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Research

The Effect of Modified Early Warning Score (MEWS) and Nursing Guide Application on Postoperative Patient Outcomes: A Randomized Controlled Study

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postoperative care
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A B S T R A C T

Purpose: The aim of this study is to determine the effect of nursing guide application (NGA) on patient outcomes in patients followed up according to the modified early warning score (MEWS) in the postoperative period.
Design: A randomized controlled clinical trial.
Methods: The sample of the study consisted of 252 patients who underwent surgical intervention under general anesthesia in a university hospital between July 29, 2022, and October 31, 2022.
Findings: Results showed that the development of complications was less in the study group (SG) compared to the control group (CG) during anesthesia (P = .027), in the postanesthesia care unit (PACU) (P = .017), and in the clinic (P = .001). It was found that the duration of stay in PACU in the CG was significantly shorter than in the study group (P < .001), and as the duration of stay in PACU in CG decreased, the MEWS increased (r = −0.201, P = .024). We found that there were fewer patients transferred to the intensive care unit (ICU) after PACU (P = .007), the MEWS was lower, and the number of nursing interventions applied to patients was higher (P < .05).
Conclusions: In patients followed up according to MEWS, NGA had a positive effect on preventing the development of complications and shortening the intervention time for complications, decreasing ICU admission, decreasing MEWS and increasing the number of nursing interventions. Based on the results, it may be recommended to use MEWS+NGA in the early postoperative period as it positively affects patient outcomes.
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Despite significant advances in anesthesia, ventilation, surgical practices, and monitoring technologies, approximately 25% of surgical patients suffer from postoperative complications.[1,2] Early postoperative hemodynamic instability is one of the main determinants of deterioration in patients' condition.[3,4] Previous studies have shown that many patients may show signs of complications hours before their hemodynamics deteriorate and that these early signs can be captured by routinely measured clinical data such as vital signs or laboratory test results.[5–7] The National Confidential Inquiry into Patient Outcomes and Mortality report, as cited by Alam et al, reports that evidence of clinical deterioration often exists hours before the occurrence of serious adverse events such as cardiac arrest, death, and intensive care unit (ICU) admission, so many of such serious events could have been prevented.[7] Preventable conditions often include poor clinical monitoring, inadequate interpretation of changes in physiological parameters, and failure to take appropriate action. Also reported is that failure to correctly recognize and initiate treatment of the critically unwell patient not only leads to higher levels of morbidity but also to overuse of financial resources, such as increased ICU utilization and longer hospital stays.[7]

Early warning scoring systems developed to help clinicians recognize early signs of physiological deterioration allow for timely intervention and focus on care for patient data that deviate from

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normal.[6] Modified early warning score (MEWS), one of the scoring systems developed for this purpose, is a scoring system that can be easily used during routine bedside observations to identify patients who show signs of deviation from normal in vital signs in the early period and direct them to seek help from a competent clinician in a timely manner in case of any abnormality.[7,8] MEWS is cited as a useful and appropriate risk management tool that should be applied in surgical patients because it allows better monitoring of vital signs, prevents unplanned admissions to the ICU, and reduces cardiac arrest and mortality rates.[7,9] In addition, the use of these systems increases patient safety in the early postoperative period and is important in urgently identifying patient deterioration and initiating an appropriate response.[6,10,11] Hospitals are increasingly using these systems due to their positive contributions to patient safety culture.[9,12]

Nurses play a vital role in detecting and managing deviations from normal in the patient's vital data in the early postoperative period, as they are in the professional group with high patient contact.[3] The MEWS can be easily used by nurses and provides guidance in identifying and intervening in patients with deteriorating conditions.[11,13,14] Based on the score obtained from MEWS, nurses are directed to follow a clinical practice guide to initiate care interventions and/or inform the physician.[15] Clinical practice guidelines (CPG) are designed to regulate physical, mental, and behavioral health with the best available evidence-based clinical practices. Clinical guidelines guide health care professionals in decisions regarding treatment and care.[16,17] CPGs are reported to improve the quality of care for health care professionals and facilitate care and treatment practices in difficult medical situations. From the perspective of patients, the most important effect of CPG is to increase patient safety and improve patient outcomes by reducing mortality and morbidity. These guidelines prevent medical hazards by reducing inappropriate care methods. In addition, they have benefits for health institutions as CPGs reduce expenditures such as drug costs, surgery or other procedures. However, these national and international guidelines are not sufficiently used by health care professionals at the bedside to improve patient care.[18] The only study in our country on the use of early warning system and CPG together, which can be used by nurses in the care period is the study by Pazar and Yava.[19] The early warning system and CPG togther can be used in the postoperative period a very critical time where early intervention is important for patients whose condition worsens and can also serve as a guide in notifying the emergency response team.[19]

Studies investigating the effect of MEWS on patients undergoing surgical intervention and nursing practices,[15] guidelines used by nurses in the clinic, and studies investigating CPGs for nurses in the literature are reported to be insufficient.[17] Based on this lack in the literature, in this study, patients will be followed up with MEWS and nursing practice guidelines for 2 hours both in the postanesthesia care unit (PACU) and in the clinic where they are transferred after PACU. The aim of this study was to determine the effect of nursing guide application (NGA) on patient outcomes in the care process of surgical patients followed up according to MEWS.

