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Development and Validation of a Scoring System for Predicting Complications of Pancreatitis in Patients with Post Endoscopic Retrograde Cholangiopancreatography

Leonard A. Melatunan,[1] Toar Mambu,[2] Michael Tendean,[2] Fredrik G. L. Langi[3]

[1]Department of Surgery, Faculty of Medicine, Universitas Sam Ratulangi - Prof. Dr. R. D. Kandou Hospital, Manado, Indonesia
[2]Division of Digestive Surgery, Department of Surgery, Faculty of Medicine, Universitas Sam Ratulangi - Prof. Dr. R. D. Kandou Hospital, Manado, Indonesia
[3]Faculty of Public Health, Universitas Sam Ratulangi, Manado, Indonesia
Email: Lamelatunan@gmail.com
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Abstract: Post ERCP pancreatitis (PEP) is the most common complication of endoscopic retrograde cholangiopancreatography (ERCP) with significant morbidity and mortality rates. Several factors are associated with the occurrence of PEP. There are several methods available to predict such complications, however, they are not yet valid and need some improvement. This study aimed to obtain a scoring system to predict the incidence of post ERCP pancreatitis. This was a retrospective study using medical records of patients who underwent ERCP at Prof. Dr. R. D. Kandou Hospital from 2017 to 2023. The results obtained 372 patients as samples. Gender, previous history of ERCP, cannulation attempt ≥5 times, pancreatogram, double wire technique, EPBD, and pancreatic duct stent failure were independently associated with PEP and included in the model, which achieved AUC 96.7%, sensitivity 95.0% and specificity 89.8%. In conclusion, a predictive scoring system to assess the incidence of post ERCP pancreatitis (PEP) using seven risk factors related to patient, procedure, operator, and technique is used to aid early identification of PEP and therapeutic intervention. This scoring system is simple and easy to use, and has high area under curve (AUC), sensitivity, and specificity.
Keywords: endoscopic retrograde cholangiopancreatography (ERCP); post ERCP pancreatitis; scoring system

INTRODUCTION

Endoscopic retrograde cholangiopancreatography (ERCP) is an exclusive procedure and modality therapy of endoscopy as well as procedure for diagnosis and maintenance of pancreatic and bile system.[1] The first biliary sphincterotomy was performed in 1974. Nowadays, the ERCP has become a procedure for therapeutic intervention on bile duct.[2]

In generally, ERCP is performed for diagnosis and management of choledocholithiasis, biliary and pancreatic neoplasms, and management of postoperative and perioperative biliary complications. However, this ERCP procedure is still the most complex endoscopy procedure in management of non-surgical pancreatobiliary diseases.[3]

Although it is considered safe, the ERCP is associated with a high complication rate. Post ERCP pancreatitis (PEP) is the most common complication of ERCP with significant morbidity and mortality. In addition, a therapeutic endoscopist who perform the ERCP must have comprehensive understanding about patient- and procedure-related risk factors for the occurrence of PEP.[2] Complications of ERCP are 7% of all complications, and the mortality rate is less than 0.1%. The most common major complications arising from ERCP therapy reported are pancreatitis, bleeding, perforation, and cholangitis. The incidences of post ERCP complications are pancreatitis 1-5%, perforation 1-2%, and cholangitis 1-5%. Another study of Szary and Al-Kawas reported that post ERCP complications were pancreatitis in 5.4% and bleeding in 2% of cases.[3,4] A number of studies reported that the incidence of PEP was 3%-5%. According to Parekh's meta-analysis study consisting of 21 candidates, the incidence of PEP was consistent with previously described studies of approximately 3.5%. The PEP levels ranged from 1% to almost 16% depending on patient's condition.[5]

Currently a number of studies have shown several factors related with PEP and produced several methods available for predicting the occurrence of these complications. Albeit, these methods are not yet valid and need some improvement. Therefore, in this study we discuss about an effective scoring system that doctors can use to predict the complications of pancreatitis in patients after the ERCP procedures.

