Perioperative Desaturation and Risk Factors in General Anesthesia

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Objective: *Despite advances in anesthetic technique, the incidence of perioperative desaturation in general anesthesia has remained high. Knowledge on factors associated with intraoperative desaturation is relatively scanty. The purpose of the present study was to investigate the distribution of time dependent intraoperative desaturation and factors predicting perioperative desaturation.*
Material and Method: *A prospective observational analytic study was conducted. One thousand and ninety three patients schedule for elective surgery under general anesthesia (GA) were enrolled. Exclusion criteria were patients with preoperative arterial oxygen saturation (SpO_2) $\leq$ 95%, pregnant women, obvious difficult airway, and those requiring mechanical ventilation postoperatively. Desaturation was defined as oxygen saturation $\leq$ 95% for $\geq$ 10 seconds.*
Results: *Among 1093 eligible cases, 30 cases (2.74%) developed intraoperative desaturation. The probability of desaturation during induction, maintenance, and emergence were 0.55% (6/1093), 2.01% (22/1093), and 0.18% (2/1093), respectively. Occurrences of desaturation at the recovery room (RR) were noted in 224 patients (20.49%). Younger, obese patients, snorers, and lower respiratory tract infection were significant high-risk groups of intraoperative desaturation. Elderly, obese patients, snorers, positive history of pulmonary disease, modified Aldrete's score $\leq$ 8, and duration of GA $\geq$ 180 minutes predicted desaturation at RR.*
Conclusion: *Obesity and snorers were the high-risk groups of perioperative desaturation. Elderly patients are at lower risk of desaturation than children intraoperatively, but at a higher risk in the postoperative period. Higher FiO_2 should be given to high-risk patients during the intraoperative period. Desaturation can still occur at RR, even in patients who received oxygen. Pulse oximeter monitoring should be continued throughout RR care.*

Keywords: *Desaturation, General anesthesia, Perioperative, Risk factor, Recovery room*

J Med Assoc Thai 2008; 91 (7): 1020-9
Full text. e-Journal: *http://www.medassocthai.org/journal*

Despite recent advances in anesthesia and surgical care, perioperative respiratory morbidity is still a common problem. One of the major perioperative pulmonary complications that is a life threatening problem is desaturation. The incidence of desaturation has remained high because of the increasing complexity of the surgery and condition of patients. Consequences of perioperative desaturation are increased morbidity, mortality, and hospital length of stay[1,2].

The incidence of postoperative desaturation from preliminary investigations varies from 0.32 to 55% according to the diagnostic criteria used[3-7]. However, the incidence of the intraoperative period was relatively scanty. This may be because of the rareness of intraoperative desaturation, which therefore required a large sample size. The risk for desaturation during the general anesthetic period may vary from time to time

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depending on different steps of the anesthetic procedure. Such time dependent function has never been reported.

Similar to the difference of knowledge gap of intraoperative and postoperative desaturation risk, the information on risk factors for postoperative desaturation is much more established than those for intraoperative desaturation. Numerous articles identified the several risk factors for postoperative desaturation, namely, age, gender, obesity, history of snoring, smoking, preexisting pulmonary disease, and duration of anesthesia[8-12]. Weaknesses of previous studies include possible uncontrolled confounding, small sample size, and the use of specific populations that might limit generalibility. To the authors' knowledge, none of the articles addressed the evidence of intraoperative risk factor.

Although care for patients with perioperative desaturation is well documented, effective prevention would be even more desirable. Knowledge on risk factors for such prevention is crucial. For the above reason, the purpose of the present study is to clarify the distribution of a time dependent intraoperative desaturation and association between potential predictive factors and perioperative desaturation.

Material and Method

This was a prospective observational analytic study conducted between June 2004 and December 2005 at Songklanagarind Hospital, which is the largest university hospital in the South of Thailand. With approval of the local ethics committee and informed patient consent, 1093 patients were studied following elective surgery under general anesthesia (GA). Patients with preoperative arterial oxygen saturation (SpO_2) $\leq$ 95%, pregnancy, obvious difficult airway, and requiring postoperative intensive care unit admission or mechanical ventilation were excluded.

