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Original Article

ICU Nurses—An Impact Factor on Patient Turnover in Cardiac Surgery in Western Denmark?

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Objective: The aim of this study was to describe changes in performance indicators such as length of stay [LOS] in the intensive care unit [ICU] and ventilation time, during the last six years in an attempt to identify associations between patient and systemic performance indicators, including the impact of nurse turnover.
Design: A retrospective study of prospectively registered data (2013-2018). Propensity- score matching was performed to establish comparable groups.
Setting: Three Danish university hospitals.
Participants: The study included a total of 12,404 adult cardiac surgical patients registered in the Western Denmark Heart Registry. The cohort was divided into an "early" group (2013-2016) and a "late" group (2017-2018).
Interventions: An analysis of dynamics in patient indicators and systemic performance indicators, including the impact from selected performance parameters and nurse turnover.
Measurements and Main Results: Comorbidity, calculated from the European System for Cardiac Operative Risk Evaluation, and the mean age were stable in the study period. Strong predictors of long LOS in the ICU included postoperative use of inotropes, re-exploration surgery, high postoperative drainage, and the "late" time group. Time parameters (relative risks) were all significantly longer in the "late" time group": ventilation time 1.21 (1.05-1.39), length of stay ICU 1.28 (1.11-1.48), and in-hospital time 1.36 (1.19-1.57). ICU nurse turnover increased from four (2013-2014) to 52 (2017-2018).
Conclusion: No single patient factor, such as age or comorbidity, could explain the decrease in patient turnover in the ICU. In the same period, the turnover of ICU nurses increased. Patient turnover is complex and affected by a mix of patient and systemic performance factors.

Key Words: comorbidity; ventilation time; length of stay; intensive care unit; nurse turnover; work-life balance

Introduction

An altered balance between demand and resources in cardiac surgery has crafted a challenge for healthcare providers during the last two decades. Major changes in logistics and focus on fast-track protocols significantly have increased productivity and patient turnover. Various multidisciplinary strategies, including careful selection and extended preoperative patient preparation,[1,2] selection of best suitable procedures,[3,4] application of advanced surgical and anesthetic equipment[3] together with the implementation of different anesthesia and postoperative management protocols,[5,6] were part of the backbone of this development.

Cardiac surgery, with its inborn higher frequency of adverse events, commands critical postoperative observation in an intensive care unit (ICU). Ventilation time during ICU stay was long considered to be the deciding factor in the expansions

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of resources and total in-hospital stay,[7-9] compared to other surgical procedures. Consequently, various perioperative interventions focused on ventilation time and length of stay (LOS) in the ICU became an integral part of clinical practice.[10,11]

However, following improvements over the last decades,[12] department quality reports surprisingly indicated an increase in the focused time parameters during the last six years. The aim of this study was to reveal and describe the changes in performance indicators (like LOS in the ICU and ventilation time) during this period, attempting to identify associations between patient profile indicators and the systemic primary performance indicators. In addition, and as a possible contributing factor to altered systemic performance indicators, the authors investigated nurse turnover in the ICU in the same time period.

Methods

Data Sources

Study data were obtained from the Western Danish Heart Registry (WDHR), which collects data from three cardiac centers (Aarhus University Hospital, Odense University Hospital, and Aalborg University Hospital). WDHR is a population-based longitudinal database and includes all types of adult surgical interventions and all invasive cardiac procedures. The present study was approved by the Danish Data Protection Agency (1-16-02-48-19). In Denmark, individual consent is not required in epidemiologic studies.

Study Population

The study period was from January 2013 to December 2018. A total of 12,404 adult cardiac surgical patients were identified in the WDHR (Fig 1). Eligible surgical procedures included on-and off-pump coronary artery bypass grafting, aortic valve surgery, mitral valve surgery, and combinations of coronary artery bypass grafting plus valves. A total of 1,681 patients were excluded due to noneligible procedures. Moreover, 42 patients (17 for a missing civil registration number, ten for missing data, and 15 died during surgery) were excluded, leaving 10,681 patients for analysis. The cohort was separated into two groups for further investigation: "early" (January 1, 2013, through December 31, 2016) and "late" (January 1, 2017, through December 31, 2018). The "early" group consisted of 7,633 patients and the "late" group of 3,048 patients. Propensity-score matching was based on 2,648 patients from each group.