METHODS

This was a retrospective study using medical records of patients who underwent ERCP at Prof. Dr. R. D. Kandou Hospital from 2017 to 2023. Research samples were taken based on inclusion and exclusion criteria. Inclusion criteria consisted of patients aged more than 18 years, undergoing an ERCP procedure, and having complete data. Exclusion criteria consisted of having diseases like malignancy of pancreas and pancreatitis before surgery, installation pancreas stent for prevention of PEP, was given indomethacin for prevention of PEP, and failed cannulation of ampulla Vateri. Sample size was calculated with Lemeshow formula.

The independent variables in this study were patient variables (young age, female, previous history of PEP, previous history of ERCP pancreatitis); procedure variables (pancreatogram, difficulty in cannulation, double wire, balloon dilatation, amount of contrast used); and operator or technique variables (operator team, failure to use pancreatic duct stent on high-risk procedure). The dependent variable consisted of post ERCP pancreatitis (PEP).

Data were analyzed using the chi-square test, followed by creating initial scores using logistic regression, validating using simulation with validation data and training data, analyzing using ROC analysis, calibrating scores using the chi-test. square, and determining the final system score using logistic regression to check goodness of fit.

RESULTS

In this study, 372 subjects met the inclusion criteria. This study was conducted at the Digestive Surgery Department of Prof. Dr. R. D. Kandou Hospital, Manado, from year 2017 to 2023. Table 1 showed the basic characteristic data of research subjects. The number of female subjects was greater than that of male subjects (51.9% and 48.1% respectively); and 59.9% of the

subjects were >60 years old with an average age of 61 years. Most subjects had never undergone ERCP or PEP previously. Of the 372 subjects, 40 (10.8%) subjects experienced PEP events in this study. When the ERCP procedure was carried out, it was found that the majority of patients had <5 cannulation attempts, used <30 ml of contrast, and did not undergo a pancreatogram, EPBD, and did not use the double wire technique. In this study, 12.1% of ERCP procedures involved fellow participation and 6.7% experienced pancreatic duct stent failure.

Table 1. Basic characteristics of research subjects

Characteristics of subjects	Total (n=372)
Gender	
Male	179 (48.1%)
Female	193 (51.9%)
Age	61.61 ± 13.67 years
≤60 years	149 (40.1%)
>60 years	223 (59.9%)
Previous history of ERCP	
Yes	52 (14.0%)
No	320 (86%)
Previous history of PEP	
Yes	27 (7.3%)
No	345 (92.7%)
Number of cannulation attempts	
<5x	338 (90.9%)
≥5x	34 (9.1%)
Pancreatogram	
Yes	78 (21%)
No	294 (79%)
Contrast volume >30 ml	
Yes	20 (5.4%)
No	352 (94.6%)
EPBD action	
Yes	66 (17.7%)
No	206 (82.3%)
Double wire technique	
Yes	24 (6.5%)
No	348 (93.5%)
Fellow participation in ERCP	
Yes	45 (12.1%)
No	327 (87.9%)
Pancreatic duct stent failure	
Yes	25 (6.7%)
No	347 (93.3%)
PEP events	
Yes	40 (10.8%)
No	332 (89.2%)

Table 2 showed the results of analysis of risk factors associated with PEP events. Of the 372 patients who underwent the ERCP procedure, it was found that 10.8% of subjects experienced PEP. To analyze what factors could be developed to become predictors of PEP, two stages of statistical analysis were be carried out. The first stage was bivariate analysis which analyzed the relationship between predictor factors and the incidence of PEP. Since the data were categorical, the Pearson chi-square statistical test would be used if the expected count was <5 or <20% of the total cells, and if it did not meet the requirements, the Fisher's exact test would be used . In the second stage, predictor factors that had a significant relationship with the incidence of PEP would be included in the multivariate analysis. From the results of bivariate analysis, it was found that

the variables namely gender, age ≥60 years, previous history of ERCP and PEP, cannulation attempts ≥5x, number of contrast uses, pancreatogram, EPBD, double wire technique, fellow participation, and pancreatic duct stent failure had a significant relationship. with PEP events.