According to the authors' routine anesthetic practice, all patients who underwent general anesthesia breathed FiO_2 1.0 for preoxygenation, FiO_2 0.33 (N_2O 2 liters per minute (LPM) and O_2 1 LPM) intraoperatively, and FiO_2 1.0 immediately prior to and after extubation. The intraoperative care followed the standard practice for patient care and safety. Oxygen was not administered during transportation to the recovery room (RR) and RR care was not altered. On arrival in the RR, all patients were given FiO_2 0.4 with nebulizer face mask, flow 6-8 LPM for 10 minutes. Patients were discharged when they met the discharge criteria as described by modified Aldrete's score[13].

Arterial oxygen saturation was continuously monitored with a pulse oximeter during the intraoperative period and throughout RR care. Each patient was also monitored by automatic, oscillometric blood pressure measurement, and electrocardiography. Desaturation during the intraoperative period and at RR were defined as at least one episode of $SpO_2 < 95\%$ for $\geq$ 10 seconds. This value was chosen because the authors wanted to identify the risk factors that predicted early desaturation. From the oxyhemoglobin dissociation curve, the value of $SpO_2 < 92\%$ has a minimal margin of safety, a small decrease in O_2 partial pressure resulting in large decrements of SpO_2. In addition, the pulse oximeter has a lag time of response of nearly 30 seconds[14]. Therefore, the alter-value of SpO_2 95% on a finger pulse oximeter may not represent the real time arterial O_2 saturation. The authors chose more than 10 seconds of desaturation, because a very brief period of desaturation could occur without any harm and the interference of plethysmographic pulse waveform could be excluded.

Data collection

The following preoperative clinical characteristics were obtained from history taking, physical examination, and medical records on the day preceding operation, age, gender, body mass index (BMI), history of smoking, snoring, upper respiratory tract infection, lower respiratory tract infection, pulmonary disease, and ASA physical status. Patient's data related to intraoperative and RR period including duration of anesthesia, site of operation, posture, fluid administration during surgery, anesthetic technique, the use of muscle relaxant, dose of opioid (morphine equivalence), modified Aldrete's score, shivering, temperature, and pain score by verbal numerical rating scale (VNRS) were also recorded.

Definitions of perioperative variables assessment

1. BMI was classified into four categories, < 25, 25-29.99, 30-34.99, and $\geq$ 35 kg/m^2. The cut off points for BMI for overweight and obesity in children age $\leq$ 18 years was different from adults. Therefore, the authors used the international cut off points for BMI in children obtained by averaging the centile curves demonstrated by the study of Cole et al to classified BMI categories[15].

2. Smoking history was classified into three categories, never, active, and passive smoker (children exposed to parental smoking). Patients who were active or passive smokers were asked for the amount

of cigarette smoking, duration since last smoking, and duration of smoking.

3. Pulmonary disease included the presence of bronchitis, emphysema, chronic obstructive pulmonary disease (COPD), asthma, bronchiectasis, and interstitial lung disease.

4. Acute upper respiratory tract infection was defined as having symptoms and signs such as cough, fever, sore throat, or rhinorrhea within two weeks.

5. Acute lower respiratory tract infection was defined as bronchitis or pneumonia within one month.

6. Modified Aldrete score included levels of motor activity, respiration, blood pressure**,** consciousness, and color on admission to the RR.

Statistical analysis

The outcome of the present study was the occurrence of perioperative desaturation. The identification of predictors was based on a comparison of the proportion of potential risk factors between patients who developed and did not develop perioperative desaturation. Therefore, the required sample size was calculated based on the expected ratio of patients developing and not developing the outcome, the magnitude of association to be detected, the proportion of the exposures in the two outcome groups from previous studies[5,9], a power of 80% and type I error of 5%. The estimated sample sizes were 1093 intraoperative patients, among whom 30 were expected to develop intraoperative desaturation, and 480 recovery room patients, of whom 50 were expected to develop desaturation at RR.

Analyses were performed with the R program version 2.3.1[16] Descriptive statistics were computed for all variables and included frequency, proportion, mean $\pm$ SD and median (range). Incidence of intraoperative desaturation was calculated by incidence density (number of events/person-time at risk). Predictor variables were categorical data either originally, or, if continuous, categorized by selection of cut off point. The number of events and person-hours at risks were aggregated by categories of independence variable. The crude incidence density ratio was computed with p-value under Poisson regression. The relationship between each variable and desaturation at RR was first explored in a univariate analysis using the chi-square test or Fisher's exact test as appropriate. Those with a significance level of $p \leq 0.2$ were then included in Cox regression analysis for intraoperative result and multiple logistic regression analysis for RR result. Results were reported as hazard ratio (HR), adjusted odd ratio (OR) and 95% confidence interval (CI) and the statistical significance of each variable in the model assessed by the likelihood ratio test. Model refinement was done by backward elimination until only variables with a significant of $p \leq 0.05$ remained. The authors compared the probability of intraoperative desaturation occurrence over time across levels of predictors using the Kaplan-Meier estimate and the log-rank test. In addition, the association of risk over time was assessed by Nelson-Aalen cumulative hazard estimate.