Methods

Aim

This randomized controlled study aimed to examine the effect of NGA on patient outcomes in the care process of surgical patients followed up according to MEWS.

The research questions were as follows:

1. What is the effect of NGA on patient outcomes in patients followed up with MEWS?
2. Is there a significant difference between the study and control groups in terms of patient outcomes?

Research Type and Aim

The study is a randomized controlled clinical trial. The application flow chart was created by using the CONSORT diagram recommended for randomized controlled studies (Figure 1).

Study Population and Sampling

This research was carried out in PACU, Department of Anesthesiology and Reanimation of a research and practice hospital, between July 29 and October 31, 2022.

The population of the study consisted of patients who underwent surgery for brain and nerve, thoracic, orthopedic, abdominal, plastic,

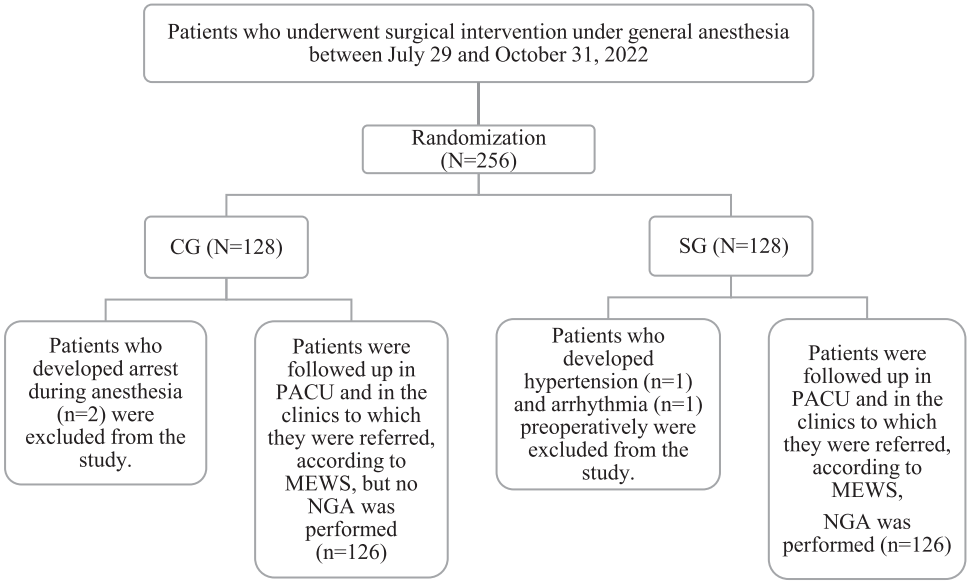

Figure 1. Flow chart of the study.

reconstructive and esthetic, urology, gynecology, and head and neck regions in the operating theaters of the hospital on the specified dates. The sample of the study consisted of patients aged 18 to 65 years, who volunteered to participate in the study, who underwent planned surgery for brain and nerve, head and neck, thoracic, orthopedic, abdominal, plastic, reconstructive, and esthetic, urology, gynecology, and obstetrics and were followed up in PACU and then transferred to ICU or surgical wards (n = 252). Patients who underwent surgical intervention with general anesthesia within the last 6 months and developed serious life-threatening complications during anesthesia and surgical intervention were not included in the study.

As a result of the power analysis ($\alpha = .05$, 1-β(Power) = .85 and effect size = 0.41) calculated based on the statistics obtained from Pazar and Yava's study,[19] the sample size of the study was determined as 220 patients, 110 patients in each group. However, considering the possible losses in the study, 126 patients who met the inclusion criteria were included in the study group (SG) and 126 patients were included in the control group (CG) between the specified dates. The study was conducted with a total of 252 patients (Figure 1). This is the first study with the highest sample size in the field of nursing on this topic. In the study, randomization by lottery method was used to determine SG and CG patients. In the preoperative period, the patients participating in the study were asked to draw 1 of 2 sealed envelopes, one labeled SG and the other CG. After determining the number of patients who would undergo surgery on the same day so that the distribution of both groups would be equal if the number of patients who would undergo surgery that day was 8 and 4 patients chose the SG envelope, the remaining patients were accepted as CG patients without being asked to choose an envelope.