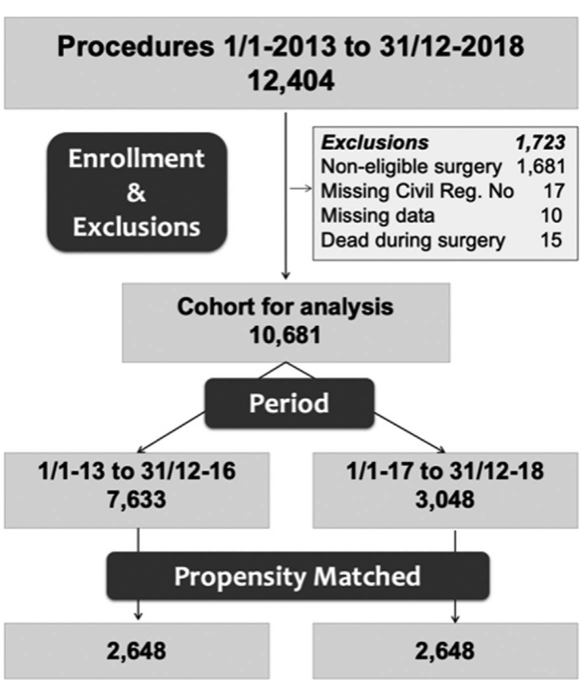

Fig 1. The cohort before and after propensity-score matching.

Selected Patient and Procedure Factors

Epidemiologic patient characteristics were based on the European System for Cardiac Operative Risk Evaluation (EuroSCORE) I and II factors,[13,14] procedure types, and departments. Moreover, data on preoperative anticoagulation, body mass index, and extracorporeal circulation time were obtained, together with the perioperative use of vasoconstrictors and inotropes.

Outcome Factors

Primary time parameters were ventilation time and LOS in the ICU and hospital. The upper 75th percentile was used to localize negative outliers. The definition of ventilation time was from the time of admission to the ICU until the removal of the endotracheal tube, and LOS in the ICU was from ICU admission to ICU discharge. Hospital LOS was defined as the time of intervention until discharge from the hospital ("post-procedure hospital LOS"). Other impact and outcome factors included a selection of postoperative events: myocardial infarction, new dialysis, hemostatic agents, postoperative inotropes and constrictors, postoperative bleeding, re-exploration, and the use of a PAC (pulmonary artery catheter). Information regarding turnover of ICU nurses in the whole period (early and late) in the three departments was obtained from the in-hospital registration of staff members.

Statistical Analyses

The data analysis was based on propensity-score matching in order to reduce the risk of bias due to confounding and non-random impact of factors. Before matching, logistic regression was performed to identify relevant independent factors on "long" LOS in the ICU (top quartile). Categorical and nominal variables are described as number and percentages. To describe continuous variables, median values with interquartile ranges or mean ± standard deviation are used. The chi-square test was used for categorical covariates. The Wilcoxon rank-sum test was used for continuous covariates (ICU time, ventilation time, postoperative bleeding, red blood cells, plasma, platelets), and the McNemar test for the remaining chosen outcome factors (paired nominal data). A p value of <0.05 was considered to be statistically significant. Crude and adjusted conditional regression analyses were used on the top quartile of time parameters to describe the independent impact of the "early" or "late" time group, and the impact of relevant independent factors on time parameters was analyzed. Propensity matching and conditional regression analyses were done with STATA 14, and all other statistical analyses were performed using MedCalc Statistical Software, version 19.

Results

A total of 10,681 patients were enrolled before propensity-score matching (Fig 1). The baseline clinical characteristics of enrolled patients before and after propensity-score matching are given in Table 1. The chosen factors in Table 1 primarily were based on EuroSCORE I and II factors combined with selected perioperative treatment and logistic factors. During the observation period, the average use of perioperative constrictors increased from 43.8% to 59.9 % ($p < 0.0001$), as did the amount of urgent surgery (from 5.8% to 14.4%; $p > 0.0001$). Moreover, the use of the American Society of Anesthesiologists (ASA) physical status classification system in the study period increased from 38.3% to 50.6% ($p < 0,0001$). However, after propensity-score matching, these characteristics did not significantly differ (Table 1).

