Perioperative Risk Evaluation

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Citation

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Abstract

The classification of Physical Status of the American Society of Anesthesiologists (ASA) is not useful to predict the risk of perioperative complications. We propose a method that, besides ASA Classification, uses a stratification of the type of surgery and anesthesia to predict the risk of complications, to anticipate them and to reduce morbidity and mortality. Cardiovascular complications (the most common found) in 188 surgical patients operated during the first semester of 2002 were randomly selected and checked retrospectively, in the Hospital San Jose TEC de Monterrey, in Mexico. A comparison was performed among the ability of the ASA classification and the classification with three variables: ASA, Surgery and Anesthesia (PSA: Patient, Surgery, Anesthesia) to "predict" the risk to which every patient was submitted. Statistical analysis showed that usefulness to predict the risk by PSA method duplicated that one using only ASA classification (R^2 ASA: 179, R^2 PSA: 358).

INTRODUCTION

A patient submitted to a surgical procedure is taken away from his natural and daily environment and surrenders with full confidence and certainty that it will be quite safe and accurate to send him back, already “healed”, to his familiar, social and working life, without any problem.

But there is something the patient is usually afraid of and it is not necessarily the surgery. He is afraid of the anesthesia to which he will be submitted and which he knows that, as the surgery, implies risks. It is something well-taken, since the anesthesia is a state in which he will never be, but it is a necessary step in order to permit that doctors and all the people in the operating room, can do whatever they have to do without him to suffer. At the end of the treatment he will have to get back to his normal state of consciousness, also a task entrusted to the Anesthesiologist.

All the risks anesthesia implies are recognized by the own Anesthesiologist, who will always do the necessary things to minimize the risk that the potential complications take place and to diminish therefore the morbidity and the mortality that they always find as a constant threat, aside that way the patient walks through.

Shall we be able to predict the possibility that such complications appear? What is the risk of complications appearing during and after the surgery and anesthesia?

We would like to have an opportunity to predict how big is the possibility of a complication to appear during the perioperative stage, so we could lower morbidity and mortality in our patients.

Objective: Our proposal claims that the Anesthesiologist has a useful tool to determine the real and whole risk to which his patient will be exposed to.

The assessment of the Perioperative Risk, with regard to the morbidity and mortality, has been always done by the Anesthesiologist to: ([1], [2], [3]):

1. Diminish the potential risk.
2. Modify the perioperative and postoperative management to minimize morbidity.
3. Provide the adequate information to the patient and his family.

This evaluation of the risk needs to include all the factors related, as ([4]):

1. Severity of any pathological coexistent conditions.
2. The invasivity of the surgical procedure.
3. The urgency of the same one.

We should admit that anesthesia by itself is one more of the perioperative risk factors according with the degree of

invasion to the patient because of:

1. Monitoring
2. Vascular approach
3. Pharmacological invasion and
4. Use of special technical maneuvers.

In this case we will need to establish a method that assesses the REAL RISK to which the patient will be exposed. Factors such as Patient, Surgery and Anesthesia should be included and expressed it in a numerical form.

In this article we propose a method of prediction of the Perioperative Risk, which takes the three mentioned factors and allow to assign ultimately a numerical value between 1 and 5, which represents the possibility that the patient suffers some complications during or after the surgical procedure.

METHOD

It is necessary to establish 5 categories of evaluation for every aspect of a surgical procedure:

This will be the base to define the group of risk where the patient will be located.

PATIENT: the ASA classification is still the basis in regard of this part ([5], [6]).

- P1. A normal healthy patient
- P2. A patient with mild systemic disease
- P3. Patient with severe systemic disease
- P4. A patient with severe systemic disease that is a constant threat to life
- P5. A moribund patient who is not expected to survive without the operation

The ASA 6 physical status, a declared brain-dead patient whose organs are being removed for donor purposes is not applicable in these circumstances of the classification.

SURGERY: the classification is done in accordance with the extension and/or complexity of the procedure, with one or several of the mentioned characteristics.

1. S1. Minor Surgery: minimal extension, local anesthesia, ambulatory
2. S2. Major Simple Surgery: performed on one organ or system, without any other added procedure
3. S3. Major Complex Surgery: performed on one organ or system, with other procedure or procedures related with the scheduled one, potential important bleeding, perhaps with some surgical problem that can be solved.
4. S4. Major Multiple Surgery: on several organs or systems, important bleeding, potential perioperative complications, it needs special preparation
5. S5. “Rescue” surgery, danger of death

ANESTHESIA: It is classified in accordance with the complexity of the procedure, with one or several of the mentioned characteristics.