Results

During the present study period, 1093 patients were included. The mean age was 37.6 $\pm$ 22.59 years, were female 58.5% and 41.5% male. ASA class 1, 2 and 3 comprised 28.6%, 68.4% and 2.9% respectively. The percentages of patients with BMI < 25, 25-29.99, 30-34.99, and $\geq$ 35 kg/m^2 were 73.65, 20.13, 5.58, and 0.64 respectively. Never smoking was reported by 72.6% of patients and active, passive smokers, and snorers comprised 8%, 19%, and 22.1% respectively. Patients with a history of upper respiratory tract infection, lower respiratory tract infection, and pulmonary disease comprised 5.4%, 0.82%, and 3% respectively. Thoracic surgery was the lowest common procedure (1.6%). The most common general anesthetic technique was the balanced anesthesia (intubated and controlled ventilation) 82.1%, and the median (range) of intraoperative opioid dose (morphine equivalence) was 7.5 (5-10) mg. Of 2465 hours of GA, 30 cases (2.74%) developed intraoperative desaturation (incidence density rate of 1.22/100 person-hours). The probability of desaturation during induction, maintenance, and emergence were 0.55% (6/1093), 2.01% (22/1093), and 0.18% (2/1093) respectively. Occurrences of desaturation at RR were noted in 224 patients (20.49%) and overall incidence of perioperative desaturation (intraoperative and RR) was 23.23% (254/1093). None of the patients developed more than one event.

Univariate and multivariate analysis of intraoperative desaturation

Crude incidence density ratios (IDRs) and 95%CI were calculated for each of the 23 variables. The seven variables had crude IDRs with $p \leq 0.2$ (Table 1) and were submitted to Cox regression analysis. The four risk factors were found statistically significant, namely age, BMI, snoring, and lower respiratory tract infection (Table 2).

Patients aged less than 5 years had a greater risk than those aged more than 20 years; HR (95%CI)

Table 1. Univariate analysis of intraoperative desaturation (n = 1093)

Variables	Intraoperative desaturation (person-time at risk = 2465 persons-hours)					
	Total number	Person-hours	Event number	Incidence density rate*	Crude IDR** (95%CI)	p-value!
Age (year-old)						0.0016
0-4.99	109	189.50	10	5.28	1	
5-9.99	86	155.25	2	1.29	0.24 (0.04-0.93)	
10-19.99	102	206.08	2	0.97	0.18 (0.03-0.7)	
20-54.99	525	1269.23	9	0.71	0.13 (0.05-0.33)	
55-64.99	134	344.78	3	0.87	0.16 (0.04-0.54)	
65-94	137	300.75	4	1.33	0.25 (0.07-0.75)	
BMI (kg/m^2)						0.0003
< 25	805	1756.85	18	1.02	1	
25-29.99	220	358.53	9	1.67	1.63 (0.70-3.54)	
30-34.99	61	148.47	1	0.67	0.66 (0.04-3.18)	
$\geq$ 35	7	21.75	2	9.19	8.97 (1.43-31.07)	
Smoking duration (yr) #						0.1734
No smoking	801	1801.43	25	1.39	1	
< 20	131	292.83	2	0.68	0.49 (0.08-1.65)	
20-39.99	132	306.92	1	0.33	0.23 (0.01-1.10)	
$\geq$ 40	29	64.42	2	3.10	2.24 (0.36-7.5)	
Snoring #						0.0023
No	848	1892.72	16	0.85	1	
Yes	242	562.30	14	2.49	2.95 (1.42-6.05)	
Lower respiratory tract infection						0.0001
No	1084	2447.43	27	1.10	1	
Yes	9	18.17	3	16.51	14.97 (3.57-42.35)	
ASA classification						0.0314
1	313	658.10	5	0.76	1	
2	748	1728.25	22	1.27	1.68 (0.69-5.00)	
3	32	79.25	3	3.79	4.98 (1.02-20.31)	
Site of operation #						0.0540
Extremities/perineum	98	211.92	7	3.03	1	
ENT	367	773.10	10	1.29	0.39 (0.15-1.08)	
Eyes,face,esophagus	237	503.15	2	0.39	0.12 (0.02-0.50)	
Lower abdomen	277	733.52	8	1.09	0.33 (0.12-0.94)	
Upper abdomen	89	191.08	2	1.05	0.32 (0.05-1.31)	
Thoracic	18	40.08	1	2.49	0.76 (0.04-4.24)	