Before propensity-score matching, logistic regression analysis showed the predictors' impact on long LOS in the ICU (top quartile) (Table 2). Strong predictors included the postoperative use of inotropes, re-exploration surgery, high postoperative drainage, and the "late" time group (with longer and/or increased time parameters). In contrast, an extracorporeal circulation time >120 minutes and PAC and TEE monitoring had a positive impact on shorter LOS in the ICU.

In the observation period, the EuroSCORE changed clinically marginally ($p = 0.008$), while the comorbidity score, defined as EuroSCORE I minus age and sex score, did not change ($p = 0.126$, Fig 2). Further, the mean age fluctuated over time, contributing to the change in EuroSCORE, while the percentage of female patients was stable in the study period ($p = 0.292$). Minor changes in comorbidity related to age groups were seen in the period ($p = 0.025$), with a decline in comorbidity score in the oldest age group (≥80 years), and only marginal differences between departments were seen ($p < 0.001$). Nevertheless, the small changes in EuroSCORE represented a 22% higher logistic EuroSCORE compared over the observation time (5.59 [2016] and 6.83 [2013]) and, thus, indicating some impact on outcomes. All parameters in Figure 2 are shown as spreads compared to study years.

Outcome factors for the "early" and "late" groups are presented in Table 3. Significantly more patients in the "late" group had postoperative constrictors ($p < 0.0001$), slightly fewer had postoperative inotropes ($p < 0.0042$), and, at the same time, a considerable number of patients in the "late" group did not have PAC monitoring ($p < 0.0001$). Time parameters (ICU time [hours], ventilation time [minutes], and long ICU time) were all significantly longer in the "late" group" ($p = 0.0001$). The "late" time group had an impact on all of the time parameters (lower 95% confidence interval of odds ratio [OR] >1.00), and the impact of the specific adjustment factors on time parameters are outlined in Table 4. It demonstrates that bleeding and vasoactive medical treatment all have an impact on long ICU, long ventilation, and long in-hospital times. The use of PAC monitoring was associated with a shorter ICU time and shorter ventilation time (OR 0.86 and 0.57, respectively), but not a shorter in-hospital time (OR 1.37).

Figure 3 shows the ICU nurse turnover in the study period (+ year 2019) according to department. The numbers indicate newly employed ICU nurses (positive) and ICU nurses who left the department (negative). The figure strongly indicates that all three departments during the study years experienced an increase in the turnover of ICU nurses.

Discussion

This study investigated possible factors that could explain the increases in ventilation times and LOS in the ICU in relation to cardiac surgery in the authors' setting. Patient profile indicators were evaluated, along with systemic profile indicators.

Comorbidity in the study population was described with EuroSCORE I and II factors, and showed an overall slight decrease in comorbidity and stable patient age (mean). The EuroSCORE is a tool developed to evaluate the risk of short-time mortality after cardiac surgery.[13] It is one of the various medical scoring systems used to objectively measure the severity of illness and predict outcomes for use in both comparative and predictive clinical research. The slight decrease in EuroSCORE in the study period may indicate fewer comorbidities in the population in Western Denmark presenting for cardiac surgery, together with an improved healthcare system. To isolate real comorbidity, the authors' removed influencing variables, such as age, sex, and procedures. Figure 2 shows this comorbidity score according to age groups and departments, besides a comparison with the EuroSCORE. Throughout the study period, the EuroSCORE and the Comorbidity Score were without great fluctuation. However, a visible decline in the comorbidity score was seen in the higher age groups (75-79 and ≥80 years). A possible explanation for the decline in comorbidity in these age groups in the study period could be that more patients with a higher age are offered a transcatheter aortic valve implantation procedure for aortic valve disease instead of open cardiac surgery.

Information regarding selected perioperative treatment factors revealed increased use of ASA and perioperative constrictors together, with a higher number of patients undergoing urgent surgery in the "late" group when compared to the "early" group. The altered use of ASA in the study period most likely reflected altered protocols for antithrombotic therapy management for patients undergoing cardiac surgery,[15] whereas the higher use of perioperative constrictors was more unclear. A possible explanation could be the greater number of

Table 1
Baseline Characteristics of Enrolled Patients Before and After Propensity-Score Matching