1. A1. Local anesthesia or none at all, with or without sedation / analgesia.
2. A2. Anesthesia with basic monitoring, without vascular invasion, without using non-anaesthetic drugs, without using co-adjuvant neither supplementary drugs.
3. A3. Anesthesia with basic and special monitoring, vascular invasion for hemodynamic and fluid administration control, pharmacological support (non-anaesthetic drugs, cardioactive or vasoactive drugs), use of co-adjuvant and not habitual drugs (antagonists, vg.), supplementary drugs, anaesthetic combined procedures.
4. A4. Similar to A3, longer than 2 hours or with special maneuvers (difficult intubation, or with an awaken patient, use of double lumen endotracheal tube, one lung ventilation, special mechanical ventilation, fiberlaryngoscopy needed, use of a Swan Ganz catheter, extracorporeal circulation, hypothermia, induced hypotension, CPR).
5. A5. Anaesthetic method limited in its options because of the critical state of the patient.

After assigning a patient (P, S and A) we had three digits, which were already combined from 1-1-1 up to 5-5-5. Obviously 1-1-1 represented a patient with a minimal

potential risk to compromise him, and a patient with a high risk (5-5-5, for example), was a patient with the highest possible risk. Certainly, different combinations of the three parameters values involved a great difficulty for interpretation. This was studied exhaustively from the statistical point of view to define the method of integration of the three original variables: ASA, Surgery and Anesthesia, in order to express the real potential risk.

To study the validity of the method if it had been applied before the anesthesia and surgery, 188 records were checked in the clinical files of the Hospital San Jose TEC of Monterrey, in Mexico, all of them belonging to patients surgically treated during the first semester in 2002. Randomly selected, we defined sex, age, weight and height, and in accordance with the registered information. The categories corresponding to their physical status, type of surgery and anesthesia were assigned according to the classification noted earlier. There were patients of diverse specialties and in every one of them was studied the occurrence of one or several of the complications defined in table 1.

Figure 1

Table 1: Perioperative Complications

PERIOPERATIVE	*POSTOPERATIVE*
1.- Cardiovascular	1.- Cardiovascular
Arterial Hypertension	Arterial Hypertension
Arterial Hypotension	Arterial Hypotension
Arrythmia	Arrythmia
Myocardial Ischaemia	Myocardial Ischaemia
Blood loss	Blood loss
2.- Respiratory	Cardiac Failure
Hypoxemia	2.- Respiratory
Hypercapnia	Hypoxia
Difficult tracheal intubacion	Hypercapnia
Difficult Airway Management	Delayed Extubation
3.- Renal	Compromised Airway
Low Urinary Volume	3.- Renal
Hyperkalaemia	Low Urinary Volume
Hypokalaemia	Hyperkalaemia
4.- Metabolic	High Urinary Volume
Temperature disorders	Hypokalaemia
Hyperglycaemia	4.- Metabolic
Hypoglycaemia	Temperature disorders
5.- Neurological	Hyperglycaemia
Respiratory depression	Hypoglycaemia
Myoneuroplegia	5.- Neurological
Awareness disorders	Respiratory depression
6.- Digestive	Myoneuroplegia
Regurgitation	Awareness disorders
Vomit	6.- Digestive s
Abdominal distension	Regurgitation
7.- Healing	Vomit
In surgical wound	Abdominal distension
Deep tissues	7.- Healing
8.- Infectious	In surgical wound
Findings and events	Deep tissues
Dissemination	8.- Infectious
9.- Nutritional	In the surgical wound
Hypoproteinemia	Respiratory
Anemia (caused by bleeding)	Urinary tract
	Sepsis
	9.- Nutritional
	Hypoproteinemia
	Anemia (caused by bleeding)

Each of the complications was graded from 1 to 3 depending on the severity of the complication, 1 being the least serious grade and 3 the most serious. Each of these grades got its corresponding definition and a qualitative or quantitative value was assigned.

The table of results was checked later and considering the great number of obtained variables, we decided to study first the most frequent complications which corresponded with cardiovascular perioperative complications.

