Original Article

Agreement of Evolution ASA-PS Classification Evaluated by Anesthesia Residents and Research Team and Association with Perioperative Complications

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Objective: To evaluate the agreement of the American Society of Anesthesiologists physical status (ASA-PS) classification in clinical practice between anesthesia residents and research team and association with perioperative complications.

Materials and Methods: A cohort study of 1,684 patients that underwent elective surgery were classified conventional ASA-PS classification by the anesthesia resident and the research team. The measurement of agreement of ASA-PS scoring was done between the two groups using Kappa coefficient (κ). The results were compared by using with chi-square test and two-sample independent student t-test. The perioperative complications were recorded.

Results: Only 62.7% of the studied patients were classified at the same level between the anesthesia residents and the research team. The anesthesia residents classified in higher level than the research team statistically ($p<0.01$) with a Kappa coefficient of 0.345 (95% CI 0.31 to 0.37). The weighted Kappa statistic was 0.428 (95% CI 0.39 to 0.45). All the ASA classification by the research team or by the anesthesia residents and modified ASA classification associated with perioperative complication, which significantly increased with higher ASA-PS score.

Conclusion: The present study was a large single-tertiary institution cohort study. The ASA-PS rating score had 'moderate' agreement in clinical practice. The ASA-PS score is one important tool associated with perioperative complications.

Keywords: ASA-PS classification, Modified 7-grade preoperative status assessment, Agreement of ASA-PS classification, post-operative complications

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The pre-operative assessment is an important consideration in an anesthetic management and is a major part of a perioperative risk reduction. The American Society of Anesthesiologists physical status (ASA-PS) classification[1] of surgical patients is widely used to subjectively assess pre-operative health condition based of physical fitness or sickness and regarded as a scale score for risk prediction[2-5].

The ASA-PS scale scores[1] was originally launched by Saklad in 1941 and adopted by the ASA in 1963 to classify patients undergoing a surgery into the following categories, (I) healthy patient, (II) patient with mild systemic diseases, (III) patient with severe systemic diseases not incapacitating, (IV) patient with incapacitating systemic diseases, (V) moribund patient not expected to survive 24 hours with or without operation, and (VI) declared brain-dead patient. An "E" is added for emergency procedures. The ASA-PS scoring system is also a very useful tool for communication, medical record, and statistical analysis[6].

According to the residency training program in the authors' institute, Department of Anesthesiology, Faculty of Medicine, Siriraj Hospital, Mahidol University, inpatients and outpatients must be pre-operatively visited and their health status assessed by residents based on the ASA-PS classification.

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The ASA-PS scoring system is based on only the patient's health status. Its definition is very broad and the classification can be misunderstood by a trainee. Although there is strong relationship between ASA-PS score and the perioperative outcomes, it does not precisely assess the perioperative risks. From a previous study, Higashizawa and Koga launched a modified ASA-PS classification that can provide a better grading outcome for predicting the incidence of intra- and post-operative complication in surgical patients compared with the conventional ASA's[7].

The primary objective was to evaluate the agreement of the ASA-PS scoring system in clinical practice between the anesthesia residents and the research team. The comparison between the conventional ASA-PS classification and the modified ASA-PS scoring system for association of perioperative outcomes was evaluated as the secondary objective.

Material and Method

Patients

The present study was conducted at Siriraj Hospital, Mahidol university (Bangkok, Thailand). Patients age 18 years or older who underwent elective non-cardiac surgery including general, urologic, and orthopedic surgery except trauma and obstetrics were studied.

Exclusion criteria were patients who were unable to communicate in Thai language, emergency procedures, and refusal to participate in the study. After the Institutional Review Board approval and written informed consents were obtained, 1,779 consecutive patients were eligible for the study (Figure 1).

Study design

The present study was conducted as a prospective cohort study between June and September 2017. Patients were admitted one day before surgery and were independently pre-operative evaluated by the anesthesia residents and the research team who were considered as gold standard. The research team were well-trained, tested, and checked for knowledge and understanding regarding to the ASA-PS classification. All the participants were assessed based on the conventional 5-grade ASA-PS by the anesthesia residents and the research team. They also were assessed based on the modified 7-grade pre-operative status assessment by the research team according to the demographic data (age, sex, weight, and height), comorbidities, severity of systemic disease, and functional capacity. In this 7-grade status assessment, the operative and anesthetic risks were added to the conventional ASA-PS. Intra-operative period variable were recorded and included the type of procedures, anesthetic techniques, incidence of difficult ventilation and intubation, surgical and anesthetic complications, intra- and post-operative continuous vasopressor infusion, needed post-operative intensive care unit, and ventilator support. In the post-operative period, every patient was visited by the research team to identify any post-operative complication, until the patient was discharged. Hospital length of stay and type of post-operative complications was recorded.

