were associated with pulmonary complications observed such as atelectasis, pleural effusion, pneumonia, pneumothorax, pulmonary edema and airway problem.

Results **---** Three hundred thirty (65.2%) out of 506 children developed post-operative pulmonary complications with atelectasis (25.6%) being the most frequent complication observed. Among the clinical variables analyzed, only three variables were independently predictive of post-operative complications, namely: FVC of < 80 (p=.030); blood pH of < 7.35 (p=.024) and white blood cell count of > 12 T per cubic mm (p=.0001). ROC analysis derived the best minimum cut-off score of 11 points with a sensitivity of 88.8%, specificity of 85.1%, and positive likelihood ratio (LR+) of 5.41. The overall accuracy of the scoring index was 81.6% [p=0.002].

Conclusion **---** Pre-operative risk stratification for pediatric patients undergoing cardiothoracic surgery using this scoring index is simple and rapid. ***Phil Heart Center J 2012; 16(2):35-46***

Key Words: PediaRiSM ■ Risk Stratification ■ Postoperative complication

Pulmonary complications are the most common form of postoperative morbidity experienced by pediatric patients who undergo surgical abdominal procedures and thoracotomy; and they frequently occur after surgical cardiac procedures.[1] The American Academy of Pediatrics recommends guidelines for the preoperative anesthetic environment for children undergoing any kind of surgery. Few prospective trials critically examined the various criteria used in preoperative assessment. The problem with the physiologic evaluation of the patient undergoing surgery, particularly in pediatric thoracic and cardiovascular, is that there is as yet no "gold standard" or single test to predict the patient's response postoperatively. Instead, a multitude of procedures and tests have been described and performed in adult patients and these are often used to evaluate children and adolescent patients.[2] A scoring system suggested by Dr. Barry Shapiro to evaluate the risk for postoperative pulmonary complications this scheme allows the clinician to stratify patients undergoing thoracic and upper abdominal surgery. In adult patients, it can be stratified on clinical grounds into low-, medium-, and high-risk categories. These categories, along with consideration of the type and urgency of surgery,

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allow for a reasonable approach to pre-operative testing. [3] Children and adolescent with congenital heart disease who underwent surgical repair are a special group of patients associated with an increased risk of development of post-operative pulmonary complications. Most postoperative pulmonary complications such as pneumonitis, bronchospasm, lobar collapse, prolonged mechanical ventilation and generalized pulmonary dysfunction develop as a result of changes in lung volumes that occur in response to dysfunction of muscles of respiration and other changes in chest wall mechanics.[4] Two local studies done by AMA Reyes et al[5] and GL Gillera et al[6] last 2001 and 2004 respectively showed that the incidence of pulmonary complications was higher among this group of children and adolescents. To our knowledge there have been no local guidelines and standard protocol for pediatric evaluation or risk stratification for postoperative complications for cardiothoracic surgery. We made a 6-year retrospective review of all young patients undergoing cardiothoracic surgery from year 2003-2008 at our institution, and attempted to identify specific pulmonary risk factors that may underlie the development of postoperative pulmonary complications.

The goal of preoperative evaluation of the surgical patient is to identify patients at risk for complications during or following cardiothoracic surgery but up to this time there have been no standard guidelines for risk stratification or assessment in pediatric age group. For this reason, this study was meant to establish a scoring system for risk stratification for postoperative pulmonary complications and to determine predictors of complications in patients at risk for post-operative pulmonary complications. The objective of this study is to develop guidelines and propose a scoring system for pediatric risk stratification for postoperative pulmonary complications in patient undergoing cardiothoracic surgery; to determine the risk factors for the development of postoperative pulmonary complications in children and adolescents with congenital heart defects undergoing cardiac operations; to assess the degree of correlation of preoperative and perioperative risk factors and verify whether they have a role as a predictor of complications postoperatively and to determine the accuracy of a simple pre-operative scoring system to predict post-operative complications among children undergoing cardiothoracic surgery.

