

Evaluation of Complication Development in General Surgery Patients Admitted to the Post Anesthesia Care Unit

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Received: 07.03.2021

Accepted: 27.02.2022

ABSTRACT

Objective: This study was conducted to analyze the development of complications and risk factors in general surgery patients admitted to the Post-Anesthesia Care Unit (PACU).

Methods: This prospective and cross-sectional study was performed with 230 patients admitted to the PACU of a university hospital in Istanbul. The data were collected pre – and post-operatively in the PACU using the “Patient Monitoring Form”, which was created by the researcher to track the patient’s descriptive characteristics and development of complication. Percentage, mean, chi-square, Student’s t, and logistic regression tests were used for data analysis.

Results: It was found that most of the patients were female aged between 50-65, with a chronic disease included in the ASA II class, who had undergone a laparoscopic cholecystectomy surgical operation, and had a profile of minimal obesity. The most common complications in the PACU were pain (75.7%), hypothermia (58.7%), nausea-vomiting (30.7%), and hypoxemia (20.0%) respectively. Length or duration of operation (OR:1.05; p=0.001) and age (OR: 1.08; p=0.027) were effective risk factors for development of complication; however, no correlation was found between descriptive characteristics of the patients and development of pain (p=0.023). A positive relationship was found between hypothermia and surgical operations with a duration of more than 120.3 minutes (p=0.001). Additionally, age of 57.8 (p=0.002), BMI of 30.8 (kg/m²; p=0.003), and inclusion in the ASA III/IV group (p=0.001) were significant in relation to hypoxemia.

Conclusions: It was found that pain, hypothermia, nausea-vomiting, and hypoxemia remained the most common complications in the PACU, and age and duration of operation were effective risk factors in the development of complications. Based on these results, it is recommended to identify high risk factors specific to the patient in advance and to increase nursing practices to prevent/reduce complications.

Keywords: Complication, post-anesthesia care unit, general surgery, nursing care.

1. INTRODUCTION

Patients require post-operative nursing care for a certain period of time in the post-anesthesia care unit (PACU). The aim of post-anesthesia care is to provide care for patients who have just undergone surgery with anesthesia in the PACU until vital signs are stable. Surgery and anesthesia always carry potential for the development of complications. In this critical period, when post-operative complications and mortality rates are the highest, factors such as having a limited patient follow-up period, complex patient care, emergency administrations of medications, and monitoring of the patient by multiple teams affect patient safety and increase the risk of complications (1-3).

Despite the advanced levels of science and technology available today, morbidity and mortality continue to be observed due to complications in the PACU, which in turn cause material and morale losses in patients and/or their families (3-5). When the reasons for the post-anesthesia

death of 306 patients were reviewed in a study conducted in 1947, it was seen that approximately half the deaths could have been prevented by the presence of a PACU and one-third by post-operative professional nursing care (6). Half of the complications that occur in the PACU happen intra-operatively or in the first 15 minutes of post-anesthesia care (7-8). As well, 7.1% of post-operative malpractice cases in the United States of America (USA) result in anesthesia-associated death or neurological complications in the PACU (9). Studies have shown that complications increase the nursing care burden by 52.2% (10) and the cost of care by 89% (11).

While surgical operations generally vary based on the complexity of the procedure to be performed, the general condition of the patient, the available technology, and financial resources, all patients must stay in the PACU for a certain period of time. This period is critical as meeting the

patient's basic needs and aiding in their recovery depend on nursing care. In this context, the effectiveness of the care given to the patient is based on the nurse's professional knowledge as well as the ability to identify and meet these needs (12-13). According to the literature review, it was observed that most of the research was retrospective and carried out with different types of surgical operations and anesthesia applications, but that prospective studies examining the development of specific complications in general surgery patients were very limited (9,14-19). Based on this need, the present study was conducted in order to determine the complications and analyze the risk factors in the complications by monitoring PACU patients who had undergone elective surgery in the general surgery department.

Research Questions

- Which complications are most common in the PACU?
- Do demographic and descriptive characteristics have an effect on the development of complications?