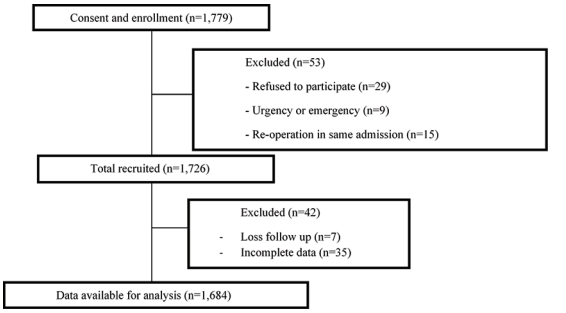

Figure 1. Study patient selection process.

Statistical analysis

The present study was designed to test the agreement of ASA-PS score of the same group of patients between the anesthesia residents and the research team. The authors measured agreement of ASA-PS scoring assigned between the anesthesia residents and the research team using Kappa coefficient (κ). Landis and Koch characterized reliability statistic values of 0 as 'absent', more than 0 to 0.20 as 'slight', 0.21 to 0.4 as 'fair', 0.41 to 0.60 as 'moderate', 0.61 to 0.8 as 'good', and more than 0.8 as 'excellent'[8]. The sample size was calculated from the n4 studies with an estimated agreement of 80%. Therefore, 1,600 subjects were needed with the power of the test at 0.8 and the error set at 0.02. Results were expressed as percentage (%) as appropriated. Comparisons between ASA-PS by the anesthesia residents and the research team were compared by using with chi-square test and two-sample independent student t-test. The statistical software package SPSS for window version 22 (SPSS Inc., Chicago, IL) was used to analyze the data. All statistical comparisons were made at the two-sided with a 5% level of significance.

Results

The cohort study consisted of 1,684 patients (50.7% male, 49.3% female), underwent the following

Table 1. Demographic and characteristic profile of studied patients

Characteristics	Frequency (n=1,684) n (%)
Male	854 (50.7)
Age (years), Mean±SD	58.0±16.6
Weight (kg), Mean±SD	64.7±14.8
Hight (cm), Mean±SD	160±9.3
Underlying diseases	
Diabetes mellites	339 (20.1)
Hypertension	771 (45.8)
Coronary artery disease	126 (7.5)
Chronic kidney disease	124 (7.4)
Surgical service	
General surgery	620 (36.8)
Orthopedic surgery	744 (44.2)
Urology	320 (19.0)
Postoperative complications	142 (8.4)
Death	5 (0.3)
Postoperative infection	99 (5.9)
Re-operation	14 (0.8)
Acute myocardial infarction	4 (0.2)
Acute atrial fibrillation	11 (0.7)
Acute heart failure	5 (0.3)
Postoperative respiratory complication	14 (0.8)
Postoperative kidney impairment	8 (0.5)
Acute pulmonary emboli	1 (0.1)
Intraoperative cardiac arrest	3 (0.2)

SD=standard deviation

types of elective surgery, orthopedic surgery 44.2% (n=744), general surgery 36.8% (n=620), and urology surgery 19% (n=320) (Table 1).

Twenty-point-four percent (n=344) were classified to ASA-PS class I, 55.2% (n=929) classified to class II, and 24.4% (n=411) classified to class III by the anesthesia residents. Thirty-seven-point-five percent (n=632) were classified to ASA-PS class I, 58.9% (n=992) classified to class II, and 3.6% (n=60) classified to class III by the research team. The ASA-PS classification was statistically significant different between the anesthesia resident group and the research team (Table 2).