Factor		Before Matching			After Matching		
		Early Period	Late Period	p Value	Early Period	Late Period	p Value
Number of procedures, n		7,633	3,048		2,648	2,648	
Coronary artery bypass, n (%)		4,936 (64.7)	1,833 (60.1)	<0.0001	1,551 (58.6)	1,607 (60.7)	0.117
Aortic valve surgery, n (%)		2,632 (34.5)	1,044 (34.3)	0.821	946 (35.7)	923 (34.9)	0.508
Mitral valve surgery, n (%)		1,032 (13.5)	496 (16.3)	0.0002	416 (15.7)	412 (15.6)	0.880
Other procedure, n (%)		702 (9.2)	333 (10.9)	0.006	304 (11.5)	284 (10.7)	0.382
Female sex, n (%)		1,779 23.3)	687 (22.5)	0.395	603 (22.8)	600 (22.7)	0.922
Age (EuroSCORE), n (%)		2.28 ± 1.6	2.20 ± 1.6	0.004	2.15 ± 1.6	2.19 ± 1.6	0.234
Chronic obstructive lung disease, n (%)		808 (10.6)	316 (10.4)	0.073	267 (10.1)	280 (10.6)	0.557
Peripheral artery disease, n (%)		659 (8.6)	175 (5.7)	<0.0001	140 (5.3)	156 (5.9)	0.339
Poor mobility, n (%)		306 (4.0)	80 (2.6)	0.0005	55 (2.1)	74 (2.8)	0.090
Previous cardiac surgery, n (%)		365 (4.8)	138 (4.5)	0.604	126 (4.8)	121 (4.6)	0.745
S-creatinine >200 μg/L, n (%)		130 (1.7)	39 (1.3)	0.126	31 (1.2)	37 (1.4)	0.464
Endocarditis, n (%)		212 (2.8)	104 (3.4)	0.081	85 (3.2)	89 (3.4)	0.758
Critical preoperative state, n (%)		216 (2.8)	76 (2.5)	0.124	64 (2.4)	64 (2.4)	1.0
Unstable angina pectoris, n (%)		86 (1.1)	13 (0.4)	0.0006	15 (0.6)	13 (0.5)	0.705
Myocardial infarction ≤90 days, n (%)		1,199 (15.7)	408 (13.4)	0.0023	338 (12.8)	351 (13.3)	0.596
Urgent surgery, n (%)		443 (5.8)	438 (14.4)	<0.0001	285 (10.8)	288 (10.9)	0.894
Left ventricular ejection fraction, n (%)	>50	5,008 (66.5)	1,889 (64.2)	0.080	1,760 (66.5)	1721 (65.0)	0.460
	30-50	2,012 (26.7)	842 (28.6)		698 (26.4)	738 (27.9)	
	<30	506 (6.7)	210 (7.1)		190 (7.2)	189 (7.1)	
Perioperative vasoconstrictors, n (%)		3,343 (43.8)	1827 (59.9)	<0.0001	1528 (57.7)	1543 (58.3)	0.676
Perioperative inotropes, n (%)		1,186 (15.5)	429 (14.1)	0.058	375 (14.2)	374 (14.1)	0.969
Procedure EuroSCORE II, n (%)	0	3,964 (51.9)	1,487 (48.8)	0.044	1,271 (48.0)	1,298 (49.0)	0.522
	1	2,141 (28.0)	959 (31.5)		863 (32.6)	820 (31.0)	
	2	1,384 (18.1)	547 (17.9)		460 (17.4)	482 (18.2)	
	3	144 (1.9)	55 (1.8)		54 (2.0)	48 (1.8)	
Diabetes, n (%)	None	6,226 (81.6)	2,523 (82.8)	0.113	2,222 (83.9)	2,190 (82.7)	0.497
	Insulin treated	543 (7.1)	183 (6.0)		149 (5.6)	159 (6.0)	
	Tablet treated	864 (11.3)	341 (11.2)		277 (10.5)	299 (11.3)	
Body mass index, n (%)	<18.5	74 (1.0)	18 (0.6)	0.068	17 (0.6)	16 (0.6)	0.977
	18.5-24.9	71 (0.9)	32 (1.1)		27 (1.0)	27 (1.0)	
	25.0-29-9	2,404 (31.7)	944 (31.1)		829 (31.3)	827 (31.2)	
	30.0-34.9	3,284 (43.3)	1,278 (42.1)		1,131 (42.7)	1,115 (42.1)	
	35.0-39.9	1,369 (18.1)	589 (19.4)		489 (18.5)	513 (19.4)	
	≥40.0	376 (5.0)	177 (5.8)		155 (5.9)	150 (5.7)	
Preoperative anticoagulation, n (%)	None	4,264 (55.9)	1,363 (44.7)	<0.0001	1,213 (45.8)	1,211 (45.7)	0.658
	ASA	2,923 (38.3)	1,541 (50.6)		1,330 (50.2)	1,324 (50.0)	
	Clopidogrel	56 0.7)	26 (0.9)		19 (0.7)	23 (0.9)	
	ASA + Clopidogrel	94 (1.2)	22 (0.7)		9 (0.3)	19 (0.7)	
	Ticagrelor	102 1.3)	32 (1.0)		26 (1.0)	26 (1.0)	
	ASA + Ticagrelor	15 (0.2)	27 (0.9)		14 (0.5)	11 (0.4)	
	Other	67 (0.9)	6 (0.2)		8 (0.3)	5 (0.2)	
	ASA + Other	112 (1.5)	31 (1.0)		29 (1.1)	29 (1.1)	
Extracorporeal circulation time, n (%)	Off pump	911 (11.9)	277 (9.2)	<0.0001	241 (9.1)	250 (9.4)	0.764
	0-120 min	4,727 (62.0)	1,995 (65.9)		1,763 (66.6)	1,738 (65.6)	
	≥120 min	1,990 (26.1)	754 (24.9)		644 (24.3)	660 (24.9)	
Department, n (%)	A	3,238 (42.4)	1,116 (36.6)	<0.0001	1,020 (38.5)	982 (37.1)	0.303
	B	3,004 (39.4)	1,365 (44.8)		1,171 (44.2)	1,227 (46.3)	
	C	1,391 (18.2)	567 (18.6)		457 (17.3)	439 (16.6)	