These complications were defined and classified (as it was done with all other) in accordance with the following concepts:

a) HYPERTENSION / HYPOTENSION:

- TAa1: Increase or decrease of less than 20 % in the Arterial Pressure, with regard to the cyphers found in the patient´s arrival to the operating theatre, before his anesthesia and surgery were initiated.
- TAa2: Increase or decrease from 20 to 30 % in the Arterial Pressure, with regard to the cyphers found in the patient´s arrival to the operating theatre, before his anesthesia and surgery were initiated.
- TAa3: More than 30 % of increase or decrease in the Arterial Pressure, with regard to the cyphers found in the patient´s arrival to the operating theatre, before his anesthesia and surgery were initiated.

b) ARRHYTHMIA:

- TAb1: Benign. - Modification of the normal cardiac rhythm (sinus rhythm), not representing a threat for patient's life and that can be spontaneously reverted or with medical treatment. Types: sinus tachycardia or bradycardia, fast junctional rhythm and atrial ectopic beats.
- TAb2: Potentially malignant. - Modification of the normal cardiac rhythm (sinus rhythm) that represents a potential threat for the patient's life and that can be spontaneously reverted or, as it usually happens, with medical treatment. Types: ventricular ectopic beats, supraventricular tachycardia and second degree atrioventricular blockade.
- TAb3: Letal. - Modification of the normal cardiac rhythm (sinus rhythm) representing a real threat for the patient's life and that must be immediately reverted with medical treatment. Types: ventricular fibrillation, ventricular tachycardia, asystole, third degree atrioventricular blockade, cardiac frequency

less than 40 beats per minute.

c) MYOCARDIAL ISCHEMIA:

- Tac1: Ischemia. – First stage of the absence of oxygenation in cardiac muscle, usually because of a lack of blood supply, demonstrated in the EKG with a T wave inversion.
- Tac2: Lesion. - Following phase of the absence of oxygenation in cardiac muscle, usually because of a lack of blood supply, demonstrated in the EKG like a difference in the ST segment.
- Tac3: Necrosis. - Final terminal stage of the absence of oxygenation of the cardiac muscle, because of a lack of blood supply, demonstrated in the EKG like an alteration of the QRS complex, which turns into a negative wave so called “Q wave”.

d) BLEEDING:

- TAd1: Blood loss from intravascular towards extravascular space or the outside, in a quantity equal or less than 10 % of the circulating defined volume. It could be not dangerous nor a threat for patient's life, even if it is not replaced.
- TAd2: Blood loss from intravascular towards extravascular space or the outside, in a quantity between 11 and 20 % of the circulating defined volume. It can be dangerous and endanger the patient's life, if it is not adequately replaced.
- TAd3: Blood loss from intravascular towards extravascular space or the outside, in a quantity bigger than 20 % of the circulating defined volume. It is dangerous and endangers the patient's life, if it is not adequately and promptly replaced (hypovolemic shock).

Now, we had three main variables (“input “ variables): ASA, Surgery and Anesthesia, ordinal and in a scale from 1 to 5 in accordance with the associated grade of risk. Then, after assigning a “grade of importance” to each complication (“output” variables) based on its clinical transcendency, it was given a “proportional value” to each one (all inside the group of cardiovascular perioperative complications).

The assigned values were:

a) MYOCARDIAL ISCHAEMIA - 40 %
b) ARTERIAL HYPERTENSION / HYPOTENSION - 30 %
c) ARRHYTHMIA - 20 %
d) BLEEDING - 10 %

The measured sum of these four variables was considered to be the variable we called “risk”, with a continuous scale going from 0 (absence of the complication) to 3 (the most serious).

Then, the “factor analysis” was used for summing up the information of the input variables for turning them into one, normal and continue, that allowed to use a linear simple regression with the obtained factor (of ASA, surgery and anesthesia) and the measured sum (risk).

A linear regression was also done between ASA and measured sum (risk), to establish the comparison between this one and that of the analysis with three variables, as for their predictive character. To do this, we used the measurement of prediction capability called “determination coefficient” or R^2 which is the base of comparison in the result of the analysis ($_8$).

RESULTS

We consider at this time the results were obtained in two important ways:

1.- We performed a comparison between the commonly used ASA method ($_6$) and the proposed one, which considers the physical status of the patient (ASA) as well as the type of surgery and anesthesia, based on the grade of complexity and/or aggressiveness of the procedure (table 2). Table 2 shows that predictive capability of cardiovascular perioperative complications with the three variables method duplicates the predictive capability by using only the Physical Status (or ASA) for evaluation.