Data Collection

Usual care is that preoperative body mass index (BMI) and American Society of Anesthesiologists' (ASA) scores of patients undergoing surgery under general anesthesia at the hospital where the study was conducted are assessed. The duration of anesthesia for these patients varies from 45 minutes to 6 hours. Patients are transferred to the Phase I PACU after surgery. Patients are observed for an average of 30 to 45 minutes and then transferred to the ward or ICU by the anesthesiologist, depending on the patient's medical condition. Patients who are monitored in the PACU are followed up with the postoperative observation form, which includes oxygen saturation (SpO_2), blood pressure, heart rate, respiratory rate, body temperature, follow-up fluid balance, type of anesthesia, postoperative complications, postoperative physician order, physician and nurse notes, and recovery score (activity, breathing, circulation, consciousness, skin color). This device measures vital signs and recovery scores at 15-minute intervals. No other assessment tool is used other than this information. Patients transferred to the ICU from the PACU are evaluated using the ICU Patient Follow-Up Form, which includes vital signs, ventilation information, APACHE II score, sedation level, pain score, blood glucose, Glasgow Coma Scale, fall risk, pressure ulcer, and total system diagnostics. Patients are typically followed in the ICU at one-hour intervals. Patients who are transferred to the ward after the PACU are monitored with the Nurse Follow-up and Treatment Form, which consists of body temperature, pulse, respiration, blood pressure, physician treatment, orders, follow-up fluid balance. These patients are followed at half-hourly intervals in the second hour after surgery, at hourly intervals after the third hour, and then at 2- or 4-hourly intervals, depending on their condition.

In this study, questions included information from three periods: preoperative, intraoperative, and postoperative periods.

1. **Information about the preoperative period** consisted of the patient's name and surname, gender, age, educational status, weight, height, medical diagnosis, previous surgeries, presence of chronic diseases, medication use, and ASA classification. This information was obtained from the patient files related to the preoperative period.
2. **Intraoperative information** included surgical intervention, duration of anesthesia, and complications during anesthesia. This information was obtained from the anesthesia form.
3. **Information about the postoperative period**, this information was obtained after the patient came to the PACU. The practices and data collection tools in the PACU and afterward in the clinic were performed in four steps as shown below.
   a) **Patient results registration form** (includes the length of stay in PACU, complications developed in PACU, duration of intervention to complications, clinical status after PACU, complication development in the transferred clinic and nursing interventions).
   b) **Calculation of patients' MEWS**
   The Early Warning Score System (EWS), which aims to provide communication between the nurse and the physician during the follow-up process of the patient whose clinical status deteriorates was defined by Morgan et al in 1997.[20] Later in 2001, Subbe et al.[21] modified the early warning score and modified the instrument. MEWS is calculated according to the physiologic data in Table 1. Scoring ranges from 0 to 14. The higher the patient's score, the worse the clinical condition. A score of five and above is considered a high-risk group for discharge.
   According to MEWS, as the patient's score increases, the clinical condition worsens. MEWS follow-up was carried out in the CG patients at 10-minute intervals in the PACU, and after the patient passed from the ward or ICU, the follow-up interval was routinely observed in the clinics. In the SG, MEWS follow-up was performed at 10-minute intervals in the PACU and in post-PACU ward or ICU if the MEWS was four or less and at five-minute intervals if the MEWS was five or more (Figure 2). The MEWS of the patients in both groups were calculated for two hours in the postoperative period.
   c) **Nursing guide application (NGA)**
   This application was developed by Pazar and Yava by taking the example from the literature and using expert opinion to develop a standard in care.[19] NGA, which can be used in many clinics, has been put into use by shortening the follow-up intervals due to the instability and rapid change in the

Table 1
MEWS

Score	3	2	1	0	1	2	3
Respiratory rate		< 9		9-14	15-20	21-30	≥30
Heart rate		< 40	41-50	51-100	101-110	111-130	≥130
Systolic blood pressure	< 70	71-80	81-100	101-199		≥200	
Body temperature		< 35		35-38.4		≥38.5	
Level of consciousness (AVPU)				Alert	Voice	Pain	Unresponsive