NS, Not significant; Factors with p $\leq$ 0.2 were introduced in the multivariate analysis
* Incidence density rate per 100; ** IDR, incidence density ratio
! p-value from Chi-square test or Fisher exact test
Total numbers do not sum to 1093 owing to missing data

of patients with age 20-54.99 years was 0.11(0.04-0.29), 55-64.99 years was 0.15(0.04-0.58) and $\geq$ 65 years was 0.26(0.08-0.84). Compared with age group 5-9.99 and 10-19.99 years, the under 5 year-old group showed a greater risk but this was not statistically significant.

Compared with patients with BMI < 25 kg/m^2, those with BMI 25-29.99 kg/m^2, 30-34.99 kg/m^2 and $\geq$ 35 kg/m^2 had HR (95%CI) of 1.53 (0.63-3.69), 0.50 (0.07-3.93) and 10.09 (2.09-56.75) respectively.

Patients with a positive history of snoring had HR of 2.87, 95%CI 1.28-6.43 and those with lower respiratory tract infection showed HR of 15.2, 95%CI 4.46-52.07.

Survival analysis of intraoperative desaturation

The survival probability of desaturation in patients who were aged $\geq$ 5 years and BMI < 35 kg/m^2 shown the similar results (> 95%). The proportions of

Table 2. Cox regression analysis of intraoperative desaturation and logistic regression analysis of recovery room desaturation

Variables	Intraoperative desaturation			Recovery room desaturation		
	Hazard ratio (HR)	95%CI	p-value*	Adjusted OR	95%CI	p-value*
Age (year-old)			0.0020			0.0001
0-4.99	1[a]	-		1[c]	-	
5-9.99	0.25[ab]	0.05-1.17		1.16[c]	0.47-2.88	
10-19.99	0.23[ab]	0.05-1.08		1.81[bc]	0.79-4.16	
20-54.99	0.11[b]	0.04-0.29		1.63[c]	0.83-3.22	
55-64.99	0.15[b]	0.04-0.58		3.20[ab]	1.52-6.77	
65-94	0.26[b]	0.08-0.84		4.21[a]	2.02-8.78	
BMI (kg/m^2)			0.0182			0.0001
< 25	1[a]	-		1[a]	-	
25-29.99	1.53[ab]	0.63-3.69		2.11[b]	1.46-3.05	
30-34.99	0.50[ab]	0.07-3.93		2.69[b]	1.46-4.98	
$\geq$ 35	10.09[b]	2.09-56.75		2.79[ab]	0.57-13.66	
Snoring			0.0328			0.0144
No	1	-		1	-	
Yes	2.87	1.28-6.43		1.52	1.06-2.18	
Lower respiratory tract infection			0.0014			NS
No	1	-				
Yes	15.20	4.46-52.07				
Pulmonary disease						0.0033
No	p > 0.2 by			1	-	
Yes	univariate analysis			2.99	1.41-6.36	
Modified Aldrete's score						0.0153
$\leq$ 8	Not applicable			1	-	
9-10				0.51	0.30-0.85	
Duration of GA(minute)						0.0036
< 180	p > 0.2 by			1[a]	-	
180-239.99	univariate analysis			2.09[b]	1.26-3.45	
$\geq$ 240				1.72[b]	1.02-2.91	

NS, Not significant
* p-value from likelihood ratio test, $p < 0.05$ was considered significant
a, b, c: Values within a column not having a superscript in common differ significantly ($p < 0.05$)

patients developing intraoperative desaturation within 3 hours were 15% among patients aged < 5 years and BMI $\geq$ 35 kg/m^2 (Fig. 1, 2). The cumulative hazard profiles showed a brief rapid increase in cumulative hazard rate in the first 5 minutes, a slow down until the 30th minute, and a steep rate up to the 90th minute. Thereafter, this rate was relatively slow and constant (Fig. 3).