Table 2. Comparison of risk factors to PEP events

Variables	PEP (n=40)	No PEP (n=332)	p-value
Patient-related risk factors			
Gender			<0.001*
Male	2	177	
Female	38	155	
Age			<0.001*
≥60 years	40	109	
<60 years	0	223	
Previous history of ERCP			<0.001*
Yes	28	24	
No	12	308	
Previous history of PEP			<0.001**
Yes	22	5	
No	18	327	
Procedure-related risk factors			
Attempted cannulation ≥5 times			<0.001**
Yes	20	14	
No	20	318	
Pancreatogram			<0.001*
Yes	25	53	
No	15	279	
Contrast volume >30 ml			<0.001**
Yes	10	10	
No	30	322	
EPBD action			<0.001*
Yes	16	50	
No	24	282	
Double wire technique			<0.001**
Yes	13	11	
No	27	321	
Operator or technique related risk factors			
Fellow participation in ERCP			<0.001**
Yes	7	38	
No	33	294	
Pancreatic duct stent failure			<0.001**
Yes	16	9	
No	24	323	

* *Pearson chi-square*
** *Fisher's exact test*

Table 3 showed the results of analysis of the relationship between general and clinical characteristics with mortality in PEP events. To analyze what factors could be predictors of the incidence of PEP in the subjects of this research, two stages of statistical analysis were carried out. The first stage is bivariate analysis which will analyze the relationship between predictor factors and the incidence of PEP. Because the data is categorical data, the Pearson chi-square statistical test or Fisher's exact test will be used if the chi-square test requirements are not met. In the second stage, predictor factors that have a significant relationship with the incidence of PEP, with a p value <0.001, will be included in the multivariate analysis. From the results of bivariate analysis using the chi-square test, it was found that age ≥60 years, previous history of ERCP and PEP, ≥5x cannulation attempts, number of contrast uses, pancreatogram, EPBD, double wire

technique, fellow participation, and pancreatic duct stent failure had a significant relationship with the incidence of PEP.

After the bivariate analysis was carried out as the first stage analysis, predictor variables with a p value <0.001 were included as variables to be analyzed multivariately as the second stage analysis. The statistical test used is logistic regression. The results of the multivariate analysis were presented in the form of Odd Ratio (OR). In this study, the predictor factor with the largest OR was a previous history of PEP with an OR of 79.933 (95% CI 27.124 – 235.56), which means patients who underwent the procedure ERCP with a previous history of PEP is 79 times more likely to experience PEP than patients who have never experienced PEP. The next largest predictor factor was a previous history of ERCP, followed by pancreatic duct stent failure, cannulation attempts ≥5 times, double wire technique, amount of contrast used >30 ml, pancreatogram, EPBD, fellow participation, age ≥60 years, and gender.

Table 3. Bivariate analysis of all predictor variables with PEP events

Variables	PEP (n=40)	No PEP (n=332)	p value	Odds Ratio (IK95%)
Patient-related risk factors				
Gender			<0.001*	0.046 (0.011 – 0.194)
Man	2	177		
Woman	38	155		
Age				
≤60 years	40	109	<0.001*	0.732 (0.664 – 0.806)
> 60 years	0	223		
Previous history of ERCP			<0.001*	29,944 (13,541 – 66,219)
Yes	28	24		
No	12	308		
Previous history of PEP			<0.001**	79,933 (27,124 – 235.56)
Yes	22	5		
No	18	327		
Procedure-related risk factors				
Attempted cannulation ≥5 times			<0.001**	22,714 (10,015 – 51,517)
Yes	20	14		
No	20	318		
Pancreatogram			<0.001*	8,744 (4,338 – 17,744)
Yes	25	53		
No	15	279		
Contrast volume >30 ml			<0.001**	10,733 (4,138 – 27,838)
Yes	10	10		
No	30	322		
EPBD action			<0.001*	3.76 (1.866 – 7.575)
Yes	16	50		
No	24	282		
Double wire technique			<0.001**	14,051 (5,478 – 34,347)
Yes	13	11		
No	27	321		
Operator or technique related risk factors				
Fellow participation in ERCP			<0.001**	1,641 (0.679 – 3.968)
Yes	7	38		
No	33	294		
Pancreatic duct *stent* failure			<0.001**	23,926 (9,574 – 59,791)
Yes	16	9		
No	24	323		

