Association of Unplanned Reintubation with Higher Mortality in Old, Frail Patients: A National Surgical Quality-Improvement Program Analysis

Efstathios Karamanos, MD; Nathan Schmoekel, DO; Dionne Blyden, MD; Anthony Falvo, DO; Ilan Rubinfeld, MD

Perm J 2016 Fall;20(4):16-017

E-pub: 10/12/2016

http://dx.doi.org/10.7812/TPP/16-017

ABSTRACT

Background: Unplanned postoperative reintubation increases the risk of mortality, but associated factors are unclear.

Objective: To elucidate factors associated with increased mortality risk in patients with unplanned postoperative reintubation.

Design: Retrospective study. Patients older than 40 years who underwent unplanned reintubation from 2005 to 2010 were identified using the American College of Surgeons National Surgical Quality Improvement Program database. Multiple regression models were used to examine the impact on mortality of factors that included the modified frailty index (mFI) we developed, American Society of Anesthesiologists (ASA) score, age decile, and days to reintubation.

Main Outcome Measure: Mortality.

Results: A total of 17,051 postoperative reintubations in adults were analyzed. Overall mortality was 29.4% (n = 5009). On postoperative day 1, 4434 patients were reintubated and 878 (19.8%) died. On postoperative day 7 and beyond, 6329 patients were reintubated and 2215 (35.0%) died. Increasing mFI resulted in increasing incidence of mortality (mFl of 0 = 20.5% mortality vs mFl of 0.37-0.45 = 41.7% mortality). As ASA score increased from 1 to 5, reintubation was associated with a mortality of 12.1% to 41.6%, respectively. Similarly, increasing age decile was associated with increasing incidence of mortality (40-49 years, 17.9% vs 80-89 years, 42.1%). After adjustment for confounding factors, mFI, ASA score, age decile, and increasing number of days to reintubation were independently and significantly associated with increased mortality in the study population.

Conclusion: Among patients who underwent unplanned reintubation, older and more frail patients had an increased risk of mortality.

INTRODUCTION

Unplanned reintubation is a measurable complication of surgical care that is associated with significant morbidity and mortality.[1] Postsurgical physiologic deterioration or alterations of normal hormonal and metabolic physiology may contribute to respiratory failure and lead to eventual unplanned reintubation.[2,3] In modern health care, quality is not only expected but is also reportable. Unplanned reintubation is an identifiable event in a patient's postoperative course and serves as an outcome marker for quality improvement.

The population of Americans over the age of 65 years is projected to increase by 53.2% from the year 2003 to 2020.[4] An increasing number of elderly patients will be undergoing surgery, leading to a projected 31% increase in general surgery workload.[5] In recent years, a standardized measure of a patient's physiologic reserve has been developed in an effort to predict postoperative morbidity and mortality.[6,7] Frailty has been utilized to analyze multiple postoperative complications, including mortality.[8,9] However, there is insufficient literature regarding the impact of unplanned reintubation in the elderly population.

We hypothesized that the use of the modified frailty index (mFI) in reintubated patients would be predictive of increased mortality. We further hypothesized that the time to reintubation and American Society of Anesthesiologists (ASA) score would also affect mortality.

METHODS

This study used the American College of Surgeons National Surgical Quality Improvement Program (NSQIP) database. The NSQIP is a dataset used by hospitals nationally to help track areas of surgical performance for quality improvement.[10] Trained nurse reviewers at each participating hospital are responsible for collecting the data, which encompasses approximately 136 variables per patient. These variables include patient demographics, preoperative risk factors, and postoperative mortality and complications within 30 days of surgery for patients undergoing major operations, such as unplanned reintubation. The NSQIP database defines unplanned reintubation as placement of an endotracheal tube and mechanical or assisted ventilation because of the onset of respiratory or cardiac failure manifested by severe respiratory distress, hypoxia, hypercarbia, or respiratory acidosis within 30 days of the operation.[11]

Patients age 40 years and older who underwent unplanned reintubation from 2005 to 2010 were included in our study. The following variables were extracted from the NSQIP database for each patient: age, sex, ASA classification, race, wound