NOTE. Statistics: Categorial variables chi-square test, longitudinal independent t-test.
Abbreviations: ASA, American Society of Anesthesiologists; EuroSCORE, European System for Cardiac Operative Risk Evaluation.

patients who underwent urgent cardiac surgery in the study period, but, as described above, the entire patient group did not show an increase in comorbidity over time ("early" versus "late"). Maybe explanations could be found in local policies and logistics. The authors wonder if the "lack of PAC" has left the anesthesiologist with limited information on patient hemodynamics, whereby the use of perioperative constrictors was based mainly on information on blood pressure. Furthermore, the decline in the use of PAC could be due to economic considerations, and the increased use of perioperative constrictors might be a result of more fluid- restrictive protocols. The increase in the number of patients undergoing urgent surgery

Table 2
Logistic Regression Analyses for Independent Factors Associated With Long LOS in the ICU (>75% Percentile) Before Propensity-Score Matching

Factor	OR (95% SL)
Age (EuroSCORE)	1.03 (0.99-1.06)
Female sex	1.35 (1.21-1.52)
Diabetes insulin treatment	1.38 (1.15-1.65)
Diabetes tablet treatment	1.14 (0.98-1.32)
EuroSCORE patient factors	1.17 (1.13-1.21)
EuroSCORE cardiac factors	1.05 (1.01-1.09)
Surgery single procedure	1.19 (1.06-1.35)
Surgery double procedure	1.28 (1.10-1.49)
Surgery triple procedure	1.67 (1.18-2.37)
Acute surgery	1.22 (1.03-1.46)
Off-pump surgery	1.28 (1.08-1.51)
ECC time >120 minutes	0.86 (0.75-0.98)
Postoperative inotropes	3.21 (2.81-3.67)
Postoperative vasoconstrictors	1.54 (1.39-1.71)
PACmonitoring	0.75 (0.67-0.83)
TEEmonitoring	0.81 (0.99-1.00)
Reexploration surgery	1.69 (1.37-2.09)
High postoperative drainage	1.79 (1.66-1.92)
Time group "Late"	1.26 (1.13-1.41)

NOTE. Age: EuroSCORE groups (6); EuroSCORE patient factors: Chronic obstructive lung disease, peripheral artery disease, poor mobility, previous cardiac surgery, S-creatinine >200 μg/L, endocarditis and critical preoperative state. EuroSCORE cardiac factors: Unstable Angina Pectoris, Myocardial Infarction ≤90 days, Left ventricular EF and pulmonary Hypertension. Abbreviations: ASA, American Society of Anesthesiologists; ECC,; EF, ejection fraction; EuroSCORE, European System for Cardiac Operative Risk Evaluation; PAC, pulmonary artery catheter; SL, safety limit; TEE, transesophageal echocardiography.

could be a question of real increase versus a more practical interest in order to avoid cancellations.