* *Pearson chi-square; ** Fisher's exact test*

Table 4 showed the results of the multivariate analysis. Therefore, a logistic regression equation can be created, namely as follows: $y = \alpha + \beta 1X1 + ... + \beta iXi$;
y = -19.056 – 1.851*Gender(M) + 3.037*ERCP History(Yes) + 2.900 * Cannulation attempts 5 times(Yes) + 1.857*Pancreatogram(Yes) + 1.341*EPBD action(Yes) + 1.834* ≥Double Wire Technique (Yes) + 2.978* Pancreatic duct stent failure (Yes)

Table 4. Results of multivariate analysis of predictor factors for PEP events

Predictor variables	p-value	β-value	Odds Ratio (IK95%)
Male gender	0.030	-1.851	0.157 (0.03-0.832)
ERCP history	<0.001	3.037	20.85 (6.224-69.842)
Attempted cannulation ≥5 times	<0.001	2.900	18,177 (3.753-88.048)
Pancreatogram	0.002	1.857	6,402 (1.977-20.732)
EPBD action	0.005	1.834	6,257 (1.726-22.673)
Double wire technique	0.068	1.341	3.823 (0.907-16.108)
Pancreatic duct stent failure	0.001	2.978	19.654 (3.469-111.458)
Constant (α)		-19.056	

The quality of the logistic regression equation formed was tested based on the quality of its calibration and discrimination. Based on the Hosmer-Lemeshow test (Table 5), the p-value was >0.05, indicating a good calibration. This means that with this equation, there is no difference between the observed and expected results. The coefficient of determination indicated by Nagelkerke's $R^{2\ value}$ shows that the incidence of PEP can be explained by the presence of male gender, history of ERCP, ≥5 cannulation attempts, pancreatogram, EPBD procedure, double wire technique, and pancreatic duct stent failure of 73.9%.

Table 5. Hosmer-Lemeshow test and Nagelkerke R square value of regression equations

Chi-square	df	p-value	Nagelkerke R Square
1.771	5	0.649	0.739

From the results of the multivariate analysis above, a scoring system can be created that can be used in daily clinical practice. The initial step is to make a score for each variable, namely gender, history of ERCP, attempted cannulation, pancreatogram, EPBD procedure, double wire technique, and pancreatic duct stent failure, by simplifying the results of dividing the β-value and the smallest value of the result (SE). The β and SE-values were obtained from the results of multivariate analysis. Table 6 showed the simplification of scores and variables with each scoring result.

Table 6. Creation of scoring predictor variables for PEP events

Predictor variables	β	S.E	β/SE	(β/SE)/1.826	Simplification
Gender	-1.851	0.85	-2.177	-1.191	-1
Man					-1
Woman					0
Previous history of ERCP	3.037	0.617	4.922	2.694	3
Yes					3
No					0
Attempted cannulation	2.900	0.805	3.602	1.971	2
≥5 times					2
<5 times					0
Pancreatogram	1.857	0.600	3.095	1.694	2
Yes					2
No					0

EPBD action	1.834	0.657	2.719	1.527	2
Yes					2
No					0
Double wire technique	1.341	0.734	1.826	1.000	1
Yes					1
No					0
Pancreatic duct stent	2.978	0.885	3.364	1.841	2
Failed to install					2
Installed successfully					0
Total score					(-1) to 12

The second step after making the scoring, namely creating a scoring model by carrying out logistic regression analysis on the total score variable. From the results of this regression analysis, a p-value <0.001 was obtained, indicating that the total score variable was significant as a predictor of the incidence of PEP, with the regression equation y = 5.451 – 1.104 total score. From this equation, the probability of a subject with a certain score to experience PEP can be calculated.