Efstathios Karamanos, MD, is a Surgeon in the Division of Acute Care Surgery in the Department of Surgery at Henry Ford Hospital in Detroit, MI. E-mail: ekarama1@hfhs.org. **Nathan Schmoekel, DO**, is a Surgeon in the Division of Acute Care Surgery in the Department of Surgery at Henry Ford Hospital in Detroit, MI. E-mail: nschmoek1@hfhs.org. **Dionne Blyden, MD**, is a Surgeon in the Division of Acute Care Surgery in the Department of Surgery at Henry Ford Hospital in Detroit, MI. E-mail: dblyden2@hfhs.org. **Anthony Falvo, DO**, is a Surgeon in the Division of Acute Care Surgery in the Department of Surgery at Henry Ford Hospital in Detroit, MI. E-mail: afalvo1@hfhs.org. **Ilan Rubinfeld, MD**, is a Surgeon in the Division of Acute Care Surgery in the Department of Surgery at Henry Ford Hospital in Detroit, MI. E-mail: irubinf1@hfhs.org.

classification at the end of the surgery, whether or not the surgery was emergent, inpatient or outpatient status, surgical subspecialty performing the surgery, diabetes mellitus status, tobacco use and number of packs smoked per year, history of comorbidities, functional status, and preoperative laboratory values (hematocrit and albumin). The total operative time for each patient also was extracted. Additionally, weight and height were used to calculate the body mass index for each patient.

Modified Frailty Index

Frailty has been associated with increased adverse events and prolonged postoperative recovery in several studies.[6,7,12] The Canadian Study of Health and Aging Frailty Index (CSHA-FI) is one index that has been developed to measure frailty. For this study, we calculated mFI by mapping the 70 variables from the CSHA-FI to the existing NSQIP preoperative variables, resulting in 11 matched

Table 1. Univariate comparison of patients' demographics and clinical characteristics of patients who required unplanned reintubation[a]

Characteristic	Overall (N = 17,051)	Alive (n = 12,042)	Dead (n = 5009)	p value
Age at reintubation (years), mean ± SD	69.4 ± 11.8	67.4 ± 11.9	71.4 ± 11.7	< 0.001
Men	9229 (54.2)	6462 (46.3)	2767 (44.6)	0.05
Emergent operation	5344 (31.3)	3583 (29.8)	1761 (35.2)	< 0.001
Inpatient	16,756 (98.3)	11,817 (98.1)	4939 (98.6)	0.032
Tobacco use	4697 (27.5)	3532 (29.3)	1165 (23.3)	< 0.001
Packs per year, mean ± SD	15.6 ± 44.8	17.6 ± 43.1	13.5 ± 46.5	< 0.001
Body mass index (kg/m^2), mean ± SD	28.2 ± 25.1	29.2 ± 42.2	27.2 ± 7.9	0.002
Diabetes				
Type 1	2328 (13.7)	1570 (13.0)	758 (15.1)	< 0.001
Oral medication	1749 (10.3)	1264 (10.5)	485 (9.7)	< 0.001
Comorbidities				
Mechanical ventilation	1233 (7.2)	884 (7.3)	349 (7.0)	0.391
COPD	3263 (19.1)	2272 (18.9)	991 (19.8)	0.166
Pneumonia	705 (4.1)	455 (3.8)	250 (5.0)	0.001
Hypertension requiring medications	12470 (73.1)	8668 (72.0)	3802 (75.9)	< 0.001
Wound classification at end of surgery				
Clean	5582 (32.7)	4034 (33.5)	1548 (30.9)	< 0.001
Clean/contaminated	6391 (37.5)	4559 (37.9)	1832 (36.6)	
Contaminated	1951 (11.4)	1314 (10.9)	637 (12.7)	
Infected	3127 (18.3)	2135 (17.7)	992 (19.8)	
Surgical subspecialty				
Cardiac surgery	324 (1.9)	261 (2.2)	63 (1.3)	< 0.001
Thoracic surgery	316 (1.9)	214 (1.3)	102 (0.6)	
Vascular surgery	3797 (22.3)	2621 (21.8)	1176 (23.5)	
General surgery	11756 (68.9)	8329 (69.2)	3427 (68.4)	
Obstetrics and gynecology	80 (0.5)	57 (0.5)	23 (0.5)	
Neurosurgery	236 (1.4)	170 (1.3)	66 (1.4)	
Orthopedics	285 (1.7)	195 (1.8)	90 (1.7)	
Otolaryngology	78 (0.5)	63 (0.3)	15 (0.5)	
Plastic surgery	36 (0.2)	22 (0.3)	14 (0.2)	
Urology	143 (0.8)	110 (0.6)	33 (0.2)	
Functional status				
Independent	11492 (67.4)	8513 (70.7)	2979 (59.5)	< 0.001
Partially dependent	3314 (19.4)	2079 (17.3)	1235 (24.7)	
Totally dependent	2229 (13.1)	1436 (11.9)	793 (15.8)	
Unknown	16 (0.1)	14 (0.1)	2 (0)	
Other clinical factors				
Total operative time (minutes), mean ± SD	171 ± 127	182 ± 133	159 ± 120	< 0.001
Preoperative hematocrit (%), mean ± SD	35.2 ± 6.6	35.9 ± 6.6	34.5 ± 6.5	< 0.001
Modified frailty index, mean ± SD	0.21 ± 0.14	0.20 ± 0.14	0.23 ± 0.15	< 0.001