2. METHODS

2.1. Design and Sample

The study was designed and carried out as a cross-sectional and prospective study between October 2009 to August 2010 in Turkey. 230 patients were included in the study according to the medium effect size (effect size=0.2) and 80% power analysis in the calculation of the sample with a known population (n=422). The most frequently performed surgical interventions in general surgery were determined. Data were collected according to the surgical grade classification of the Turkish Society of Anesthesiology and Reanimation (TARD) from surgical interventions in 2 and 3 with a simple random method. Complication development of high surgical grade 4 (eg whipple operation) was not considered (20). Patients who had undergone laparoscopic surgery, thyroid surgery, colon and rectum surgery, hernia surgery and bariatric surgery, over 18 years of age, without communication problems, and with oral and written consent were included in the study.

2.2. Instruments

The data were collected using the "Patient Follow-up Form" prepared by the researcher, according to relevant literature (12,14) and considering expert opinions.

The patient follow-up form consists of three parts:

Part 1 consists of "personal information" [age, gender, body weight (kg), height (cm), BMI (kg/m²), educational status, diagnosis, surgery performed, smoking and alcohol use, surgery history]; "patient risk factors" [Chronic Obstructive Pulmonary disease, heart failure, diabetes, drug use, ASA (American Society of Anesthesiologists) class]; and "surgical operation information" [pre-medication status, operation

time, anesthetics and drugs used, complications during surgery].

The second part includes the "Patient Monitoring and Evaluation Form in the Post-Anesthesia Care Unit" (respiratory rate, partial oxygen saturation, heart rate, arterial blood pressure, body temperature, pain score, nausea and vomiting score, state of consciousness, recovery score, duration of stay in the PACU, color and condition of the skin, condition of the dressings and follow-up of fluid in-out).

The final section contains the "Form for Monitoring Complications in the Post-Anesthesia Care Unit" [airway obstruction, hypoxemia (oxygen saturation <90%), hypoventilation (respiratory rate <10, prolonged sleepiness), hypertension (30% increase compared to basal value), hypotension (30% reduction compared to basal value), tachycardia (heart rate 120/min), bradycardia (heart rate ≤50/min), bleeding, oliguria, agitation, delayed awakening (awakening ≥60 min), cognitive dysfunction, nausea, vomiting, hypothermia (parameters including body temperature <36°C (96.8°F), tremor, and pain (pain ≥4 according to the Visual Analogue Scale (VAS))].

The "Visual Analogue Scale" (VAS), created by Cline (1992), was used for evaluation of pain and nausea (21). The literature states that VAS is sensitive enough to detect the severity of a symptom and is a one-dimensional scale with proven validity and reliability, which is frequently used in the measurement of subjective parameters such as nausea, pain intensity, and patient satisfaction. In this study, 0-2 cm obtained from the scale was considered "mild", 2.1-4 cm was "uncomfortable", 4.1-6.0 cm was "moderate", 6.1-8.0 cm was "severe", and 8.1-10.0 cm. was "intolerable". It is reported that in the VAS, horizontal drawing tends to mark higher scores than vertical, and the scale drawn vertically gives more reliable results. Considering these data, the vertical VAS was used in the present study (22).

In the PACU, the "Modified Aldrete Scoring System" was used to evaluate recovery. In this system, if the score evaluation result is ≤7 in total, the patient remains in the post-anesthesia care unit or is transferred to the intensive care unit until general condition improvement. If the total score is ≥8, the patient can be sent to an inpatient department or home (23).

2.3. Data Collection

Patients who consented to remain in the study after the research objectives were explained were interviewed in the pre-operative period and the scales used to evaluate pain, nausea, and vomiting in the PACU were completed with patients who met the inclusion criteria. Patients were then followed-up and evaluated by the researcher.

In order to evaluate the clarity and usability of the data collection forms, a pilot study was performed in which 10 patients were asked to complete the forms on a voluntary basis. The questions were then rearranged based on feedback received from these volunteers. After the pilot study, follow-up was done on all patients included in the sampling and data were collected.