Methodology

We made a retrospective review of the charts of children 6 to 19 years old who underwent cardiothoracic surgery from June 2003 to June 2008. Data was extracted from Medical Records of the hospital. Patients were identified by discharge diagnosis, PICU admissions log, and Pediatric Critical Care for Congenital Heart Disease from the surgical databases.

A checklist /evaluation form was provided to assess the preoperative risk factors such as demographic characteristics (age, gender and primary cardiothoracic anomalies), nutritional status, presence or absence of co-morbid diseases, neurologic status, and past medical history of each patient. Laboratory data such as complete blood count, pulmonary artery pressure and chest radiographs prior to surgical procedure were reviewed. American Society of Anesthesiologist (ASA) physical status was also evaluated. We also recorded perioperative parameters such as surgical procedure, total duration of surgery, cardiopulmonary bypass time, aortic cross-clamp time; and duration of postoperative mechanical ventilation. Operability was evaluated by means of pulmonary function tests and blood gas analysis.

Postoperative complications and mortality were considered as those occurring within seven (7) days postoperatively or over a longer period if the patient was still in the hospital.

Descriptive data were expressed as medians or as means for normally distributed data. Group and categorical data were analyzed with appropriate statistical tools. The study population was divided into 2 groups based on the presence or absence of complications. The pulmonary complications are as follows: (1) *Atelectasis* – defined as a radiographic findings of lobar infiltrate and volume loss in the absence of clinical signs of infection; (2) *Pleural effusion* – patients with pleural drainage > 5ml/kg/day and requiring continued

chest tube drainage beyond the 3rd post operative day; (3) *Pneumothorax;* (4) *Pulmonary congestion/ edema;* (5) *Airway problem*- bronchospasm, wheezing, obstruction; and (6) *Pneumonia*- new or progression of localized infiltrates on CXR with fever and leukocytosis >10,000/mm^3. A system for evaluating the risk category for pulmonary complications was based on point system. Each of the 3 categories was evaluated and patient was ascribed a total score from 0-16 (only one score is assigned for each variable), making 16 the highest score possible.

Using Pediatric Pulmonary Risk Stratification Method (PediaRiSM), pre-operative assessment was done and labeled as follows:

- "LOW RISK"
  - Little expectation for complications
  - Incentive spirometry and deep breathing exercises usually not necessary after discharge from recovery room
- "MODERATE RISK"
  - Significant incidence of complications
  - if treated, should not be life- threatening
  - Aggressive post-operative bronchial hygiene Oxygen therapy often indicated or necessary for several days
- " HIGH RISK"
  - Seriously consider ICU stay for at least 24-48 hours
  - Serial evaluation of cardiopulmonary status
  - Aggressive bronchial hygiene is strictly observed

Statistical Analysis All analyses were done using the Statistical Package for the Social Sciences (SPSS Version 14, Chicago Ill. USA) and the NCSS-PASS softwares. Descriptive statistics included mean and standard deviation for continuous data and frequencies and percentages for categorical data. Comparison of categories between with and without postoperative complications was done using Chi-square and independent T test for all continuous variables. All independent variables were entered into a binary logistic regression model using stepwise technique. Standardized and non-adjusted beta-coefficients and their corresponding odd ratios to determine the independent predictors of treatment failure. Odd ratios of greater than 1, falling within the 95% confidence limits and possessing a p-value of less than 0.05 were considered significant prognostic factors. Score transformations were done on these predictors by dividing them by the smallest beta-coefficient of the mode. A raw score was done by dividing this coefficient by the number of analyzed factors. A score was assigned by rounding the coefficient to a whole number. For the validation set of the proposed scoring system, we utilized the same set of patients. The predictive accuracy of the prediction model was obtained by receiving operator curve analysis (ROC) where the best minimum cut-off scores to predict postoperative complications. Corresponding sensitivity, specificity, positive likelihood ratio and percentage of correct prediction were likewise derived.