[a] Data are no. (%) unless indicated otherwise.
COPD = chronic obstructive pulmonary disease; SD = standard deviation.

variables, and then mapping these variables to the patients' medical history. These 11 variables included nonindependent functional status; history of either chronic obstructive pulmonary disease or pneumonia; history of diabetes mellitus; hypertension requiring the use of medications; history of congestive heart failure; history of myocardial infarction; history of percutaneous coronary intervention, cardiac surgery, or angina; peripheral vascular disease or resting pain; transient ischemic attack or cerebrovascular accident without residual deficit; cerebrovascular accident with deficit; and impaired sensorium. A patient's mFI was calculated as the proportion of variables present ("positive") in a patient's medical history from the total 11 variables. The primary outcome was mortality.

The mFI has been validated in previous studies. Park et al[13] showed that the mFI correlates with postesophagectomy morbidity and mortality using the NSQIP database.

Statistical Analysis

To identify if age predicts mortality in patients undergoing unplanned reintubation, we divided the study population into groups by their age decile (40-49, 50-59, 60-69, 70-79, and 80-89 years). The incidence and odds ratio (OR) for mortality were calculated for each age decile.

To examine the impact of time to reintubation after surgery, we defined 4 different groups: Postoperative Days 0 to 1, 2 to 3, 4 to 6, and 7 and beyond. The postoperative complications were cross-tabulated with mortality and examined for differences using Student's *t*-test or the χ^2 test as appropriate.

The study population was divided in 2 groups: patients who died and patients who survived. A univariate comparison was performed to identify differences between the 2 groups. Categorical variables were compared using the Pearson χ^2 or Fisher exact test as appropriate. Continuous variables were examined for normality of distribution using the Shapiro-Wilk test. Normally distributed variables were compared using the Student *t*-test, and nonnormally distributed variables were compared using the Mann-Whitney *U* test. Variables that were different at $p < 0.05$ were entered in a binary logistic regression to examine the impact on mortality of mFI, ASA, age decile, and days to reintubation. Adjusted ORs with 95% confidence interval (CI) were derived from the regression.

RESULTS

A total of 1,334,886 patients were included in the NSQIP database from 2005 to 2010. Of those, 17,051 (1.3%) met our inclusion criteria and were analyzed. Of these 17,051 reintubated patients, 5009 had a documented death within 30 days of surgery. Therefore, the overall rate of postoperative mortality in patients requiring reintubation was 29.4%. Further analysis was performed to investigate the effect on mortality of patient age, ASA score, days to reintubation, and mFI. Patients who died were significantly more likely to be older compared with patients who survived (mean 71.4 years vs mean 67.4 years, p < 0.001), more likely to have undergone an emergent operation (35.2% vs 29.8%, p < 0.001), more likely to have type 1 diabetes (15.1% vs 13.0%, p < 0.001), and more likely to have an infected wound (19.8% vs 17.7%, p < 0.001). The mFI was significantly higher for patients who died (0.23 vs 0.20, p < 0.001). Details of patient clinical characteristics and demographics are presented in Table 1.