Vital signs, pain, and nausea-vomiting evaluations of the patients were measured every 15 minutes. A digital sphygmomanometer to measure blood pressure, a tympanic thermometer to measure body temperature, and a pulse oximeter (finger) to measure oxygen saturation were used.

2.4. Ethical Considerations

The study commenced after obtaining the required permission of the Ethics Committee of Marmara University (B.30.2.MAR.0.01.02/AEK/531) and of the University Hospital (B.30.2.MAR.0.H1.00.00/4064). In accordance with the Helsinki Declaration, patients were informed about the research via the Voluntary Information Form. Patients who volunteered to participate in the study were included in the study after their verbal consent was obtained.

2.5. Statistical Analysis

The SPSS (Statistical Package for the Social Sciences) 16.0 IBM statistics program was used for analysis of the data. Student's t test was used for parameters showing percentage, ratio, mean, and normal distribution for descriptive data, while the chi-square (χ^2) test was used for categorical variables. In addition, a multivariate model was used to evaluate multiple factors. Significant variables were determined using logistic regression and the relationship was expressed as an Odds ratio. Parameters that may be effective in the development of complications were included in the model. A 95% confidence interval and $p < 0.05$ error level were taken into consideration for the evaluation of the obtained results.

3. RESULTS

The descriptive characteristics of the patients in the PACU are given in Table 1. Review of these characteristics indicates that 62.5% of the included patients ($n=143$) were female, 37.3% ($n=63$) were aged 50 to 65, 42.7% ($n=98$) were overweight, 53.5% ($n=123$) had a chronic disease, 57.8% ($n=133$) took or had taken medicine, and 52.7% ($n=121$) were in the ASA II class. The average age of the patients was 53.49 ± 14.57 and average BMI was 28.81 ± 6.94 (Table 1).

Table 1. Descriptive Characteristics of the Patients in the PACU ($N=230$)

Demographics	N	%	
Gender	Female	143	62.5
	Male	87	37.5
Age (53.49 ± 14.57)	18 – 33	27	11.8
	34 – 49	63	27.5
	50 – 65	86	37.3
	66 – 71	30	13.0
	72 and \uparrow	24	10.4
Education status	Elementary	130	56.6
	Secondary education	27	11.7
	High School	27	11.7
	Higher education	46	20.0
Body Mass Index (kg/m ²) (28.81 ± 6.94)	Normal (20-24.9)	59	26.7
	Minimal overweight (25-29.9)	98	42.7
	Moderate overweight (30-34.9)	34	14.7
	Maximal overweight (35-39.9)	24	10.4
	Morbid (40 and \uparrow)	15	6.5
Chronic disease	Yes	123	53.5
	COPD	26	20.9
	Diabetes	21	16.9
	Heart failure	39	31.5
	Other*	37	30.7
Use of medicine	Yes	133	57.8
	Antihypertensive	70	52.3
	Antithyroid, chemotherapy	45	33.9
Previous surgery	Steroid, tranquilizer	18	13.5
	Yes	155	67.3
	No	75	32.6
Smoking	Yes	75	32.6
	No	155	67.4
ASA score	ASA I	35	15.2
	ASA II	121	52.7
	ASA III / IV	74	32.1

*Other: patients with liver and kidney failure and cancer.

COPD: Chronic Obstructive Pulmonary Disease

Multivariate analysis of the factors determining the development of complications is given in Table 2. In the logistic regression model for multivariate analysis in the development of complications, a significant difference was found between surgical operation time (Odds ratio: 1.05, $p=0.001$, confidence interval: 0.02-1.09) and age (Odds ratio: 1.08, $p=0.027$, confidence interval: 1.00-1.15). In addition, it was found that there was a statistically significant difference in females (Odds ratio: 6.58, $p=0.052$, confidence interval: 0.98-0.44) (see Table 2).