Results

A total of 506 pediatric patients who underwent thoracic surgery from June 2003 to June 2008 were reviewed. A total of 330 children (65.2%) had postoperative complications. Of these children with complications, atelectasis accounted for 25.6%, followed by pleural effusion (15.3%), pulmonary congestion (11%), pneumonia (9.6%), pneumothorax (1.7%), cardiac complications (0.9%),

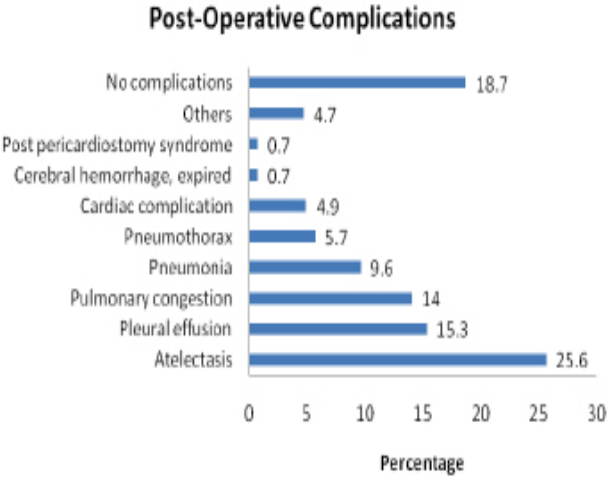

Figure 1. Frequency of post-operative pulmonary complications observed in 330 Children after cardiothoracic surgery, Philippine Heart Center, June 2003-2008

while one case each of postpericardiostomy syndrome (0.7%) and cerebral hemorrhage who eventually died (0.7%). (*Figure 1*).

Comparative Profile: The mean age of the sample was 10.2 years (with complications) and 9.78 years (without complications), with slight female predominance in both groups (56%, 64% respectively). There was no significant difference in terms of the wasting (p=0.27) and stunting (p=0.26). Tetralogy of Fallot (TOF), ventricular and atrial septal defects were the most common lesions seen with complications (22%, 38%, and 12%) although this distribution was not statistically significant (p =0.91).

Pre-Operative Diagnostic Work-Up: Two dimensional echocardiographic findings were not significantly different between the two groups (p=0.18). A higher proportion of those with complications had FVC less than 80 (51% vs. 43%) but this was not statistically significant (p=0.26) The mean FVC was slightly lower among those with complications (77.7% vs. 81.6%, p=0.092). No difference in the proportion of subjects with FEV1 less than 80 was noted (63% vs. 54%, p=0.14). The average FEV1 was slightly lower (74.6% vs. 79%, p=0.076). Likewise, no statistical difference was noted with FEV/FVC ratio (p=0.80),

Table 1. Clinical Characteristics of Pediatric Patients With and Without Post- Operative Pulmonary Complications After Cardiothoracic Surgery, Phil. Heart Center, June 2003-2008

Characteristics	With Complications		Without Complications		p-value
	n = 330	%	*n = 176*	%	
Age (Years) Mean ± SD	10.2 ± 3.9		9.78 ± 3.7		0.34*
Sex					
Male	144	44	64	36	0.25**
Female	186	56	112	64	
Wasting					
Normal	93	28	65	37	0.27**
Milde Moderate	188	57	83	47	
Severe	49	15	28	16	
Stunting					
Normal	213	65	102	58	0.26**
Milde Moderate	116	35	74	42	
Severe	0	---	0	---	
Congenital Heart Disease					
TOF	72	22	37	21	
VSD	125	38	62	35	0.91**
ASD	38	12	16	9	
PDA	87	26	56	32	
TAPVR	8	2	5	3	
History of Respiratory Tract Infection					
Present	42	13	1	1	0.87**
Absent	288	87	175	99	
ASA Classification					
1	5	2	8	4	
2	176	67	164	67	0.45**
3	75	28	64	26	
4	7	3	7	3	