Univariate and multivariate analysis of desaturation at recovery room

Sixteen variables were identified as having p $\leq$ 0.2 by univariate analysis, namely age, gender, snoring, lower respiratory tract infection, pulmonary disease, ASA class, duration of anesthesia, operative sites, position, amount of fluid, muscle relaxant, dose of opioid, modified Aldrete's score, shivering and pain score. The six risk factors remained statistically significant in the multivariate analysis (Table 2). Compared with patients with age < 5 years, those with age 55-64.99 years and $\geq$ 65 years had OR 3.20, 95%CI 1.52-6.77 and OR 4.21, 95%CI 2.02-8.78 respectively, but this was not statistically significant in age 5-9.99 years,10-19.99 years and 20-54.99 years.

Compared with patients with BMI < 25 kg/m^2, those with BMI 25-29.99 kg/m^2, and 30-34.99 kg/m^2 had OR 2.11, 95%CI 1.46-3.05, and 2.69, 95%CI 1.46-4.98, but this was not statistically significant in BMI $\geq$ 35 kg/m^2.

The odd ratios (95%CI) of patients who had a positive history of snoring, pulmonary disease, and modified Aldrete's score > 8 were 1.52 (1.06-2.18), 2.99

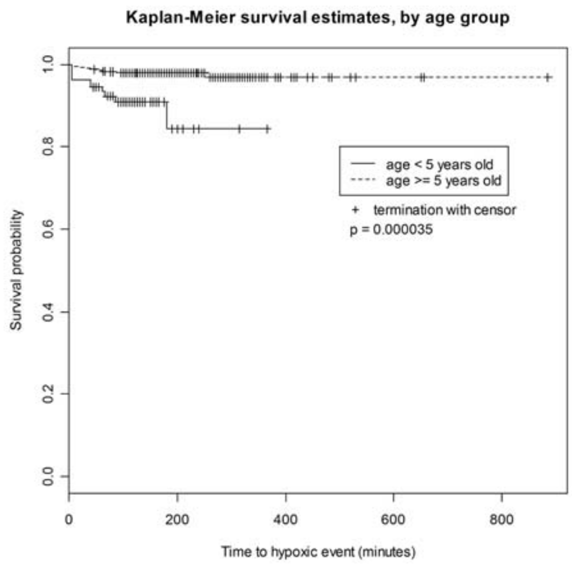

Fig. 1 Kaplan-Meier curves comparing 2 categories of age. x-axis, time to hypoxic event (minutes); y-axis, survival probability (percentage of patients without intraoperative desaturation)

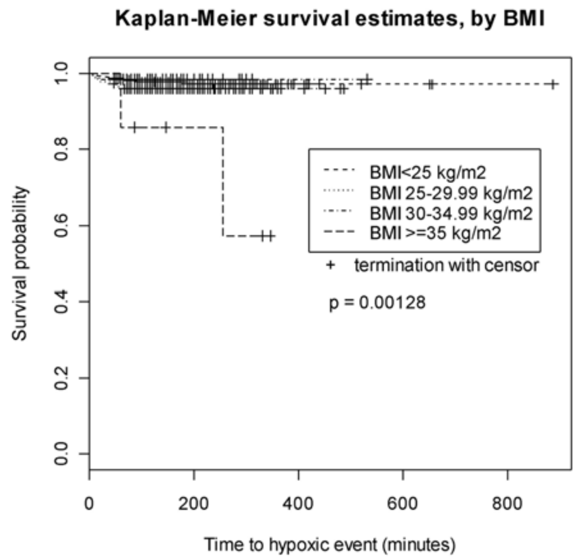

Fig. 2 Kaplan-Meier curves comparing 4 categories of BMI. x-axis, time to hypoxic event (minutes); y-axis, survival probability (percentage of patients without intraoperative desaturation)

(1.41-6.36), and 0.51 (0.30-0.85) respectively. Compared with patients having duration of GA < 180 minutes, those having duration of GA 180-239.99 minutes and $\geq$ 240 minutes showed OR 2.09 (95%CI 1.26-3.45) and OR 1.72 (95%CI 1.02-2.91) respectively.

Discussion

Among the present study subjects, approximately one-fifth had postoperative desaturation and one in forty had intraoperative desaturation. The incidence of intraoperative desaturation was around one in every 100 hours of general anesthesia. Intraoperative desaturation was common and occurred in the maintenance phase. Pertinent independent risks for intraoperative desaturation include age under 5 years, BMI $\geq$ 35 kg/m^2, present history of snoring and lower respiratory tract infection.