Most strategies regarding fast-tracking in cardiac surgery developed throughout the years focused on faster extubation and earlier discharge from the ICU,[16,17] as methods to increase overall in-hospital patient turnover.[7-9,18,19] Various other possible contributing parameters to a prolonged LOS in the ICU and in-hospital stay also have been studied.[17-20] Early studies showed that fast-track protocols with a focus on early extubation could reduce healthcare costs without increasing perioperative morbidity.[9,21] Research since then has demonstrated that ventilation time may be affected by numerous other factors, such as core temperature, bleeding, unstable hemodynamics, and local logistics,[12,22,23] and Richey et al[24] found increased LOS in the ICU and no difference in in-hospital stay with a rapid- extubation protocol. The question of fast-track protocols and their impact on both patient- and hospital-related factors is complex, and certainly no "one size fits all" can be found. With that in mind, it was rather interesting through this study to demonstrate that the use of PAC monitoring (indicating an "ill" patient) was not associated with a negative impact on time parameters, which meant it was not "ill" patients who were accounting for the increase in time parameters during the study period.

Many cardiac surgery centers have a specialized ICU or observation unit with specific protocols, and research throughout the years has been done to test different strategies in the postoperative course.[5,6,19,22] A recent analysis from the same region as this study showed that the majority of patients were extubated in the evening hours and discharged from the ICU the next morning.[12] Furthermore, Bhavsar et al described how

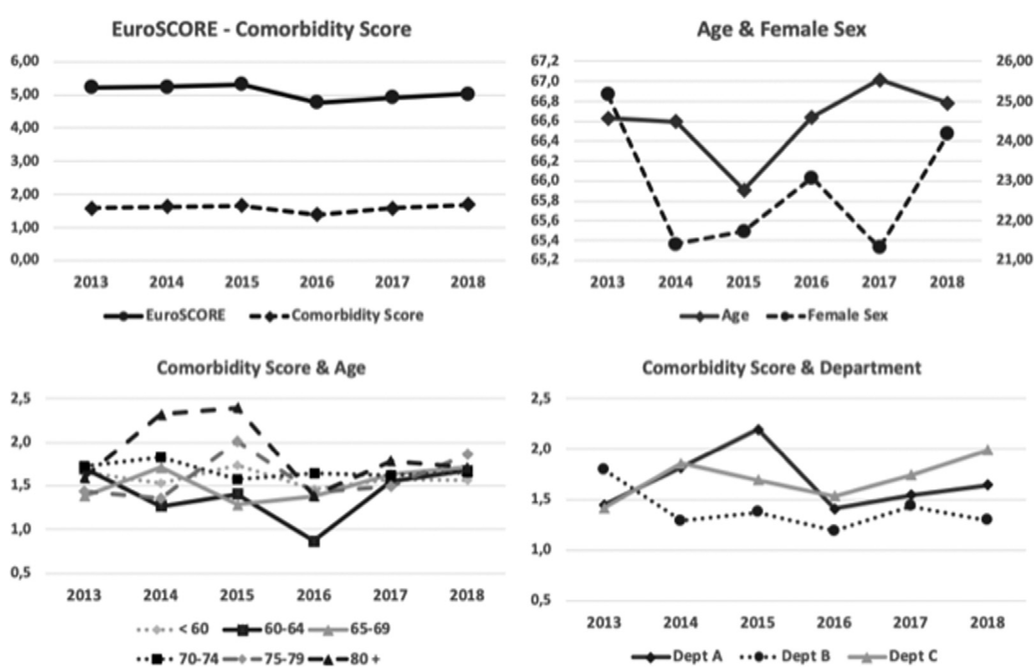

Fig 2. A presentation of EuroSCORE (p ≤ 0.008 and Comorbidity Score [p = 0.126], ANOVA upper left; demonstration of age changes (p < 0.001, ANOVA), and the percentage of female patients (p = 0.292), chi-square test. upper right; changes in comorbidity related to age group (p = 0.025) and year (p = 0.033), two-way ANOVA, lower left; changes in comorbidity related to department (p < 0.001) and year (p = 0.054), two-way ANOVA; lower right). ANOVA, analysis of variance; EuroSCORE, European System for Cardiac Operative Risk Evaluation.