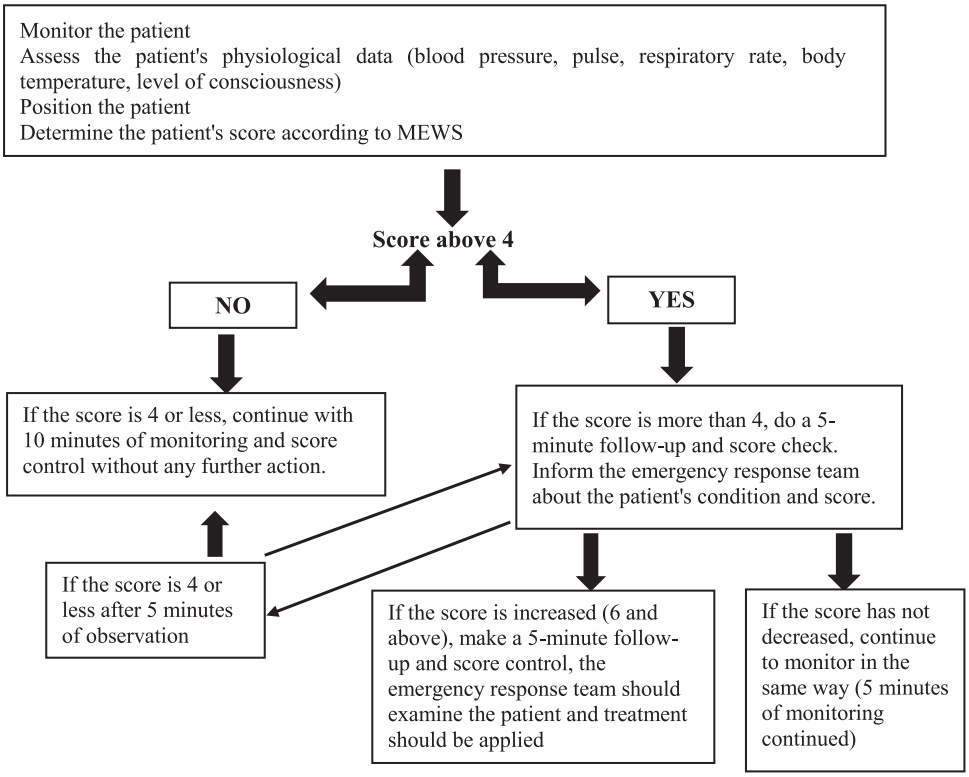

Figure 2. Nursing guideline application to be used in study group patients followed with modified early warning score.

physiological parameters of the patients in PACU. In the study, the scores of CG and SG patients were calculated according to MEWS during their transfer to PACU and afterward. MEWS scores of CG patients were calculated at ten-minute intervals in the PACU, and the patients were monitored at routine follow-up intervals after transfer to a ward or ICU. NGA is used from the moment the patient recovers from surgery. In our study, it was used when the patient was in the post-anesthesia care unit and when the patient transferred to the ward/ICU. Even though the scores of CG patients were found to be high, the nursing guide developed for the research was not applied. Nursing guidelines according to MEWS were applied to SG patients. According to the nursing guide applied in the SG; if the patient's MEWS was four or less, a ten-minute follow-up was performed. If the Mews score is more than a 4, a 5 minute follow up is done. If the score decreased to four or less, a ten-minute follow-up was started; if the score increased, five-minute follow-ups were continued and the emergency response team (consisting of an anesthesiologist and a specialist nurse) was informed and evaluation of the patient was provided (the emergency response team was informed about the study) (Figure 2).

d) **Nursing interventions checklist**

This list includes the most commonly applied nursing interventions in patients transferred to PACU, surgical service, and ICU. These initiatives are oxygen (O_2) application, aspiration application, O_2 saturation, pulse, blood pressure, respiratory rate, body temperature and pain controls, alertness and consciousness status (AVPU), blood glucose monitoring, positioning, oral care, and aseptic applications (eg catheter). Care includes administering medication and informing the physician. This list was used in both groups. The number of nursing practices performed on patients during 2 hours was recorded in this list. Since the patients in the SG were monitored at 5 or 10 minutes intervals according to the MEWS (Figure 2), nursing interventions were applied more frequently. This list recorded the number of nursing interventions provided over 2 hours. Since the patients in the SG were monitored at 5- or 10-minute intervals according to the MEWS, nursing interventions were applied more frequently. Patients in the control group were followed at 10-minute intervals in the PACU and routine follow-up intervals in the clinics to which they were transferred after the PACU. The nursing guide was not applied to these patients. Therefore, nursing interventions for CG patients were limited. Nursing interventions applied to this group were derived from observations made by the researchers and nursing interventions recorded in the patient files. In this study, patients were followed for 2 hours in the clinics (ICU or ward) to which they were transferred, starting from the process of admission to Phase I PACU, and the tools specified in the data collection section were applied. As far as we know, our study is a study in which patients are followed for the longest period of time by using a NGA together with MEWS.

Ethical Considerations

Before starting the study, approval was obtained from the Kocaeli University Clinical Research Ethics Committee (Date: 28.07.2022, Decision No: KAEK/17.bl.02). In addition, administrative permission was obtained from the chief physician of the hospital where the study was conducted and the Turkish Ministry of Health, Turkish Medicines, and Medical Devices Agency. Informed verbal and written informed consent was obtained from the participants. Clinical trial number obtained from ClinicalTrials.gov (Identifier: NCT05575531).

Table 2
Comparison of Sociodemographic and Disease-Related Characteristics of Patients According to Groups (N = 252) (Median (25.-75th Percentile)/n [%])