*Significant p-value if less than 0.05, * by Independent T-test , ** by Chi-Square*
TOF Tetralogy of Fallot VSD Ventricular Septal Defect ASD Atrial Septal Defect PDA Patent Ductus Arteriosus
TAPVR Total Anomalous Pulmonary Venous Return ASA American Society of Anesthesiologist

Table 2. Pre-Operative Echocardiography, Pulmonary Function Tests and Radiographs of Children with and Without Post-Operative Complications after Thoracic Surgery, Phil. Heart Center, June 2003-2008

	With Complications N= 330		Without Complications N = 176		p-value
	Frequency	%	*Frequency*	%	
2D Echocardiography					
Mild	179	54	93	53	
Moderate	72	22	23	13	0.018**
Severe	35	11	28	16	
No data	44	13	32	18	
FVC (% Predicted) ≥ 80	163	49	100	57	0.26**
FVC (% Predicted) Mean ± SD	77.7 ± 18.8		81.6 ± 15.1		0.092**
FEV_1 (% Predicted) ≥ 80	122	37	81	46	0.14*
FEV_1 (% Predicted) Mean ± SD	74.6 ± 19.3		79 ± 18.2		0.076*
FEV_1 /FVC (% Predicted) ≥ 80	274	83	148	84	0.80**
FEV_1 /FVC (% Predicted) Mean ± SD	88.12 ± 11.3		88.15 ± 8.8		0.98*
FEF (25/75) Best ≥ 80	161	49	93	53	0.56**
FEF (25/75) Mean ± SD	73.1 ± 29		76.7 ± 30.1		0.34*
Chest Radiography					
Hypervascular	191	58	95	54	0.53**
Hypovascular	139	42	81	46	

*Significant p-value if less than .05, * by Independent T-test, ** by Chi-Square*
FVC-forced vital capacity, FEV1- forced expiratory volume at 1 min

Table 3. Arterial Blood Gas, Hematologic and Other Intra-operative Parameters of Children With and Without Post-Operative Complications After Thoracic Surgery, Phil. Heart Center, June 2003-2008

	With Complications N= 330		Without Complications N = 176		p-value
	n	%	*n*	%	
Arterial Blood pH					
7.35 - 7.45	299	91	162	92	0.68**
< 7.35	31	9	14	8	
paO_2					
> 95	216	65	120	68	0.53**
70 - 94	35	11	25	14	
< 69	79	24	31	18	
$paCO_2$					
35 - 45	207	63	109	62	0.88**
< 35	123	37	67	38	
Hematologic Work-up					
Hematocrit	40.4 ± 8.4		41.6 ± 9.8		0.31*
WBC	12.9 ± 11.8		7.88 ± 1.8		***0.028***
Bypass Time (mins), mean ± SD	97.3 ± 51.7		88.3 ± 33.4		0.19*
Cross Clamp Time (mins), mean ± SD	64.4 ± 35.8		59.2 ± 25.5		0.28*
Duration of Mech Vent.					
> 120 hours	61	18	0	---	***<0.05****
< 120 hours	269	82	176	100	

*Significant p-value if less than .05, * by Independent T-test, ** by Chi-Square*

Table 4. Regression Analysis of Pre-Operative Factors Contributing to Risk of Post-Operative Complications, Analysis of 406 Children, Phil Heart Center, June 2003-2008