Incidence of desaturation

The present study found that the incidence of intraoperative desaturation was higher than a previous study. Raksakietisak et al showed this incidence of only 0.5% which was extremely low as a result of their criteria for desaturation (SpO_2 < 90%, lasting > 3min) or under reporting. In addition, their target population included patients receiving regional anesthesia, which were at low risk for desaturation[6].

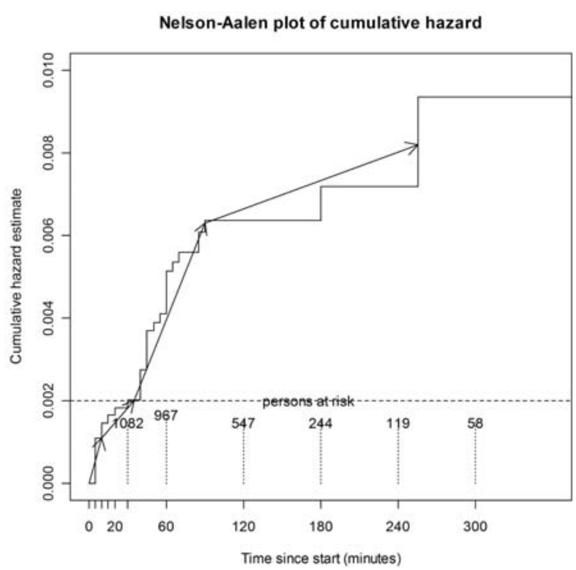

Fig. 3 Nelson-Aalen cumulative hazard estimate. x-axis, time to hypoxic event (minutes); y-axis, cumulative hazard estimate

In the present study with patients evaluated during prophylactic oxygen administration at RR, incidence of desaturation was higher than the study of Murray et al (incidence of only 7%, despite room air breathing)[5]. However, their study included only adult patients aged over 18, ASA class I or II, BMI < 30 kg/m^2, and without symptoms of pulmonary disease. Such patients may be at low risk of desaturation. The incidence of desaturation during intraoperative period and at RR in the present study was different from previous studies[5,8].This is probably explained by the different criteria used for desaturation and the heterogeneity of the presented sample, which included all age groups.

Factors associated with desaturation

The physiologic causes of intraoperative desaturation have been clearly described such as reduction of functional residual capacity (FRC), diminished cardiac output resulting from anesthetic agent effect, disproportionately increased P(A-a)O_2, or alveolar collapse. In the early postoperative period, secretion, airway obstruction, or effect of residual anesthetic agents to lung volume were demonstrated as the possible causes of desaturation. The above effects are accompanied by a variety of precipitating factors.

To the authors' knowledge, a study related to association between predisposing factor and intraoperative desaturation using multivariate analysis has not been reported. Previous studies reported the direct causes of intraoperative desaturation, such as laryngospasm, difficult intubation, or pulmonary aspiration. Nevertheless, their studies were descriptive designs, did not identify the potential risk factors, and did not control for other confounding factors[6,17].

Age

In the present study, patients aged less than 5 years have a greater risk than those older. Small children have many physiologic features of the airways and respiratory system including high oxygen consumption, decreased FRC, and small airways, which could make them more susceptible to compromised oxygenation. The precipitating effect of general anesthesia could produce patients vulnerable to developing intraoperative desaturation.

The association between age and postoperative desaturation agrees with previous reports[5,8,9,18,19]. The current study demonstrated that patients aged 55 years or over were at higher risk than younger age groups. In addition, the risk was highest in patients aged 65 years or over. It is noteworthy that this pattern is opposite that of intraoperative desaturation for which patients aged less than 5 years were the highest risk group. Physiologic changes in elderly patients such as increased ventilation-perfusion mismatching, increased closing volume and reduced FRC result in a normal decrease in PaO_2 with age. In addition, limitation of drug metabolism in elderly may cause delayed emergence from anesthesia. In the early postoperative period, especially at RR, the residual effect of anesthetic agents enhances these physiologic changes. Furthermore, most of the presented patients were intubated and had controlled ventilation intraoperatively, which overcomes the physiologic changes in elderly patients. This is the possible explanation why elderly patients are at lower risk of desaturation than children intraoperatively, but at a higher risk in the postoperative period.