Characteristics		Median (25.-75. Percentiles)			
		CG (n = 126)		SG (n = 126)	P^*
Age		48.00 (34.75-61.00)		51.00 (40.75–62.25)	.183
BMI		27.68 (23.70-31.71)		27.61 (24.22–31.25)	.869
ASA score		2.00 (1.00-2.00)		2.00 (1.00–2.00)	.744
Duration of anesthesia (min.)		120.00 (90.00-180.00)		120.00 (90.00–180.00)	.343
Length of stay in PACU (min.)		30.00 (30.00-35.00)		40.00 (30.00–48.75)	**< .001**
		CG	SG	Total	$P^\dagger$
		n (%)	n (%)	n (%)	
Age	≤59	89 (70.6)	89 (70.6)	178 (70.6)	1.000
	≥60	37 (29.4)	37 (29.4)	74 (29.4)	
	Total	126 (100.0)	126 (100.0)	252 (100.0)	
Gender	Female	84 (66.7)	74 (58.7)	158 (62.7)	.193
	Male	42 (33.3)	52 (41.3)	94 (37.3)	
	Total	126 (100.0)	126 (100.0)	252 (100.0)	
Education Status	Illiterate	4 (3.2)	8 (6.3)	12 (4.8)	.820
	Literate	2 (1.6)	2 (1.6)	4 (1.6)	
	Primary education	55 (43.7)	52 (41.3)	107 (42.5)	
	High school	37 (29.4)	39 (31.0)	76 (30.2)	
	Undergraduate and above	28 (22.2)	25 (19.8)	53 (21.0)	
	Total	126 (100.0)	126 (100.0)	252 (100.0)	
Presence of chronic disease	Yes	69 (54.8)	66 (52.4)	135 (53.6)	.705
	No	57 (45.2)	60 (47.6)	117 (46.4)	
	Total	126 (100.0)	126 (100.0)	252 (100.0)	
ASA Score	1	32 (24.4)	33 (26.2)	65 (25.8)	.603
	2	73 (57.9)	67 (53.2)	140 (55.6)	
	3	20 (15.9)	26 (20.6)	46 (18.3)	
	4	1 (0.8)	0 (0.0)	1 (0.4)	
	Total	126 (100.0)	126 (100.0)	252 (100.0)	
Type of Surgery	Brain and nerve surgery	19 (15.1)	26 (20.6)	45 (17.9)	.729
	Thoracic surgery	5 (4.0)	3 (2.4)	8 (3.2)	
	Orthopedic surgery	10 (7.9)	6 (4.8)	16 (6.3)	
	Abdominal surgery	33 (26.2)	40 (31.7)	73 (29.0)	
	Plastic, reconstructive and esthetic surgery	8 (6.3)	9 (7.1)	17 (6.7)	
	Urological surgery	13 (10.3)	13 (10.3)	26 (10.3)	
	Gynecology surgery	23 (18.3)	19 (15.1)	42 (16.7)	
	Head and neck surgery	15 (11.9)	10 (7.9)	25 (9.9)	
	Total	126 (100.0)	126 (100.0)	252 (100.0)	

ASA, American Society of Anesthesiologists; BMI, body mass index; CG, control group; PACU, postanesthesia care unit; SG, study group.
Bold faced values are shown as $P < .05$.
* Mann-Whitney U test.
† Pearson χ^2.

Data Analysis

All statistical analyses were performed using IBM SPSS for Windows version 20.0 (IBM Corp.). G*Power version 3.1.9.2 (Kiel University) software were used to determine study power. Shapiro Wilk tests were used to test the normality of data distribution. Continuous variables were expressed as median (25th-75th percentiles), and categorical variables were expressed as counts (percentages). Comparisons of non-normally distributed continuous variables between the groups were performed using the Mann-Whitney U Test. Comparisons of cathegorical variables between the groups were performed using the Pearson χ^2, Yates' χ^2 test, and Monte Carlo χ^2 test. The relationship between numerical variables was evaluated by Spearman Correlation Analysis. A two-sided P value < .05 was considered statistically significant.

Results

In the study, there was a significant difference between the groups in terms of length of stay in PACU ($P < .001$, Table 2). The study showed that the development of complications during anesthesia ($P = .027$), in PACU ($P = .017$) and in the post-PACU period ($P = .001$) was significantly less in SG. Patients transferred to ICU after PACU had significantly less complications in the SG ($P = .007$). There was no significant difference between the groups in terms of intervention time for complications that developed in PACU and post-PACU period ($P > .05$, Table 3). The study also revealed a significant positive correlation between age and ASA score in the CG ($r = 0.578$, $P < .001$) and the SG ($r = 0.525$, $P = .042$). As age increased, ASA score increased. There was a positive significant relationship between BMI and ASA score in the CG ($r = 0.199$, $P = .026$) and the SG ($r = 0.193$, $P = .030$). As BMI increased, ASA score increased. In the CG, a significant negative correlation was found between length of stay and MEWS ([$r = -0.201$, $P = .024$), Table 4]), and MEWS increased as the duration of stay at PACU decreased. There was no statistically significant difference between the groups in terms of systolic blood pressure, heart rate and respiratory rate score medians ($P > .05$), but there was a significant difference between the groups in terms of body temperature ($P = .004$), AVPU ($P < .001$) and MEWS medians ($P < .001$, Table 5). There was a significant difference between the groups in terms of O_2 saturation, pulse rate, blood pressure, respiratory rate, and body temperature controls, awake state, level of consciousness and monitoring of the output, positioning, informing the physician and administering medication ($P < .05$, Table 6).