Variable	β-Coefficient	Odds Ratio	95% CI		p-value*	Comment
			Lower	Upper		
Age	0.042	1.043	0.95	1.14	0.36	NS
Sex	0.286	1.331	0.64	2.78	0.45	NS
Wasting	0.060	1.062	0.64	1.76	0.82	NS
Stunting	0.015	1.015	0.51	2.02	0.96	NS
Type of CHD	0.097	0.907	0.66	1.25	0.55	NS
2Decho	0.160	0.852	0.63	1.16	0.31	NS
FVC	1.13	3.12	1.11	8.65	**0.030**	**Predictor if < 80**
FEV1	0.043	0.958	0.31	2.96	0.94	NS
FVC/FEV	0.476	0.62	0.21	1.79	0.379	NS
FEF	0.716	2.05	0.85	4.92	0.11	NS
Blood pH	0.78	1.40	1.20	2.07	**0.024**	**Predictor if < 7.35**
paO_2	0.181	1.20	0.78	1.82	0.39	NS
$paCO^2$	0.299	0.74	0.38	1.44	0.38	NS
history of RTI	0.43	0.090	0.032	11.2	0.87	NS
ASA classification	0.286	1.331	0.64	2.78	0.45	NS
Pre-Op CX Ray	0.16	0.85	0.44	1.64	0.63	NS
Hematocrit	0.023	1.02	0.97	1.07	0.32	NS
WBC	0.615	1.85	1.49	2.28	**0.0001**	**Predictor if < 12T**
Cross clamp time	0.009	0.991	0.97	1.011	0.38	NS
Bypass time	0.009	1.01	0.99	1.023	0.21	NS
Duration of MV	8.4	4,676.5	0	3.8^{18}	0.63	NS

**significant predictor if OR is >1 and p-value is <.05, by Binary Logistic Regression, stepwise technique*
CHD Congenital Heart Disease *FVC Force Vital Capacity* *FEV Force Expiratory Volume*
ASA American Society of Anesthesiologist *WBC white Blood Cell Count* *MV Mechanical Ventilation*
RTI Respiratory Tract Infection

mean FEF (p=0.56). Preoperative chest-x-ray findings were not different between the two groups (p=0.53). Among those with complications, a statistically higher mean WBC count was noted (12.9 vs. 7.88, p=0.028). There were more patients who had duration of mechanical ventilation >120 hours who developed complications (18% vs. 0, p <0.05). No difference was noted with regards to the arterial blood pH (p=0.68), paO2 (p=0.53), paCO2 (p=0.88), hematocrit (p=0.31), bypass time (p=0.19) and aortic cross clamp time (p=0.0028).

Table 5. Score Transformation from Standardized Beta Coefficients from Three Recognized Predictor Variables

Predictive Factors	β-Coefficient	Transformed Coefficient †	Calculated ‡ Coefficient	Assigned Score
FVC	1.13	125.6	6.6	7
Blood pH	.78	86.67	4.5	5
WBC	.615	68.33	3.6	4

*Predictor variables, †-β coefficient divided by 0.009,
‡ transformed coefficient divided by 19 variables analyzed
FVC Forced vital Capacity WBC White Blood Celll

Table 6. Proposed Scoring System to Predict Post-Operative Complications from Cardiothoracic Surgery

PREDICTOR	ASSIGNED SCORE	SCORE RANGE
FVC	7	
< 80	0	0 to 7
≥ 80		
Blood pH	5	
< 7.35	0	0 to 5
≥ 7.35 - 7.45		
WBC	4	
> 10 T/mm³	0	0 to 4
< 12 T/mm³		
Lowest Achievable Score	-	0
Highest Achievable Score	-	16

FVC Forced Vital Capacity WBC White Blood Cell

Multivariate Analysis: Among the clinical variables analyzed, only three variables were independently predictive of postoperative complications. The FVC of < 80 OR= 3.12, 95% CI 1.11-8.65, p=0.030); blood pH of < 7.35 (OR=1.4, 95% CI 1.20- 2.07, p=0.024) and WBC count of >12T per cubic mm OR=1.85, 95% CI 1.49-2.28, p=0.0001).