Figure 2

Table 2: Comparison of Determination Coefficients (R2)

POPULATION	R^2 / Only ASA	R^2 / ASA – SUR- ANESTH (P
Total	0.179	0.358
Adult Men	0.166	0.385
Adult Women	0.080	0.165
Children	Not Found	0.213

Tables 3 and 4 are corresponding to the Factors Analysis in both cases and figures 1 and 2 show the trend with the corresponding “input variables “ in the “x” axis and the risk (sum of the output variables or reported complications) in

the “y” axis.

Figure 3

Table 3: Determination Coefficient Analysis only with Physical Status

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Change Statistics					Durbin-Watson
					R Square Change	F Change	df 1	df 2	Sig F Change	
1	.423	.179	.175	3.8407	.179	41.285	1	189	.000	1.664

a Predictors: (Constant), Physical Status of the Patient
b Dependent Variable: Measured Sum (Suma ponderada)

Figure 4

Table 4: Determination Coefficient Analysis with PSA Factor

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Change Statistics					Durbin-Watson
					R Square Change	F Change	df 1	df 2	Sig F Change	
1	.503	.358	.354	3.4187	.358	103.530	1	188	.000	1.748

a Predictors: (Constant), REGR factor score 1 for analysis 1
b Dependent Variable: Measured Sum (Suma ponderada)

Figure 5

Figure 1: Complications occurrence only with ASA Physical Status

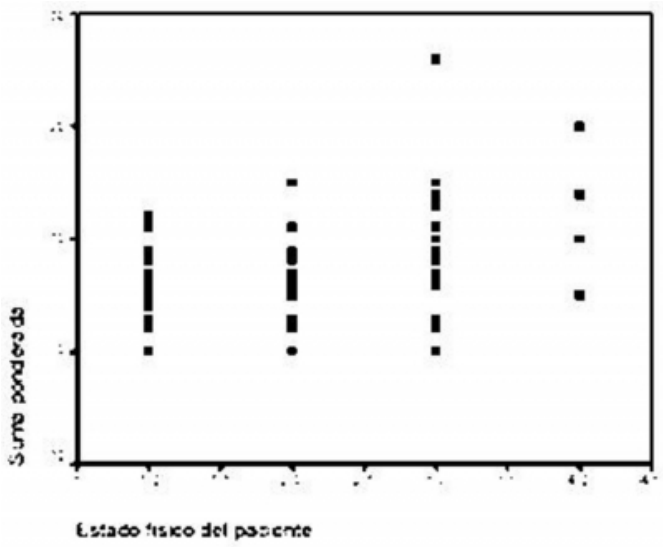
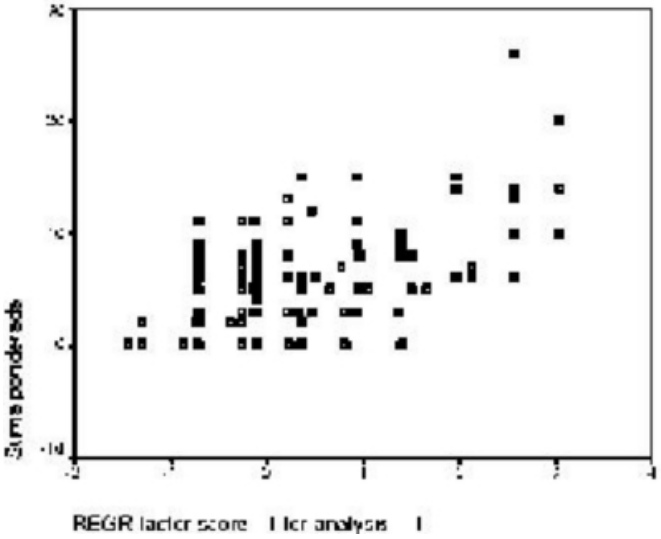


Figure 6

Figure 2: Complications occurrence with PSA Factor



2.- Based on the described result, we defined a methodology ($_{8}$) that classifies the Perioperative Risk of the patient of suffering complications (at this time, perioperative and cardiovascular), in a rapid and practical way (table 5).