Table 3
Outcome Factors for the "Early" and "Late" Groups

Outcome Factor	Early	Late	p Value
Long ICU time, n (%)	661 (25.0)	786 (29.7)	0.0001
Long ventilation time, n (%)	662 (25.0)	761 (28.7)	0.0022
Long hospital time, n (%)	661 (25.0)	782 (29.5)	0.0002
ICU time, h, OR (95% SL)	21.6 (19.0-23.3)	21.9 (19.6-23.8)	0.0001*
Ventilation time, min, OR (95% SL)	281 (176-461)	309 (195-504)	0.0001*
In-hospital time, d, OR (95% SL)	5.25 (4.23-7.04)	5.67 (4.56-7.17)	0.0144*
Stroke, n (%)	20 (0.7)	32 (1.2)	0.126
Myocardial infarction, n (%)	65 (2.5)	58 (2.2)	0.579
New dialysis, n (%)	61 (2.3)	57 (2.1)	0.779
Postoperative inotropes, n (%)	474 (17.9)	398 (15.0)	0.0042
Postoperative vasoconstrictors, n (%)	1,055 (39.8)	1,231 (46.5)	<0.0001
Postoperative CAG and/or PCI, n (%)	103 (3.9)	95 (3.6)	0.613
30-days mortality, n (%)	49 (1.9)	35 (1.3)	0.151
6-month mortality, n (%)	91 (3.4)	72 (2.7)	0.151
1-year mortality, n (%)	115 (4.3)	91 (3.4)	0.102
Postoperative bleeding, mL, OR (95% SL)	410 (270-700)	440 (275-700)	0.1486*
Red blood cells, mL, OR (95% SL)	600 (300-1,222)	600 (300-1,226)	0.342*
Plasma, mL, OR (95% SL)	616 (600-1,400)	600 (569-1,200)	0.020*
Platelets, mL, OR (95% SL)	600 (308-900)	600 (300-719)	0.138*
Hemostatic treatment	169 (6.4)	116 (4.4)	<0.0001
Re-exploration <24 hours	128 4.8)	150 (5.7)	0.194
Tamponade >24 hours	58 (2.2)	43 (1.6)	0.097
PAC-monitoring	1751 (66.1)	1393 (52.6)	<0.0001
TEE-monitoring	2513 (94.9)	2472 (93.4)	0.012

NOTE. Odds-ratio, 95% SL.
Abbreviations: CAG, coronary angiography; ICU, intensive care unit; PAC, pulmonary artery catheter; PCI, percutaneous coronary intervention; SL, safety limit; TTE, transthoracic echocardiography.
* Kruskall-Vallis test; rest McNemar test.

Table 4
The Impact of the Adjustment Factors on Time Parameters

Adjusting Factor	ICUOR (95% SL)	VentilationOR (95% SL)	HospitalOR (95% SL)
Late group	**1.28 (1.11-1.48)**	**1.21 (1.05 − 1.39)**	**1.36 (1.19-1.57)**
Reexploration surgery	1.92 (1.20-3.06)	2.72 (1.73-4.27)	2.13 (1.40-3.25)
Postoperative high drainage	1.79 (1.52-2.11)	1.66 (1.42-1.94)	1.41 (1.21-1.64)
Postoperative vasoconstrictors	1.71 (1.35-2.16)	1.32 (1.05-1.67)	1.27 (1.02-1.56)
Postoperative Inotropes	3.42 (2.53-4.16)	2.84 (2.13-3.78)	1.51 (1.17-1.97)
PACmonitoring	0.86 (0.69-1.08)	0.57 (0.46-0.75)	1.37 (1.11-1.69)

Abbreviations: ICU, intensive care unit; PAC, pulmonary artery catheter; SL, safety limit.

a shorter ventilation time did not change the median LOS in the ICU and concluded that changes in patient profiles indicators could have a major influence on the local possibilities; hence, comorbidities had a negative effect on ICU time. In the authors' study, they did not find general increases in age or comorbidity or any other single factor that could explain the increases in ICU time and ventilation time. Could changes in local logistics affect systemic primary performance indicators like time parameters?