Age, sex, wasting, stunting, type of congenital heart disease, preoperative 2D echo results, FVC/FEV1 ratio, FEF, paO2, paCO2, pre-operative chest x-ray, hematocrit, cross-clamp time, by-pass time and the duration of mechanical ventilation were not independent predictors. (*Table-4*)

Score Transformation: The beta-coefficients of the three predictors were transformed by dividing it by the smallest coefficient derived from the logistic regression (0.009). The transformed coefficient was divided by the factor 19 since there were 19 variables entered into the preliminary model to derive the calculated coefficient. By conventional notation, a whole fnteger was derived and served as the assigned score. (*Table 5*)

The final proposed scoring system is summarized as Table 6. The lowest achievable score was zero while the highest was 16. The proposed risk stratification system using the risk scoring index is seen in Table 7.

Predictive Accuracy - Table 8 summarizes the predictive accuracy of the scoring system at various cut-off scores. At a score of 11 points, the sensitivity to predict post-operative complications was 88.8% and specificity of 85.1%. A total of 92.4% of the total sample was correctly predicted. The corresponding likelihood ratio for a positive test was 5.41.

Receiver Operator Curve - The overall accuracy rating of the scoring system is 81.6% [AUC 95% CI 88.6, 74.6 St Error. =0.036, p=0.002]. The best minimum cut-off score is 11 points with sensitivity of 88.8% and specificity of 85.1%. *(See Figure 2).*

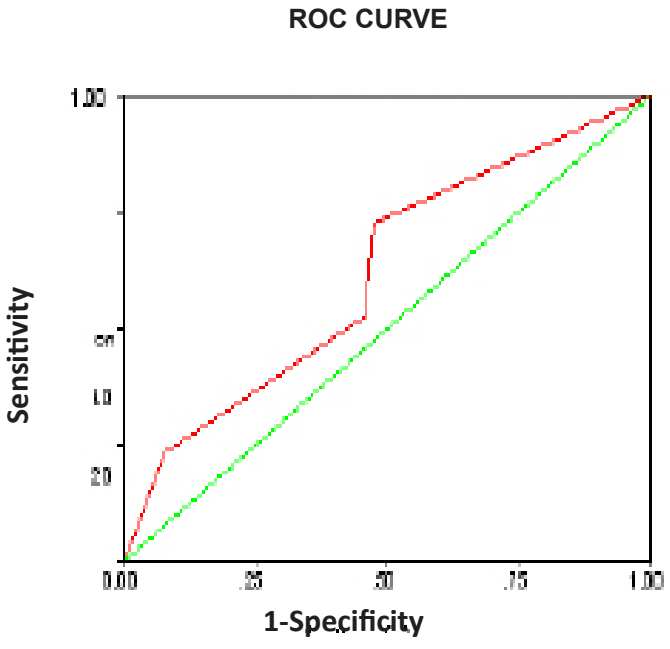

Figure 2. ROC Curve of the Scoring System Using Three Variables in Predicting Post-operative complications from cardiothoracic surgery, Phil. Heart Center, June 2003-2008

Table 7. Proposed Risk Stratification System Using the Scoring Index

Cut-off Score	Risk of Post-Operative Complication
0 - 4	Low
5 - 9	Intermediate
≥ 11	High

Discussion

The incidence of pulmonary complications after cardiac surgical procedures is high and includes generalized respiratory dysfunctions in most patients who underwent cardiopulmonary bypass. The etiology has some factors that are similar to those that have been identified for pulmonary complications that develop after lung resection, specifically alteration in the chest wall mechanics due to the incision. Abdominal and thoracic surgical procedures cause large reductions in vital capacity and smaller but crucial reductions in functional residual capacity (FRC), which has been recognized for decades as the single most important lung volume measurement involved in the etiology of respiratory complications. Although no consistent changes occur in FRC after nonabdominal, nonthoracic surgery, FRC decreases after lower abdominal operations by 10 to 15%, by 30% after upper abdominal operations, and by 35% after thoracotomy and lung resection.[7] A number of tests have been used over the years to predict post-operative pulmonary function. The overall preoperative assessment of pulmonary risk in a patient who is to undergo cardiac surgery is based more on the planned operation and less on the patient's preoperative status; while the preoperative evaluation of pulmonary risk in candidate for abdominal surgery should include an assessment of patient age, general performance status, relative weight, pulmonary co-morbid conditions, the planned operation, and the incision that is to be used. Much of the clinical practice concerning preoperative evaluation of candidates for thoracic and upper abdominal surgery is based upon clinical experience.