The agreement between ASA-PS scores classified by the anesthesia resident versus the research team

Table 2. Agreement of ASA-PS classification assessed by anesthesia residents vs. research

ASA-PS classified by residents	ASA-PS classified by research teams, n (%)		
	ASA I (n=632)	ASA II (n=992)	ASA III (n=60)
ASA I (n=344)	338 (53.5)	5 (0.50%)	1 (1.67)
ASA II (n=929)	282 (44.6)	642 (64.72)	5 (8.33)
ASA III (n=411)	12 (1.90)	345 (34.78)	54 (90.00)

ASA-PS=American Society of Anesthesiologists physical status

p<0.001, Kappa=0.345 (95% CI 0.31 to 0.37), Weighted Kappa=0.428 (95% CI 0.398 to 0.458)

is presented in Table 3. Approximately 62.7% were classified to the same ASA-PS score by the anesthesia residents and the research team. The inter-rater reliability measured by the one-way Kappa coefficient was 0.345 (95% CI 0.31 to 0.37), while the weighted Kappa statistic was 0.428 (95% CI 0.39 to 0.45). There was 'moderate' agreement in ASA-PS classification.

One thousand six hundred eighty-four patients were also classified to the modified 7-grade preoperative status by the research team, of which 27.10% (n=457) were classified to class IA, 19.70% (n=332) classified to class IB, 34.60% (n=582) classified to class IIA, 15% (n=253) classified to class IIB, and 3.6% (n=60) classified to class III.

Incidence of peri-operative complications was 8.4% (n=142) and 60% of the peri-operative complications were post-operative infections (n=99). Peri-operative cardiac arrest occurred in three cases, one of them was caused by acute pulmonary thrombosis, one was caused by massive bleeding (of more than six liters), and one was unexplained cause. The mortality rate was 0.29% (n=5), caused by massive bleeding (n=1), severe sepsis (n=2), massive fat embolism (n=1), and myocardial infarction (n=1).

Increased ASA-PS score significantly increased the risk of peri-operative complications in the anesthesia resident group. The patients with ASA-PS class II had higher risk of complications than class I (OR 2.2, 95% CI 1.2 to 3.9). Furthermore, class III had higher risk of complications than class II (OR 1.5, 95% CI 1 to 2.2). There was same result of predictive risk of complication in the research team group. In the modified 7-grade pre-operative status classification, patients with class IB had higher risk of peri-operative complication than class IA (OR 7.3, 95% CI 3.3 to 15.8), class IIB had higher risk than IIA (OR 2.2, 95% CI 1.4 to 3.4), and class III had higher risk than IIB

Table 3. Association with postoperative complication (n=142) by ASA classified by anesthesia residents, research team, and modified ASA

	Total complication n (%)	Primary cause of complication (%)				Risk increase between class	
		Anesthesia	Patient	Surgery	Infection	Risk (95% CI)	p-value
ASA classified by research team							
ASA I (n=632)	37 (5.9)	0.3	0.6	5.1	3.6		
ASA II (n=992)	93 (9.4)	1	1.4	7	6.8	1.7 (1.1 to 2.5)	0.006
ASA III (n=60)	12 (20.0)	0	3.3	16.7	15	2.4 (1.2 to 4.7)	0.01
Total n=1,684	142 (7.9)						
p-value	<0.001	0.001	0.002	0.001	<0.001		
ASA classified by anesthesia residents							
ASA I (n=344)	14 (4.1)	0.3	0.6	3.2	1.7		
ASA II (n=929)	78 (8.4)	0.8	1.1	6.6	5.5	2.2 (1.2 to 3.9)	0.004
ASA III (n=411)	50 (12.2)	1	1.7	9.5	10.2	1.5 (1 to 2.2)	0.02
Total n=1,684	142 (7.9)						
p-value	<0.001	0.001	0.003	0.003	<0.001		
Modified ASA classified by research team							
ASA IA (n=457)	8 (1.8)	0	0.2	1.5	1.1		
ASA IB (n=332)	38 (11.4)	0.6	1.2	9.6	7.2	7.3 (3.3 to 15.8)	0.001
ASA IIA (n=582)	44 (7.6)*	0.5*	1.5	5.5*	4.6	0.6 (0.4 to 1)	0.03
ASA IIB (n=253)	38 (15.0)	2	1.2*	11.9	13.1	2.2 (1.4 to 3.4)	0.001
ASA III (n=60)	14 (23.3)	3.3	3.3	16.7	16.4	1.7 (0.9 to 3.4)	0.08
Total n=1,684	142 (7.9)						
p-value	<0.001	<0.001	<0.001	<0.001	<0.001		

ASA-PS=American Society of Anesthesiologists; CI=confidence interval

* Primary cause of postoperative complication: Anesthesia 12 (0.7%), Patients 19 (1.1%), Surgery 111 (6.2%)

(OR 1.7, 95% CI 0.9 to 3.4).