Discussion

The aim of this study was to determine the effect of NGA on patient outcomes during the care process in surgical patients followed up according to MEWS. Clinical studies have shown that

Table 3
Comparison of the Information About Intraoperative, Recovery, and Clinical Status According to the Groups (N = 252)

	Information		CG (n = 126) n (%)	SG (n = 126) n (%)	Total (n = 252) n (%)	*P*
Condition during anesthesia	Complications during anesthesia	Developed	20 (15.9)	8 (6.3)	28 (11.1)	**.027**[c]
		Not Developed	106 (84.1)	118 (93.7)	224 (88.9)	
		Total	126 (100.0)	126 (100.0)	252 (100.0)	
	Type of Complications	Difficult intubation	0 (0.0)	1 (12.5)	2 (7.1)	
		Hypotension	7 (35.0)	1 (12.5)	8 (28.6)	
		Hypertension	2 (10.0)	1 (12.5)	3 (10.7)	
		ST depression	1 (5.0)	0 (0.0)	1 (3.6)	
		Haemorrhage	5 (25.0)	3 (37.5)	8 (28.6)	
		Hypothermia	1 (5.0)	0 (0.0)	1 (3.6)	
		Bradycardia	3 (15.0)	0 (0.0)	3 (10.7)	
		Hyperglycaemia	0 (0.0)	1 (12.5)	1 (3.6)	
		Pain/agitation	1 (5.0)	1 (12.5)	1 (3.6)	
		Total	**20 (71.4)**	**8 (28.6)**	**28 (100.0)**	
Condition in PACU	Complication in recovery	Developed	15 (11.9)	4 (3.2)	19 (7.5)	**.017**[c]
		Not Developed	111 (88.1)	122 (96.8)	233 (92.5)	
		Total	126 (100.0)	126 (100.0)	252 (100.0)	
	Type of Complications	Nausea and vomiting	3 (20.0)	1 (25.0)	4 (21.1)	
		Hypertension	2 (13.3)	0 (0.0)	2 (10.5)	
		Pain	9 (60.0)	2 (50.0)	11 (57.9)	
		Agitation	1 (6.7)	1 (25.0)	2 (10.5)	
		Total	**15 (78.9)**	**4 (21.1)**	**19 (100.0)**	
	Response time to complications in recovery	0-10 min	4 (26.7)	4 (100.0)	8 (42.1)	.209[b]
		11-20 min	9 (60.0)	0 (0.0)	9 (47.4)	
		31 min and over	2 (13.3)	0 (0.0)	2 (10.5)	
		Total	15 (100.0)	4 (100.0)	19 (100.0)	
	Clinical status after recovery	ICU hospitalization	33 (26.2)	16 (12.7)	49 (19.4)	**.007**[b]
		Admission to the clinic	93 (73.8)	110 (87.3)	203 (80.6)	
		Total	126 (100.0)	126 (100.0)	252 (100.0)	
Condition in the Clinic (ICU/service)	Complication in clinic	Developed	60 (47.6)	34 (27.0)	94 (37.3)	**.001**[b]
		Not Developed	66 (52.4)	92 (73.0)	158 (62.7)	
		Total	126 (100.0)	126 (100.0)	252 (100.0)	
	Type of Complications	Incision pain	24 (40.0)	5 (14.7)	29 (30.9)	
		Headache	8 (13.3)	10 (29.4)	18 (19.1)	
		Sore throat	9 (15.0)	5 (14.7)	15 (15.9)	
		Nausea and vomiting	11 (18.3)	6 (17.6)	16 (17.0)	
		Hypothermia	6 (10.0)	6 (17.6)	12 (12.8)	
		Dizziness	1 (1.7)	0 (0.0)	1 (1.1)	
		Hypertension	0 (0.0)	1 (2.9)	1 (1.1)	
		Urinary retention	1 (1.7)	1 (2.9)	2 (2.1)	
		Total	**60 (63.8)**	**34 (36.2)**	**94 (100.0)**	
	Response time to complications in clinic	0-10 min	16 (32.7)	14 (40.0)	30 (35.7)	.426[b]
		11-20 min	15 (30.6)	13 (37.1)	28 (33.3)	
		21-30 min	12 (24.5)	7 (20.0)	19 (22.6)	
		31 min and over	6 (12.2)	1 (2.9)	7 (8.3)	
		Total	49 (100.0)	35 (100.0)	84 (100.0)	

[a] Mann-Whitney U test; [b] Pearson χ^2; [c] Yates χ^2.
CG, control group; ICU, intensive care unit; PACU, postanesthesia care unit; SG, study group.
Bold faced values are shown as $P < .05$.