Pulmonary function tests among patients with congenital heart disease are known to be abnormal, which are most frequently a combination of obstructive and restrictive lung disease. The high incidence of post- operative pulmonary complications among children and adolescents with congenital heart disease are due to the abnormalities in the pulmonary blood flow, which cause the increase in the lung water causing restriction in the lung function. This influences the growth of elastic and collagen tissues in the developing lung, thus resulting in a restrictive and stiff lung.

In this study, the incidence of postoperative pulmonary complications among 506 pediatric patients with congenital heart diseases was slightly higher incidence compared to a study done by Reyes.[5] In this study, majority of the post operative pulmonary complications are atelectasis (25.6 %), pleural effusion (15.3%) pulmonary congestion (11%) and pneumonia (9%).

The study done by Reyes and Gillera et al[6] showed that the significant risk factors associated with postoperative pulmonary complications are the following: abnormal nutritional status, presence of respiratory tract infection prior to surgery, elevated pulmonary artery pressure and abnormal pulmonary function test. These variables were included in the checklist, which was tested and verified in our group of patients. Using multivariate analysis, three variables initially found to have association with post-operative complications and analyzed to be independently predictive of complications were: FVC of < 80 (OR= 3.12, 95% CI 1.11-8.65, p=0.030); blood pH of < 7.35 (OR=1.4, 95% CI 1.20-2.07, p=0.024) and white blood cell count of > 12T per cubic mm (OR=1.85, 95% CI 1.49-2.28, p=0.0001). Age, sex, wasting, stunting, type of congenital heart disease, pre-operative 2D echo results, FVC/FEV1 ratio, FEF, paO2, paCO2, preoperative chest x-ray, hematocrit, aortic cross-clamp time, bypass time and the duration of mechanical ventilation were not independent predictors. Hall and colleagues[7-8] found that the ASA classification was the single most important variable predictive of the development of post-operative

Table 8. Predictive Accuracy of the Scoring System to Predict Post-Operative Complications from Pediatric Cardiothoracic Surgery

Score Cut-off	Sensitivity (%)	Specificity (%)	% Proportion Correct	Likelihood Ratio⁺
0	0	0	0	0
4	72.4	52.6	44.4	1.5
5	76.7	53.9	52.2	1.66
7	78.9	66.6	54.5	2.32
9	81.5	72.8	67.7	2.99
11*	88.8	85.1	92.4	5.41
12	89.6	80.1	86.3	4.53
13	96.2	79.6	76.7	4.72
16	100	77.1	74.8	4.34

*Predictor variables, †-β coefficient divided by 0.009, ‡ transformed coefficient divided by 19 variables analyzed

pulmonary complication. They also found that recent respiratory infection was a significant predictor by univariate analysis. In this study, the ASA score was not significant predictor by either univariate or multivariate analysis.

The prevention of postoperative pulmonary complication is an important task for the clinician. Efforts to reduce these complication may reduce the length of hospitalization. This study identified three factors: FVC of < 80 , blood pH of < 7.35 and white blood cell count of > 12T per cubic mm. Sulc and Zapletal[8] studied lung function in patients with congenital heart disease and the most frequent abnormality was the combination of restrictive lung disease and stiff lung. A decrease in force vital capacity (FVC) to less than 80% predicted was indicative of restrictive ventilatory defect correlated with pulmonary complications after surgery. Abnormal arterial blood gas was also one of the independent predictors of complication. This is consistent with the variables in Shapiro's risk stratification used in adult patients. However, in the local study done by Reyes[5] and Gillera,[6] this variable was not identified to be associated with the development of complications maybe because of the smaller population included in their study.