The next step is to test the calibration and discrimination quality of this predictor scoring model. Based on the Hosmer-Lemeshow test, the p-value was 0.535, which indicates a good calibration. This means that in this model there is no difference between the observed and expected results. Based on the ROC curve test (Figure 1), the p-value was <0.001 and the Area Under Curve (AUC) was 96.7%, which shows that the discrimination of this prediction model is very strong. This means that this prediction model can differentiate subjects who experienced PEP or not, with a sensitivity of 95.0% and specificity of 89.8% for a cut-off point of total score >2.

The probability of PEP occurrence can be calculated based on the total score and from calculating the cut-off point, it is found that the limit for PEP occurrence is at a total score of 2. From the results of creating a scoring system model, an example of the use of this scoring can be created. in clinical practice. Table 7 showed an example of PEP event prediction scoring system model. Subjects are at risk of experiencing PEP if the total score is >2.

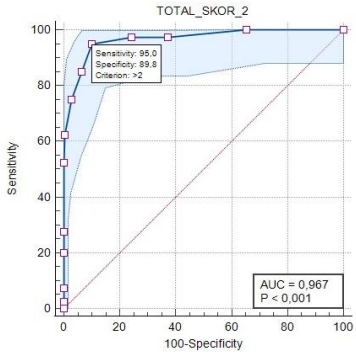

Figure 1. *Receiver Operating Curve* (ROC) prediction model curve

Table 71. PEP event prediction scoring system model

No.	Predictor variables	Yes	No	Score
1	Male gender	-1	0	
2	Previous history of ERCP	3	0	
3	Attempted cannulation ≥5 times	2	0	
4	Pancreatogram	2	0	
5	Double wire	1	0	
6	EPBD	2	0	
7	Pancreatic duct stent failure	2	0	
	Total score			

DISCUSSION

This study aimed to develop and validate a predictive model and scoring system for PEP events using patient, procedure, operator and technique related variables. This study succeeded in creating a strong predictive model for PEP using seven variables which resulted in an AUC of 96.7%, sensitivity of 95.0% and specificity of 89.8%.

Previous studies have identified a number of factors that may be associated with PEP. Based on previous studies, patient-related factors, procedure-related factors, and operator-related factors may be associated with an increased risk of PEP.[5] Based on previous research, this study also analyzed several factors based on patient-related, surgery-related, and operator-related categories to determine factors associated with PEP and build a prediction model. In this study, we identified gender, age ≥60 years, previous history of ERCP and PEP as patient-related risk factors for PEP. Cannulation attempts ≥5x, number of contrast uses, pancreatogram, EPBD, and double wire technique as risk factors for procedure-related PEP. Meanwhile, fellow participation and pancreatic duct stent failure were as risk factors for PEP regarding operators and techniques.

One of the risk factors for PEP was female gender. According to ESGE recommendations, female gender is a definitive risk factor for PEP, with an OR of 2.23 and an incidence of 4.0% compared with 2.1% in men. Although the exact relationship between gender and PEP is still unclear, it is known that this may be due to the effect of estrogen on the sphincter of Oddi, which is another risk factor for PEP.[6] Previous studies reported that younger age is a risk factor for PEP, whereas in this study it was found that patients who experienced PEP were <60 years old. Why younger age was a risk factor for PEP in this study remains unclear. Other research showed that age was not related to PEP.[7] Pancreatic exocrine function decreases with aging, which may help explain why the incidence of PEP is age dependent.[8] The decreased risk of PEP associated with aging is most likely a consequence of the progressive degradation of the pancreatic parenchyma, resulting in a less pronounced response of this organ to irritation caused by endoscopic procedures. This is confirmed by the fact that 57% of all cases of severe acute pancreatitis affect young people.[6]