Table 4
Correlation of Some Characteristics of Patients and MEWS Scores According to Groups (N = 252)

r (p)*	Groups	Age	BMI	ASA score	Length of stay in PACU	MEWS score
Age	CG (48.00 [34.75-61.00])	-				
	SG (51.00 [40.75-62.25])					
BMI	CG (27.68 [23.70-31.71])	**0.352 (*P* < .001)**	-			
	SG (27.61 [24.22-31.25])	**0.181 (0.042)**				
ASA score	CG (2.00 [1.00-2.00])	**0.578 (*P* < .001)**	**0.199 (0.026)**	-		
	SG (2.00 [1.00-2.00])	**0.525 (*P* < .001)**	**0.193 (0.030)**			
Duration of anesthesia (min.)	CG (120.00 [90.00-180.00])	0.083 (0.355)	-0.061 (0.498)	0.092 (0.307)		
	SG (120.00 [90.00-180.00])	**0.276 (0.002)**	-0.094 (0.295)	**0.208 (0.020)**		
Length of stay in recovery (min.)	CG (30.00 [30.00-35.00])	0.107 (0.234)	0.083 (0.356)	0.106 (0.238)	-	
	SG (40.00 [30.00-48.75])	-0.075 (0.405)	0.058 (0.519)	-0.066 (0.465)		
MEWS score	CG (1.85 [1.69-2.15])	-0.010 (0.915)	-0.122 (0.172)	-0.030 (0.736)	**-0.201 (0.024)**	-
	SG (1.23 [1.08-1.31])	0.079 (0.379)	-0.073 (0.417)	0.170 (0.057)	-0.097 (0.282)	

ASA, American Society of Anesthesiologists; BMI, body mass index; CG, control group; MEWS, modified early warning scoring; PACU, postanesthesia care unit; SG, study group.
* Spearman correlation analysis; Bold faced values are shown as $P < .05$.

Table 5
Comparison of Median Vital Signs and MEWS Scores by Groups (N = 252) (Median [25.–75th Percentile])

Patient	Systolic blood pressure	Heart rate	Respiratory rate	Body temperature	AVPU	MEWS
CG	125.16 (114.29-136.19)	77.62 (69.83-82.66)	19.54 (18.67-20.08)	36.25 (36.16-36.32)	0.31 (0.23-0.38)	1.85 (1.69-2.15)
SG	124.04 (116.83-134.69)	77.04 (70.92-88.62)	19.54 (18.54-20.02)	36.19 (36.10-36.28)	0.15 (0.15-0.23)	1.23 (1.08-1.31)
*P**	.745	.382	.730	**.004**	**< .001**	**< .001**

AVPU, Alert, Voice, Pain, Unresponsive; CG, control group; MEWS, modified early warning scoring; SG, study group.
* Mann-Whitney U test; Bold faced values are shown as $P < .05$.

Table 6
Comparison of Postoperative Nursing Interventions According to Groups (N = 252) (Median [25.–75th percentile]).

Initiatives	Median (25.-75. Percentiles)		*P*[a]
	CG	SG	
O_2 application	1.00 (1.00-1.25)	1.00 (1.00-2.00)	.503
O_2 saturation control	7.00 (7.00-8.00)	14.00 (13.00-14.00)	**< .001**
Pulse check	7.00 (7.00-8.00)	14.00 (13.00-14.00)	**< .001**
Blood pressure control	7.00 (7.00-8.00)	14.00 (13.00-14.00)	**< .001**
Respiratory rate control	7.00 (7.00-8.00)	14.00 (13.00-14.00)	**< .001**
Body temperature control	7.00 (7.00-8.00)	14.00 (13.00-14.00)	**< .001**
Alertness monitoring	7.00 (7.00-8.00)	14.00 (13.00-14.00)	**< .001**
Consciousness monitoring (AVPU)	7.00 (7.00-8.00)	13.00 (13.00-14.00)	**< .001**
The follow-up fluid balance	1.00 (1.00-1.00)	3.00 (3.00-4.00)	**< .001**
Pain control	1.00 (1.00-2.00)	1.00 (1.00-2.00)	.411
Positioning	1.00 (1.00-2.00)	2.00 (1.00-3.00)	**< .001**
Drug administration	1.00 (1.00-2.00)	1.00 (1.00-2.00)	**.014**
Notifying the physician	1.00 (1.00-2.00)	2.00 (1.00-2.00)	**< .001**
Other nursing interventions (suction application, oral care, aseptic applications, blood glucose monitoring, etc.)	1.00 (1.00-1.00)	1.00 (1.00-2.00)	.395

CG: control group; O_2, oxygen; SG: study group.
[a] Mann-Whitney U test; Bold faced values are shown as $P < .05$.

patients undergoing surgical intervention are at risk of acute complications in the postoperative period,[1,3,7,12] but these complications are often detected late or completely missed, resulting in prolonged hospital stay, unplanned ICU admissions, or increased morbidity and mortality rates.[14,22,23] MEWS is increasingly being used in hospitals to detect physiological changes, identify patients at risk, and initiate appropriate interventions.[10,11] MEWS is reported to be an effective risk management tool that should be applied especially in surgical patients and its use is recommended.[9,10,24]