Obesity

The present study demonstrated that elevated BMI increased the risk of perioperative desaturation. Physiologic change of respiratory system and difficult airway are the underlying mechanisms of desaturation in obesity. With increasing BMI, lung compliance, FRC and oxygen index (P_aO_2/P_AO_2) decreased, whilst lung resistance increases during general anesthesia. In addition, effect of obesity on a difficult airway has been investigated in numerous studies[20-22]. However, no patients in the present study developed intraoperative desaturation from a difficult airway. The association between obesity and intraoperative desaturation could be explained by respiratory physiologic changes in obese patients.

The underlying mechanisms of obesity that affect postoperative desaturation were suggested by several studies. Ungern-Sternberg et al showed the greatest reduction of vital capacity occurred after surgery in obese patient[23]. General anesthesia generated much more postoperative atelectasis in morbidly obese patients than in nonobese patients[24]. Fat deposit of anesthetic agents and redistribution to circulation were the possible mechanism of residual anesthetic agents in obese patients. Previous studies have reported different levels of association between BMI and postoperative desaturation. The occurrence of desaturation in post-anesthetic care unit (PACU) was more likely in patients of greater weight by multivariate analysis[9]. On the other hand, Moller et al reported obesity was not significantly associated with hypoxia in PACU from both univariate and multivariate analysis[18]. The present study found that BMI $\geq$ 35 kg/m^2 shown the greater risk but was not statistically significant, may be due to the small number of patients.

Snoring

The current study found that being a snorer was associated with perioperative desaturation. Decreased pharyngeal patency during natural sleep and sleep-related respiratory abnormalities found in obstructive sleep apnea syndrome (OSA) are the underlying mechanism of desaturation in snorers. These abnormalities are precipitated by respiratory depressant effect of induction agents during general anesthesia[25, 26] and the residual effect of anesthetic agents after anesthesia. Preliminary studies have demonstrated that upper airway obstruction is one of the common causes related to early postoperative desaturation[6,18,19]. To the authors' knowledge, no previous study related to history of snoring as an independent factor for postoperative desaturation has been reported, although Gentil et al revealed that heavy snorers were a high risk for first postoperative night desaturation. Nevertheless, their study did not focus on desaturation at the RR[11].

Lower respiratory tract infection

To the authors' knowledge, there are no available data regarding the influence of lower respiratory tract infection on intraoperative desaturation. Condition of respiratory tract infection has the biological plausibility to correlate with desaturation because of the associated excessive secretion could produce pulmonary shunt, hyperreactive airway and bronchospasm.

Pulmonary disease

Present history of pulmonary disease was the risk for desaturation at RR, which is similar to a previous study[27]. Rose et al also found COPD was significantly related to critical respiratory events (include desaturation) in PACU. However, in multivariate analysis it was not statistically significant[19].

Duration of anesthesia

Prolonged anesthetic time was related to postoperative desaturation in the present study, which is consistent with previous studies[9,18,19]. The likely mechanism is that residual anesthetic agents such as opioid, volatile agents, or muscle relaxant cause hypoventilation, resulting in early postoperative desaturation.

Strengths and Limitations

Strengths of the study include, first, the prospective design in which the measurement of exposure occurred before the outcome occurrences, resulting in minimal effect of measurement bias. Second, the present study included a heterogeneous sample of patients in order to enable us to analyze the factors associated with desaturation. Third, only a few studies investigated the intraoperative risk. Most of them used crude rate as a measurement of risk. The presented data show that the all events could happen any time in the operative period. Thus, incidence density and survival analysis calculation at the current study is more appropriate than simple binary analysis. Finally, confounding was controlled by appropriated statistical analysis, Cox regression and multiple logistic regression. Nevertheless, limitations of the present study should be noted. First, the low frequency of some potential factors results in a loss of power for analysis. Second, the present study includes the relative healthy patients that limit the generalibility to other health care setting. Finally, investigation of the risk of early desaturation (SpO_2 < 95%) limits the implication to serious adverse outcome.

Conclusion

Obesity and snorers were the high-risk groups of perioperative desaturation. Elderly patients are at lower risk of desaturation than children intraoperatively, but at a higher risk in the postoperative period. History of lower respiratory tract infection was associated with only intraoperative desaturation, while present history of pulmonary disease, low modified Aldrete's score, and prolonged anesthetic duration were related to desaturation at the RR.

For clinical implication, the authors suggest that higher FiO_2 should be given to high-risk patients during the intraoperative period. Desaturation can still occur at RR even in patients who received oxygen. Therefore, pulse oximeter monitoring should be continued throughout RR care. Further study with attention to specific high-risk groups such as the obese, snorers, children, or elderly patients would provide better understanding of precipitating causes of desaturation and development of prevention strategies.