All independent variables were entered into a binary logistic regression model using stepwise technique. Standardized and non-adjusted beta-coefficients and their corresponding odd ratios to determine the independent predictors of treatment failure. A receiver-operator curve analysis derived the best minimum cut-off score of 11 points with a sensitivity of 88.8% and specificity of 85.1%. The overall accuracy rating of the scoring system is 81.6% [AUC 95% CI 88.6, 74.6 St. Error. = 0.0036, p=0.002].

Conclusion

Patients with congenital heart disease are at increased risk of developing postoperative pulmonary complications. This scoring index is a simple and rapid way to stratify pediatric patients for cardiac surgery. The overall accuracy of the scoring index was 81.6%.

Recommendation

We recommend that a study be done to validate the proposed scoring (PediaRiSM) prospectively in a larger pediatric population with congenital heart disease; to make a pedia-tric risk stratification for pre-operative evaluation of pulmonary complication with larger sample size in general pediatric population undergoing thoracic, upper abdominal and non-thoracic surgery; and to determine the accuracy of a simple preoperative scoring system to predict postoperative complications among children undergoing thoracic, upper abdominal and non-thoracic surgery.

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APPENDIX A

SECTION OF PEDIATRIC PULMONOLOGY
DIVISION OF PULMONARY & CRITICAL CARE
PHILIPPINE HEART CENTER

PRE-OPERATIVE ASSESSMENT

Patient Name Last First Middle Initial	Sex o Male o Female	Room No.
Age	Height/Weight	Religion
Diagnosis	Date and time of surgery	Attending Physician

History of present illness

Past Medical History

History of

1. Hospitalization _____
2. Allergies _____
3. Bronchial Asthma _____
4. PKI/Tuberculosis _____
5. Recent Medical Infections (URTI/LRTI) _____

Chronic illness/disease

6. Sleep Apnea _____
7. Anemia/Bleeding problems _____
8. Seizures/Neurologic Disorders _____
9. Diabetes/Thyroid Problems _____
10. Obesity/Malnutrition _____
11. Others _____

Laboratories

- CBC/PC _____
- PT/PTT _____
- Blood Type _____
- ABG/Oxygen saturation by pulse oximetry _____
- ECG _____
- Chest X-Ray _____
- PFT/TBA _____
- Others _____

If for cardiac surgery - 2D echo for determination of PA pressure

ASA	Patient's Health	Status of Underlying Disease	Limitations on Activities	Risk of death
I	Excellent, no systemic disease; includes persons at extremes of age	None	None	None
II	Disease of one body system	Well-controlled	None	None
III	Disease of more than one body system or one major body system	Controlled	Present but not incapacitated	No immediate danger
IV	Poor with at least 1 severe disease	Poorly controlled or end-stage	Incapacitated	Possible
V	Very poor. Moribund		Incapacitated	Imminent

APPENDIX B

The Proposed Pediatric Risk Stratification Method (PediaRiSM) for Post-Operative Pulmonary Complication for Thoracic Surgery

Parameter	Finding	Points
Spirometry	Normal (FVC and FEV1 >80% predicted	0
	FVC (% predicted) <80	7
Laboratory Parameters (WBC Count)	Normal (WBC = 5-10 /hpf)	0
	WBC>12/hpf	4
Arterial Blood Gas	Acceptable saturation No cardiac lesion < 95% With cardiac lesion: Acyanotic <90%	0
	Metabolic pH abnormality < 7.30 or > 7.50	5

Proposed Risk Stratification System Using the Scoring Index

Cut-off Score	Risk of Post-Operative Complication
0 - 4	Low Risk for Post-operative Pulmonary Complication
5 - 9	Intermediate Risk or Post-operative Pulmonary Complication
≥ 11	High Risk or Post-operative Pulmonary Complication