Table 2. Multivariate Analysis of the Factors Determining the Development of Complications (N=230)

Risk Factors:	Total n=230	Complication emerged n=220	Complication non- emerged n=10	Odds ratio (95% CI) p	p
Age (years), mean (SD)	53.4 (14.5)	54.0 (14.3)	41.5 (14.2)	1.08 (1.00 - 1.15)	0.008†
Gender, n (%)					
Female	143 (62.5)	139 (63.2)	4 (40.0)	6.58 (0.98- 0.44)	0.139‡
Male	87 (37.5)	81 (36.8)	6 (60.0)	0.052*	
BMI (kg/m ²), mean (SD)	28.8 (6.9)	28.9 (7.0)	26.7 (34)	0.94 (0.81- 1.09)	0.328†
ASA classification score, n (%)					
ASA I	35 (15.2)	34 (15.5)	1 (10.0)		1.000 ‡
ASA II	121 (52.7)	115 (52.3)	6 (60.0)		
ASA III / IV	74 (32.1)	71 (32.2)	3 (30.0)	0.79 (0.04 - 13.79)	0.0820*
Duration of surgery (minutes) mean (SD)	117.4 (54.6)	120.3 (53.9)	54.5 (22.9)	1.05 (0.02- 1.15)	0.000†

ASA, American Society of Anesthesiologists; BMI, Body Mass Index
*Multi-factor logistic regression test; ‡ Based on chi-square test; † Based on Student' t test

The distribution of complications developed in the PACU can be seen in Graphic 1. Of the included patients, pain in 75.7% (n=174), hypothermia in 58.7% (n=135), nausea and vomiting in 41.3% (n=95), hypoxemia in 30.7% (n=71), hypertension in 20.0% (n=46), tremor in 16% (n=37), agitation in 12.1% (n=28), and oliguria in 4.8% (n=11) emerged.

The comparison of risk factors that may cause pain, hypothermia, nausea-vomiting, and hypoxemia are shown in Table 3. It was determined that the descriptive characteristics of the patients were not effective in the development of pain (p>0.05). As the average age (p=0.002) and BMI (kg/m²) (p=0.003) increased, the rate of hypoxemia was found to be statistically significant in patients in the ASA III/IV (p=0.001) group.

Factors that may cause nausea and vomiting were observed more frequently in female patients (p=0.023). A statistically significant (p=0.001) association with an increase in hyperthermia was found between surgical operation duration (120.3 minutes or more) and type of surgery (thyroid surgery).

Table 3. The Comparison of Risk Factors That May Cause Pain, Hypothermia, Nausea-Vomiting and Hypoxemia (n=230)

Risk factors	Pain*		Hypothermia		Nausea-Vomiting		Hypoxemia	
	Pain ≥ 4 n=174	Pain < 4 n=56	emerged n=135	non- emerged n=95	emerged n=95	non- emerged n=135	emerged n=71	non- emerged n=159
Age (years), mean (SD)	59.8 (15.0)	52.3 (13.1)	54.7 (14.4)	51.7 (14.6)	51.5 (14.8)	54.7 (14.3)	57.8 (13.4)	51.6 (14.6)
	-0.65 / 0.511†		-1.53 / 0.126†		1.63 / 0.103†		-3.09 / 0.002†	
Female, n (%)	111 (63.8)	32 (57.2)	91 (67.4)	52 (54.8)	67 (70.5)	76 (56.2)	50 (70.4)	93 (58.5)
Male, n (%)	63 (36.2)	24 (42.8)	44 (32.6)	43 (45.2)	28 (29.5)	59 (43.8)	21 (29.6)	66 (41.5)
	0.79 / 0.372‡		3.80 / 0.051‡		5.13 / 0.023‡		9.11 / 0.085‡	
BMI (kg/ m ²), mean (SD)			28.6 (6.9)	29.6 (7.2)	29.7 (8.2)	28.1 (5.7)	30.8 (8.2)	27.8 (6.0)
			-0.71 / 0.47†		1.74 / 0.082†		-3.04 / 0.003†	
ASA I	28 (16.1)	7 (12.5)	21 (15.5)	14 (14.7)	14 (14.7)	21 (15.6)	5 (7.0)	30 (18.8)
ASA II	92 (52.9)	29 (51.8)	71 (52.6)	50 (52.7)	46 (48.4)	77 (57.0)	29 (40.9)	92 (57.9)
ASA III / IV	54 (31.0)	20 (35.7)	43 (31.9)	31 (32.6)	35 (36.9)	37 (27.4)	37 (52.1)	37 (23.3)
	0.44 / 0.931‡		6.12 / 0.442‡		6.06 / 0.067‡		19.90 / 0.001‡	
Duration of surgery (minutes), mean (SD)	121.1 (65.6)	106.2 (50.2)	120.3 (53.9)	54.5 (22.9)	123.1 (59.8)	113.6 (50.6)	127.8 (51.3)	112.8 (55.5)
	-1.77 / 0.076‡		-3.60 / 0.000‡		-1.28 / 0.200‡		-1.92 / 0.055‡	
Type of surgical operation								
Hernia surgery	18	11	13	16	9	20	4	25
Laparoscopic surgery	54	22	38	38	36	40	27	49
Thyroid surgery	22	6	21	7	10	18	5	23
Breast surgery	31	9	24	16	16	24	15	25
Colon/ rectum surgery	21	5	19	7	8	18	12	14
Bariatric surgery	15	3	11	7	10	8	5	13
Gastric surgery	13	-	9	4	4	9	3	10
	9.11 / 0.167‡		10.62 / 0.010‡		6.06 / 0.416‡		11.077 / 0.086‡	