Figure 7

Table 5: Cardiovascular Perioperative Risk Tabulator

CARDIOVASCULAR TRANSOPERATIVE RISK TABULATOR					
ASA 1	SUR 1	SUR 2	SUR 3	SUR 4	SUR 5
A NES 1	1	1	1	1	2
A NES 2	1	1	1	2	3
A NES 3	1	1	2	3	3
A NES 4	2	2	3	3	4
A NES 5	2	3	3	4	4
ASA 2	SUR 1	SUR 2	SUR 3	SUR 4	SUR 5
A NES 1	1	1	1	2	2
A NES 2	1	1	2	2	3
A NES 3	1	2	3	3	4
A NES 4	2	3	3	4	4
A NES 5	3	3	4	4	5
ASA 3	SUR 1	SUR 2	SUR 3	SUR 4	SUR 5
A NES 1	1	1	2	2	3
A NES 2	1	2	2	3	3
A NES 3	2	2	3	4	4
A NES 4	3	3	4	4	5
A NES 5	3	4	4	5	5
ASA 4	SUR 1	SUR 2	SUR 3	SUR 4	SUR 5
A NES 1	1	2	2	3	3
A NES 2	2	2	3	3	4
A NES 3	2	3	3	4	5
A NES 4	3	4	4	5	5
A NES 5	4	4	5	5	5
ASA 5	SUR 1	SUR 2	SUR 3	SUR 4	SUR 5
A NES 1	2	2	3	3	4
A NES 2	2	3	3	4	4
A NES 3	3	3	4	5	5
A NES 4	3	4	5	5	5
A NES 5	4	5	5	5	5

It is a table that allows locating the patient in a grade of risk prediction based on the described analysis. Later we will carry out an analysis of the rest of the complications, which will give us the entire view of the foreseen risk in all the patients to predict not only perioperative but postoperative complications also.

The assessment of the patient's physical status is performed according to ASA classification ($_6$) by the Anesthesiologist. In addition, he also classifies the type of surgery to which the patient will be submitted and the planned anesthesia.

After this, he will select the corresponding table to the ASA and will cross the type of surgery with the type of anesthesia, which will bring him to a final digit, which corresponds to the Risk, which will be defined as:

1. Minimal risk
2. Moderate risk
3. High risk
4. Very high risk
5. Extreme risk

This scale shows what we will call “perioperative cardiovascular risk”. The scale goes from 1 to 5, corresponding number 1 to the minor risk and 5 to the biggest possibility the patient has to suffer cardiovascular complications during the anesthetic and perioperative period.

DISCUSSION

Considering the previous tables as a summary of the comparison among the two studied methods, with regard to their aptitude to predict the perioperative cardiovascular morbidity, and seeing that the graph that tends to the straight line between the dependent and independent variables is the one that uses the measured sum of the variables ASA, Surgery and Anesthesia, we believe that:

1. If we use the proposed method, the incidence of cardiovascular perioperative complications is better predicted then if we use only the ASA Classification of the Physical Status,
2. With the described method, it is possible to obtain a specific scale for every type of complication of those described earlier and to evaluate, from the same three variables, the implied perioperative and postoperative risk.
3. Establishing the entire risk of a procedure will allow the medical group attending a patient to think about the possibility of diminishing risk by locating the patient in a minor risk group based on

feasible changes in the preparation of the patient, in the surgical or the anaesthetic plan.

4. The utility of the method is complemented by the Risk Tabulation scale, which is a tool easy to use and understand.

5. The surgical and anesthetic techniques are not evaluated, but known as determinant factors of perioperative morbidity.

6. It is always necessary to define first the Physical Status of the patient, and to classify him in accordance with the scale of ASA. This is the base to establish the Perioperative Risk with the described PSA method.

CONCLUSIONS

1. To evaluate the Physical Status of a patient in agreement with the ASA Classification is the first (and very important) step to predict the Perioperative Risk to which the patient will be submitted. However, this procedure by itself it did not have statistically any predictive value in the studied population.

2. We think that having integrated the ASA factor with the type of surgery and of anesthesia, defined according to the grade of complexity and invasion to the patient, we can obtain a value of Perioperative Risk that of a glance will show the Anesthesiologist the possibility of complications. This should lead him to think about taking actions to diminish the grade of risk, morbidity and mortality.

3. The review of the PSA method and of the obtained results by means of the factors analysis and the linear simple regression showed a linear tendency. It showed that a major grade of risk defined by the factor ensued from three variables corresponded with a higher incidence of complications.

4. The same review applying only the definition of the Physical Status or ASA did not show such capability related to complications.

5. It is necessary to apply the method to review all the other types of complications in a larger sample of the population prospectively and to include the perioperative and postoperative phases of the surgical event.

6. With regard to the cardiovascular perioperative complications the tool is practical and of easy handling.

7. In the future, a tab will be designed to define the Entire Risk, since it will integrate the conclusions after studying the real incidence of all the perioperative complications.

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