Our study showed that the complications that developed during anesthesia, in the PACU and in the post-PACU period (in the clinic) were significantly less in the SG in which MEWS and NGA were used, and the intervention time for complications that developed in the PACU and post-PACU period was shorter, although not statistically significant. In addition, we found that the length of stay in CG was significantly shorter compared to SG, and the MEWS increased as the length of stay in CG shortened. Similar to our study results, a study by Pazar and Yava,[19] although not statistically significant, reported that fewer complications developed in the PACU period, the intervention time for complications that developed in the PACU period was shorter in the SG, and the length of stay was significantly shorter in the CG. In a study by Moon et al[25] involving two hospitals, there was a significant decrease in the proportion of patients admitted to the ICU after cardiopulmonary resuscitation due to the use of early warning signs (EWS).[25] Badr et al reported a significant decrease in the number of cardiopulmonary arrests, unplanned ICU admissions, emergency surgery, and acute kidney injury in the intervention group using the National Early Warning Score (NEWS) compared to the control group. In this respect, our study result supports the literature emphasizing that regular monitoring of vital parameters in line with MEWS+NGA is very important in preventing the risk of complications and deterioration in the patient, initiating appropriate interventions and preventing unplanned admissions to the ICU.[7,12,14,22,23] In addition, as another important result in our study, we found that the length of stay in recovery was significantly longer in the SG. This may be attributed to the fact that patients with MEWS above four were followed up at five-minute intervals according to the nursing guideline. The patient continued to be followed up in this way until the parameters were stable and transferred to the clinic without recovery after stabilization.

According to Somasundaram and Santhiyagappan,[9] vital signs are an early indicator of physiological deterioration and a predictor of potentially serious clinical events, routinely measured in an automated, noninvasive manner.[9] Early detection and documentation of abnormal vital signs can lead to early diagnosis, appropriate and timely treatment and care interventions, less organ dysfunction and lower risk of death.[23] Nurses play a vital role in the early detection and management of clinical deterioration as they are the group of professionals with the highest patient contact.[3] In our study, MEWS was found to be significantly lower in the SG ($P < .05$). Similar to this finding, Pazar and Yava reported that the mean EWS score of the SG patients leaving the PACU was significantly lower. Badr et al[23] found the application of NEWS was associated with a significant improvement in patient outcomes, an increase in the frequency of vital signs measurements, and an increase in the number of medical examinations following clinical instability. Liddle[12] also states that postoperative complications can be prevented, and that patients will recover and be discharged in a shorter time with accurate and complete monitoring of vital signs, signs and symptoms in the postoperative period. It is a clinically important result that the MEWS was significantly lower in the SG as a result of more frequent measurement of MEWS. This is in line with NGA and appropriate nursing interventions in our study supporting the above literature information.[5,11,12,15,23]

A careful and systematic evaluation, timely and correct interventions in the postoperative period can ensure that the patient's functions return quickly, safely, and as comfortably as possible.[19] CPG used in this process and nursing interventions applied according to these

guidelines make nursing care visible.[17] Our study showed that the nursing interventions applied in the postoperative period were significantly higher in the SG ($P < .001$). In support of our study finding, Badr et al reported that there was a significant increase in the number of medical examinations for patients whose clinical condition worsened during the intervention period in patients undergoing NEWS compared to CG, which significantly increased close observation.[23] De Meester et al[26] also reported that in patients transferred from the ICU to the surgical ward, the MEWS intervention applied for a period of 5 days increased the frequency of observation in the patient, and although there was no statistical significance, the risk of serious adverse events decreased. In the study conducted by Pazar and Yava,[19] the number of nursing interventions (saturation, pulse, blood pressure, alertness, pain monitoring, drug applications) performed in the SG was significantly higher than in the CG. In a qualitative study by Mohammmed Iddrisu et al,[3] it was reported that surgical nurses using EWS had better clinical assessment skills, were confident in recognizing the deteriorating patient, and continuously increased care based on objective physiological parameters. In our study, patients in the SG were monitored at 10 minutes intervals according to MEWS during the 2 hours they were transferred from the PACU to the clinic or ICU. Patients with a MEWS above four were followed up at 5 minutes intervals in accordance with NGA until the score decreased below four and nursing intervention was applied for the problems of these patients during care. Early warning scores provide the right communication and environment for timely implementation of patient care and increasing nursing interventions.[27] Based on this information, we can say that MEWS+NGA increased the number of nursing interventions in SG and this result was reflected positively on patient outcomes (prevention or reduction of complication development, decrease in ICU admissions, decrease in MEWS, increase in nursing practices). In addition, we believe that the results we obtained are consistent with each other.

Limitations

In the study, the patients were followed up for 2 hours after the operation when they were transferred from the PACU to the clinic or ICU. Since the patients could not be followed up for 24 hours postoperatively, the effectiveness of MEWS and nursing guidelines in the postoperative period and the mortality and morbidity rates of the patients could not be fully determined.

Conclusion

Our study showed that monitoring patients in the PACU and then in the clinical or ICU period according to MEWS+NGA had a positive effect on patient outcomes, decreased the development of complications, shortened the intervention time for complications, decreased ICU hospitalizations, decreased MEWS and increased nursing interventions. We recommend that further studies are conducted to follow up MEWS+NGA for 24 hours in the early postoperative period and to examine its effect on patient outcomes.

Declaration of Competing Interest

None to report.

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