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ปัจจัยเสี่ยงของการเกิดภาวะออกซิเจนในเลือดต่ำในระหว่างและหลังการให้ยาระงับความรู้สึกทั้งตัว

ธิดา เอื้อกฤดาธิการ, วีระศักดิ์ จงสู่วิวัฒน์วงศ์, อลัน กีเตอร์, มยุรี วศินานุกร, ศรัณยู ถิ่นจะนะ, แสงเดือน คลายนา

วัตถุประสงค์: *วิธีการให้ยาระงับความรู้สึกในปัจจุบันมีการพัฒนาไปอย่างรวดเร็ว แต่การเกิดภาวะออกซิเจนในเลือดต่ำระหว่างและหลังการให้ยาระงับความรู้สึกทั้งตัว (perioperative desaturation) ยังเป็นภาวะแทรกซ้อนที่พบได้ไม่น้อย ผลการศึกษาเกี่ยวกับปัญหาดังกล่าวรวมถึงปัจจัยเสี่ยงที่เกี่ยวข้องยังไม่แน่ชัด การศึกษาครั้งนี้จึงมีวัตถุประสงค์เพื่อวิเคราะห์อุบัติการณ์ของ perioperative desaturation ร่วมกับปัจจัยเสี่ยงต่าง ๆ*

วัสดุและวิธีการ: *เป็นการศึกษาวิเคราะห์แบบไปข้างหน้าเชิงสังเกต ในผู้ป่วยที่ได้รับยาระงับความรู้สึกทั้งตัวและผ่าตัดตามตาราง จำนวน 1,093 คน โดยไม่รวมผู้ป่วยที่มีค่าความอิ่มตัวของออกซิเจนในเลือดแดง (SpO_2) ก่อนผ่าตัดน้อยกว่าร้อยละ 95 หญิงตั้งครรภ์ ใส่ท่อช่วยหายใจยาก หรือ ต้องใช้เครื่องช่วยหายใจหลังผ่าตัด มีการเฝ้าระวัง SpO_2 ตลอดการให้ยาระงับความรู้สึกจนกระทั่งผู้ป่วยออกจากห้องพักฟื้น เกณฑ์วินิจฉัย perioperative desaturation คือ ค่า SpO_2 น้อยกว่าหรือเท่ากับร้อยละ 95 ติดต่อกันมากกว่าหรือเท่ากับ 10 วินาที*

ผลการศึกษา: *อุบัติการณ์ desaturation ในระหว่างการให้ยาระงับความรู้สึกและที่ห้องพักฟื้นเท่ากับร้อยละ 2.74 และ 20.49 ตามลำดับ โดยพบอุบัติการณ์ในช่วงนำสลบ รักษาระดับการสลบ และฟื้นจากยาสลบ เท่ากับร้อยละ 0.55, 2.01 และ 0.18 ตามลำดับ ปัจจัยเสี่ยงของภาวะออกซิเจนในเลือดต่ำระหว่างการให้ยาระงับความรู้สึก คือ อายุน้อย อ้วน มีประวัตินอนกรน และมีประวัติติดเชื้อในทางเดินหายใจส่วนล่าง ปัจจัยเสี่ยงของการเกิดภาวะออกซิเจนในเลือดต่ำที่ห้องพักฟื้น คือ อายุมาก อ้วน มีประวัตินอนกรน หรือโรคปอด modified Aldrete's scroe น้อยกว่าหรือเท่ากับ 8 และระยะเวลาการให้ยาระงับความรู้สึกมากกว่าหรือเท่ากับ 180 นาที*

สรุป: *ภาวะอ้วนและมีประวัตินอนกรน เป็นปัจจัยเสี่ยงของการเกิดภาวะออกซิเจนในเลือดต่ำทั้งในระหว่างและหลังการให้ยาระงับความรู้สึก มีผู้ป่วยประมาณ 1 ใน 5 เกิดปัญหาดังกล่าวที่ห้องพักฟื้น ดังนั้น การเฝ้าระวัง SpO_2 ตลอดระยะเวลาที่ผู้ป่วยอยู่ในห้องพักฟื้นจึงเป็นสิ่งจำเป็น และควรมีการศึกษาต่อไปเพื่อหาทางป้องกันภาวะแทรกซ้อนดังกล่าว โดยเฉพาะในกลุ่มเสี่ยง*