In the study period especially, two of the three participating departments underwent great changes in administration and locations. There was an amalgamation of departments and, hence, new leaders and new designation of departments and/or units occurred, and, during a relatively short period of time, many new local policies and working routines were introduced to the staff. Several studies have investigated factors associated with the work environment, registered nurse turnover, and patient care.[25-29] Important themes regarding nurse turnover include effective leadership,[25,27,28] high-quality relationships among staff members,[26] and job characteristics as important in creating motivating and satisfying jobs.[29]

The pervasive institutional changes that affected many of the nurses in this investigation constituted a potential risk of increased nurse turnover. The authors' found an increase in nurse turnover towards the late time period of this study, and it is their belief that this strongly could have affected the increase in time parameters found in the same period of time. With an increase in nurse turnover, more new staff members had to be introduced to the local policies and working routines by the remaining experienced nurses. Struggling in

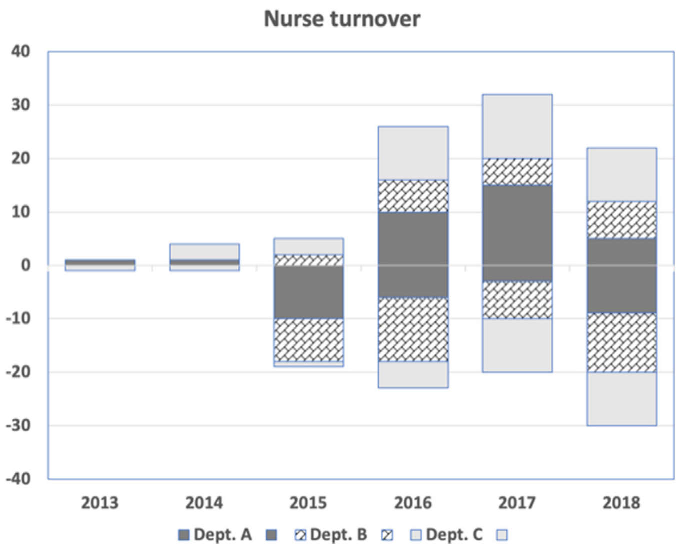

Fig 3. ICU nurse turnover according to department. The numbers indicate number of started ICU nurses (positive) and number of ICU nurses leaving left the department (negative). ICU, intensive care unit.

maintaining patient turnover at the same time might have put pressure on the whole group of nurses due to increased workload, insecurity in work assignments, and challenged interprofessional relationships. A healthy work environment and general job satisfaction are strong predictors of low turnover intention among nurses, but factors outside the working place also might influence the decision to leave the workplace or even the profession. In recent years there has been an greater focus on "work-life balance" and its implication on physical and mental health, especially among healthcare workers.[30-34] The authors of this article found that it is reasonable to believe that increased nurse turnover and patient care are closely related but complex in nature and influenced by many factors (individual, workplace, and society). It was not the aim of this study to investigate the exact reasons for the increased nurse turnover, but the authors find it important that future studies on fast-track in cardiac surgery consider that nurse turnover (irrespective of the reason) can be a single important contributor to the systemic primary performance indicators.

Study Limitations

The data used for this study were retrospective and, hence, encumbered with bias and possible confounders. All registrations, however, were obligatory and performed prospectively, and no patients were left out. Three individual departments contributed data, and certainly some variation in patient profiles, local logistics, and opinions among professionals must be present. These dissimilarities may bias the result but partly are compensated for by the high number of patients and factors included. Moreover, staff exchange among the departments was high, and the same educational system was used. It was not the aim of this study to thoroughly describe all differences among the three departments and their possible association with performance indicators. Nurse turnover was quantified by numbers only (in/out), and no qualitative assessment has been made (eg, a questionnaire).

Conclusion

Patient profile indicators in cardiac surgery patients were identified, but no single factor, such as age and comorbidity, could explain the decrease in patient turnover. The authors found that nurse turnover in the ICU could be a strong contributor to the increase in time parameters and that the nurse turnover might be affected by work-life imbalance. Patient turnover is complex and affected by a mix of patient and system performance factors. This might lead to more individualized fast-track concepts in the future, and institutions certainly should take into account the work-life balance of all crucial staff members around the cardiac surgery patient.

Conflict of Interest

None.

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