Discussion

ASA-PS classification in clinical practice is the most useful tool, used worldwide, for pre-operative assessment. Because of this, it is important to define its validity and reliability. The relationship between ASA-PS scale and post-operative outcomes has been observed in many studies, which led it to be incorporated in many predictive algorithms. The ASA-PS is currently being used for various purposes and groups, including anesthesia and non-anesthesia providers and government agencies.

Inaccuracy or poor reliability of the ASA-PS rating scale has been observed in various studies[9,10]. Previous studies found fair (κ 0.21 to 0.4) to moderate (κ 0.41 to 0.6) inter-rater agreement[11], as the present study also found moderate (κ 0.42) inter-rater agreement. The authors expected to find inseparable subjectivity to differentiate between patients with mild systemic disease, severe systemic disease, and severe systemic disease, which is a constant threat to life, especially as there is no other standardized assessment to clearly define the existing categories.

Sankar et al identified important factors associated with inter-rater disagreement such as age, type of surgery, hypertension, malignancy, and comorbidities. This is because age is not assigned in the ASA-PS scale and there is no guidelines consideration regarding patient's age[11]. Nevertheless, the present study did not clarify any factors that may relate to inter-rater disagreement.

The ability of the ASA-PS score to predict peri-operative outcomes has been observed in many studies where higher ASA-PS scores were associated with higher post-operative complications, as the present study also found higher ASA-PS scores were higher risk of peri-operative complications[2-5,12].

Higashizawa and Koga proposed a modified 7-grade pre-operative status assessment that adds operative factors and anesthetic factors to conventional ASA-PS classification for more practical use in pre-operative risk assessment[7]. Our cohort of 1,684 patients were classified to the modified 7-grade pre-operative status assessment by the research team. The authors found that higher grades were higher risk of adverse outcomes. However, criteria of the modified 7-grade pre-operative status assessment might be unfamiliar to use and not well-known, so it is questionable if it is useful for the pre-operative risk evaluation. Furthermore, as the predictive power of peri-operative outcomes is not different from the conventional ASA-PS classification, the advantages seemed to be further reduced.

There are several limitations in the present study. First, the experience of pre-operative assessment of anesthesia may affect the result of ASA-PS rating scale as the present study did not divide the anesthesia residents into the first, second, and third year residents, which would influence the inter-rater reliability. Second, the present study did not include ASA-PS class IV-V and emergency patients. There was a high proportion of ASA 1 and 2 patients. The other studies had well-distributing cases, which are necessary to get generalizable results. Third, the type of surgery was only in three divisions such as general, orthopedic, and urology surgery. A high proportion of patients with ASA-PS class III underwent cardiac, vascular, neurologic, and gynecologic surgery but were not included in the present study. Fourth, the inter-rater disagreement of the ASA-PS might affect in peri-operative care. Underestimation of the ASA-PS might decrease patient's safety and overestimation of the ASA-PS would increase unnecessary investigations and increase health care expenditures. Fifth, comorbidity indices such as Charlson comorbidity index or revised cardiac risk index were not one of parameter of the peri-operative risk assessment. Therefore, the incidence of peri-operative complications might be higher than occurred in the present study. Sixth, from the results of the study, (Table 3) most of the primary cause of peri-operative complications were from surgical conditions and most of those complications were post-operative infections in urology procedure, which was common and not dependent on ASA-PS classification. Therefore, the association of post-operative complication was a combination between pre-operative assessment and surgical procedure.

The ASA classification is very subjective with moderate inter-rater reliability in clinical practice. It still demonstrates validity as a marker of patient post-operative outcomes. The accuracy of the ASA-PS classification is very important, especially to use the data in the next research.

Conclusion

In conclusion, in a large single-tertiary institution cohort study, the ASA-PS rating score had 'moderate' agreement in clinical practice. The ASA-PS score is one important tool that associate with peri-operative outcomes.

What is already known on this topic?

The ASA-PS score is an important consideration in an anesthetic management and is a major part of peri-operative risk reduction.

What this study adds?

In Siriraj Hospital, the ASA-PS rating score had 'moderate' agreement in clinical practice. The ASA-PS score associated with peri-operative complications.

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Trial registration

Thai Clinical Trials Registry: TCTR20180408001

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Conflicts of interest

The authors declare no conflict of interest.

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