‡ Based on chi-square test (X² / p); † Based on Student t test t/ p)

4. DISCUSSION

One of the most important criteria in patient care and safety is the prevention or minimization of complications. Therefore, it is critical in this period to know the risk factors for complications, to prevent their occurrence, and to react effectively and quickly

when they are present (1,9,24). This study found that most of the patients displaying post-operative complications were female aged 50 to 65, with a chronic disease included in the ASA II class, had undergone a laparoscopic cholecystectomy surgical operation, had a profile of minimal obesity, and an average age of 53.4 (Table 1).

Distribution of Complications Emerged in the PACU

This study also found that the most common complications in the post-operative PACU were pain, hypothermia, nausea-vomiting, hypoxemia, and hypertension, respectively (see Graphic 1). In studies conducted at different times between 1986 and 2017, it was observed that the complication rate ranged from 4.5 to 36.2% depending on the type of surgery and anesthesia applications. Moderate-severe pain (7.2-54%), hypothermia (11-52%), hypoxemia (4-69%), nausea and vomiting (9-36%), hypotension (2-20%), and hypertension (3-20%) were observed as the most common complications. Bleeding, oliguria, delayed awakening, and airway obstruction were among the fewer common complications (9, 14-19, 25-27). Belcher et al. conducted a retrospective study including approximately 93 thousand patients in 2017 to evaluate complications emerged in the PACU and found most of the complications were hypertension, nausea, and hypoxemia without including pain and hypothermia (9). In this study, it is noteworthy that nausea-vomiting was included in the ranking after hypothermia, although this is similar to other studies when the profile of patients and types of complications and their incidence are compared. In some studies, it has been observed that feeling "chilly" can in fact be more disturbing than surgical pain. However, among the complications that occur in the PACU, hypothermia is the simplest complication as it is easily prevented and treated when it occurs (28,29). The complication of hypothermia ranking after pain in the present study can be explained by the fact that patients were transferred to inpatient departments earlier due to the physical conditions and lack of equipment (i.e. heaters were used alternately between patients) at the PACU where the study was performed.

Risk Factors That May Cause Complications in the PACU

This study identified 54-year-old patients and surgical operations 120 minutes or more in length as important risk factors for the occurrence of complications (Table 2). Studies have reported that age, without disease, before, during and after surgery is an independent risk factor for the emergence of complications and death. Post-operative complications have been reported to increase, especially in patients aged 60 and over (27, 30, 31). Tuchinda et al. (2010) stated that 47.9% of post-operative complications are caused by age-related problems and that 39.3% of deaths within 24 hours occur in patients aged 65 and over. In line with the literature, age in the present study was determined to be an important risk factor for the development of complications (32).