In addition, interestingly, several risk factors in this study were related to cannulation attempts. Successful biliary cannulation is considered the first step in a successful ERCP procedure. In addition, difficult biliary cannulation has been identified as an important risk factor for the occurrence of PEP. Difficult cannulation and repeated cannulation attempts are also risk factors for PEP. Repeated attempts to cannulate the duodenal papilla can cause papillary injury, papillary swelling, sphincter relaxation and contraction dysfunction, thus inhibiting the release of pancreatic juice from the pancreatic duct and causing accumulation of fluid in the pancreatic duct. As a result, the pressure in the pancreatic duct increases, causing damage to the pancreatic duct epithelial cells and acini, activation of pancreatic enzymes, and induction of PEP.[9] In this study, it was found that there were ≥5 x cannulation attempts or difficult cannulation were related with PEP events.

In addition, a previous history of PEP and ERCP was found to be associated with an increased risk of PEP and had the highest OR, which had a 79-fold higher risk of experiencing PEP compared to patients who had never previously suffered from PEP. This is in accordance with research by Chen et al [7] which reported something similar. In terms of operator- related factors, it is known that the level of ability or experience of the endoscopist can influence the incidence of PEP.[10] Some studies have also explored that trainee involvement in ERCP may increase the risk of PEP; one was by Lee et al [11] who found that endoscopists with less experience were associated with higher PEP rates compared with more experienced endoscopists. This was possible related to difficulty in cannulation bile duct. Low experience causes longer time in performing cannulation, which is associated with higher PEP occurrence.

There are a number of enhancing factors associated to PEP events with difficult cannulation to overcome this problem; one of them is double wire technique. This technique is expected to increase cannulation success rate and to reduce the risk of PEP in patients who experience difficulty in cannulation. However, there is still no study that shows useful evidence in lowering the PEP incident so far. Sakr et al[12] reported the technique to decline the incidence of PEP compared with

classic ERCP procedure. This could reduce the inspection time and upgrade the success rate in difficult cases. Meanwhile in another research showed that using double wire technique in a single way is known to increase risk of PEP due to deeply biliary cannulation compared to other techniques.[13] Our study supported that the double wire technique had significant relationship with PEP and becomes one of the scoring items in scoring evaluation system.

Although double wire technique does not have positive results in lowering PEP incidence, other studies report that the use of double wire technique simultaneously with installation of a pancreatic duct stent can reduce PEP risk,[12,13] meanwhile another research reports that installation of a pancreatic duct stent prophylaxis can reduce risks and symptoms of pancreatitis and its consequences reduce ductal hypertension.[14] In cases where the guide wire can not perform cannulation to the pancreatic duct, it is not recommended to repeat the cannulation because failed attempt in doing the stent installation tends to increase the risk of PEP up to 65%.[15]

Other techniques to get access to bile ducts is using contrast injection. This technique involves entering catheter into the papilla and injection of color contrast substance to ensure the access to bile system. However, color contrast can be injected unpurposely into pancreatic duct that can increase the PEP risk. Repeated injection can increase the PEP risk.[16] European Society for Gynaecological Endoscopy (ESGE) recommends biliary cannulation with using of guide wire to achieve higher success rate and to avoid the injection of contrast to pancreatic duct.[17]

Endoscopic papillary balloon dilatation (EPBD) is useful to reduce complications of ERCP. This is avoided in Western countries due to the relatively high incidence of PEP. Three clinical trials against EPBD showed that PEP incidents occurred significantly higher. Research analysis showed that longer inflation and higher pressurized balloons can lower PEP incidence.[18] An RCT showed that EPBD with 10 mm balloon and dilation <1 minute was linked with higher PEP (15%) in comparison with 5 minutes.[19]