The duration of the surgical operation is another important risk factor for complications. Hines et al. (1992) determined that 120-240 minutes was significant for complications,

and Yavaşcaoğlu, Kaya, and Özcan (2009) reported that surgical operations lasting more than 150.9 minutes lead to complications (14,19). Tarrac (2006) determined that emergence of complications increases in surgical procedures lasting 132 minutes or more. Again, data obtained within the present study are supported by the literature (17).

For the last 30 years, pain has continued to be an important factor affecting the comfort of patients as well as one of the complications emerging in the PACU (25,33). This research determined that the type and duration of the surgical operation and individual characteristics were not effective risk factors for the emergence of pain. Aubrun et al. (2008) and Fecho et al. (2009) reported that individual characteristics are not effective in the emergence of pain in patients with severe pain (34,35). Ip et al. (2009), in 48 studies including 23.037 patients, identified preoperative pain, anxiety, age, and type of surgery as the most important factors determining post-operative pain and analgesia consumption (36). A systematic review carried out by Aslan et al. (2018) determined that non-drug care practices of nurses for post-operative pain management were insufficient (37). In this study, care and treatment approaches for pain are considered to be more important than risk factors for pain complication.

This study also found that gender plays an important role in the development of nausea and vomiting, and that it is more often seen in women. Smith and Ruth-Sahd (2016), in a meta-analysis of 37 evidence-based studies, also identified gender and age as important risk factors for the occurrence of this complication (38). In all studies investigating the risk factors for nausea and vomiting, it is considered that these complications are more common in females and, although the cause is not clearly explained, serum gonadotropins or other hormones play a role in nausea and vomiting (39, 40).

It is stated that life-threatening respiratory complications occur within the first 15 minutes in patients transferred to the PACU and mostly hypoxemia is diagnosed (24), with this being the most common complication in malpractice cases (3). Another study states that patients stay in the hospital for about 17 days more due to respiratory complications and the cost of health care is \$ 9,500 (41). An average age of 57.8 years, moderate obesity, being in the ASA III/IV class, and hypothermia were determined in this study as risk factors for the occurrence of hypoxemia. Although age is an independent risk factor in the emergence of hypoxemia, according to the literature, total lung capacity, vital capacity, residual volume, and lung elasticity decrease by 10% every decade and stiffness of the chest wall increases. These changes make it difficult for elderly patients to tolerate stress factors against anesthesia and surgery, and respiratory complications that occur in the post-operative period have an effect that is almost life-threatening (31). While Uakritdathikarn et al. (2008) stated that the age of 55 creates increased risk of hypoxemia, Murphy et al. (2008) indicated that 64 years of age or older increases its risk (24, 42). However, Aust et al. (2015) stated that in patients with an average age of 59, a BMI of 31, and a surgical operation duration of 144 minutes

or more, the emergence of hypoxemia is greater (43). The findings of the present study thus support the literature.

5. CONCLUSION

This study determined that pain, hypothermia, hypoxemia, and nausea-vomiting were the most common complications in the PACU. Age and duration of surgery are high risk factors that cause complications. Despite scientific and technological developments, similar complications were developed as in 30 years ago. Based on these results, it is thought that reviewing patient care for interventions, identifying patients with high risk of complications, taking precautions, training employees at regular intervals and increasing compliance with care protocols will reduce the rate of complication development.

Authors'contributions

All the authors took part in the formulation of the concept, data collection, data analysis and interpretation of results. All the authors reviewed and edited the manuscript and approved the final version of the manuscript.

DS, SKS: Conceptualization, Methodology; Data curation; Writing – Original draft preparation; Visualization, Investigation; Supervision; Software, Validation; Writing – Reviewing and Editing

Informed consent

Applicable. We have ethic form.

Conflict of interest

The authors declared no potential conflicts of interest with respect to the research, authorship and/or publication of this article.

Funding

The authors received no financial support for the research, authorship and/or publication of this article.

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How to cite this article: Kula Sahin S, Selimen D. Evaluation of Complication Development in General Surgery Patients Admitted to the Post Anesthesia Care Unit. *Clin Exp Health Sci* 2022; 12: 383-389. DOI: 10.33808/clinexphealthsci.892276