A number of imaging pancreatic duct or pancreatogram reported can increase PEP events. Pancreatogram increases the pressure in pancreatic line, which results in reflux of pancreatic fluid and increase the risk of post-ERCP pancreatitis. Electrocoagulation performed during pancreas sphincterotomy can damage the pancreatic ducts which easily causes PEP.[20]

In this study, we created a predictive scoring system for PEP events. This study succeeded in creating a strong predictive model for PEP using seven variables which resulted in an AUC of 96.7%, sensitivity of 95.0% and specificity of 89.8%. The scoring system for PEP consisted of a combination of seven risk factors, namely as follows: gender, previous history of ERCP, attempted cannulation ≥5 times, pancreatogram, double-wire technique, EPBD, and failure of pancreatic duct stent.

Many studies have tried to propose scoring models based on a number of factors to predict the risk of PEP.[8,13,14] However, these scoring models still have many limitations. The main limitations of these models include low credibility due to too small sample sizes, lack of validation, and impractical complexity. Until now there is still no scoring system to predict PEP that has been validated and widely used.

Zheng et al[21] created a scoring system based on a history of gastrectomy, high direct bilirubin (direct bilirubin >7.4 μmol/L), high albumin level (albumin >37.6 g/L), common bile duct stones, villous type of papillary holes, nodular type of papillary holes, pancreatic guidewire passages (PGW), sphincterotomy precursor, and high-experience operator. Scores of 0 and 5 were determined as optimal cut points for low risk (score ≤0) and high risk (score >5), with moderate risk falled in between (score between 1 and 5). This model stratified risk into three levels and achieved an AUC of 0.718-0.793, sensitivity of 0.705-0.727, and specificity of 0.676-0.797. Meanwhile, Chiba et al[22] created a simple predictive scoring system for PEP. This simplified clinical scoring system for PEP was derived from a combination of five risk factors namely naïve papilla, PGW, difficult cannulation (>15 minutes), pancreatic injection (≥1), and absence of pancreatic stent, which was named the "Big. 5″ with AUC 0.86 as the predictive probability of PEP. Fujita et al[23] created a scoring system from seven predictive factors. This scoring system

consists of a history of PEP, intact papilla, difficult cannulation, PGW-assisted biliary cannulation, pancreatic injection, pancreatic intraductal ultrasonography (IDUS)/sampling from the pancreatic duct, and IDUS/sampling from the bile duct, which are factors well-known risks. The AUC of this model was 0.799 on the training set and 0.791 on the validation set. Cheng et al[24] constructed a multivariate risk model based on minor papilla sphincterotomy, possible sphincter of Oddi dysfunction, history of PEP, younger age, contrast injection, and trainee involvement. These models had their own advantages and disadvantages. For example, cannulation of the minor papilla occured only in a small proportion of the ERCP population, and thus limited clinical significance. Apart from that, there are other limitations in scoring system since the studies were mostly conducted in single center and had small number of samples.

In this study, gender, previous history of ERCP, attempted cannulation ≥5 times, pancreatogram, double wire technique, EPBD, and pancreatic duct stent failure were independently associated with PEP and included in the model, which achieved an AUC of 96.7%, sensitivity of 95.0%, and specificity of 89.8%. Some of the factors identified in this study and used to build the scoring system were also included in previous prediction models. Nevertheless, as explained above, all of the included factors had a biological basis as possible explanations for their associations with the occurrence of PEP.

CONCLUSION

Predictive scoring system to assess the incidence of post ERCP pancreatitis (PEP) using seven risk factors related to patient, procedure, operator, and technique is used to aid early identification of PEP and therapeutic intervention. This scoring system is simple and easy to use, and has high area under curve (AUC), sensitivity, and specificity.

Conflict of Interest

The authors confirm no conflict of interest in this study.

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