Table 2 shows the incidence of mortality for different study groups. The mortality rate was higher among patients who were reintubated later after their original surgery, compared with those reintubated sooner after their initial surgery. Patients who required reintubation on postoperative days 0 to 1 had a mortality rate of 19.8%; days 2 to 3, 28.4%; days 4 to 6, 32.9%; and day 7 and beyond, 35.0% (p < 0.001). When mortality was calculated for age, an associated increase in mortality with increase in age decile was observed. As patient age increased from the fourth through the eighth decile of age, the mortality rate increased from 17.9% to 42.1%. As seen in Table 1, the mean age of patients requiring reintubation who died was 71.4 years; however, Table 2 illustrates that mortality in patients requiring unplanned reintubation in the younger age deciles was significantly high (40-49 years, 17.9%; 50-59 years, 21.6%; p < 0.001). Similarly, Table 2 also illustrates that an increasing ASA score was associated with significantly higher mortality.

The impact of mFI on mortality after reintubation was examined using trend analysis and Mantel-Haenszel testing (Table 3). As mFI increased from 0 to 0.45, mortality rate increased from 20.5% to 41.0% (p < 0.001, linear $R^2 = 0.976$).

After adjustment for differences between the 2 groups (dead vs alive), an increasing mFI was significantly associated with

Table 2. Incidence of 30-day mortality by postoperative days to reintubation, age decile, and American Society of Anesthesiologists (ASA) score[a]

Variable	N	Mortality, n (%)	p value
Postoperative days to reintubation			
0-1	4434	878 (19.8)	0.003
2-3	3404	967 (28.4)	
4-6	2884	949 (32.9)	
≥ 7	6329	2215 (35.0)	
Age decile (years)			
40-49	2016	361 (17.9)	< 0.001
50-59	3125	675 (21.6)	
60-69	4678	1212 (25.9)	
70-79	3556	1213 (34.1)	
80-89	3676	1548 (42.1)	
ASA score			
1 - No disturbance	91	11 (12)	< 0.001
2 - Mild disturbance	1651	317 (19.2)	
3 - Severe disturbance	9236	2503 (27.1)	
4 - Life-threatening	5723	2032 (35.5)	
5 - Moribund	350	146 (41.6)	

[a] 5009 total deaths out of 17,051 total reintubations.

Table 3 . Incidence of 30-day mortality by modified frailty index[a]

Modified frailty index	N	Mortality, n (%)
0	1990	408 (20.5)
0.01-0.09	4252	1097 (25.8)
0.10-0.18	4486	1301 (29.0)
0.19-0.27	3479	1082 (31.1)
0.28-0.36	1204	437 (36.3)
0.37-0.45	1640	684 (41.7)

[a] Linear R^2 = 0.976, p < 0.001.

Table 4. Multivariate analysis for 30-day mortality[a]

Variable	Adjusted odds ratio (95% CI)	Adjusted p value
Frailty index	2.57 (1.94-3.40)	< 0.001
ASA score	1.27 (1.20-1.35)	< 0.001
Age decile	1.31 (1.27-1.35)	< 0.001
Days to reintubation	1.23 (1.20-1.27)	< 0.001

[a] Adjustment was made for emergent surgery, diabetes, tobacco use, body mass index, history of comorbidities, wound classification at end of surgery, surgical subspecialty performing the operation, functional status of the patient, total operative time, and preoperative hematocrit value.
ASA = American Society of Anesthesiologists; CI = confidence interval.

an increasing probability of dying (adjusted OR = 2.57, 95% CI = 1.94-3.40, p < 0.001; Table 4). Similarly, increased mortality was significantly associated with increasing ASA score (adjusted OR = 1.27, 95% CI = 1.20-1.35, adjusted p < 0.001), age decile (adjusted OR = 1.31, 95% CI = 1.27-1.35, p < 0.001), and days to reintubation (adjusted OR = 1.23, 95% CI = 1.20-1.27, p < 0.001).

DISCUSSION

This retrospective study of mortality in reintubated patients examined well-known risk factors such as age, ASA score, and time to reintubation. However, to the best of our knowledge, this is the first study specifically examining the impact of frailty on mortality in this population.

Unanticipated reintubation in the surgical patient population is a measurable event associated with significant morbidity. The present study suggests that the prognosis of reintubation depends on several factors including frailty, ASA class, age, and time to reintubation. In this study, the overall mortality of patients who required unplanned reintubation was exceedingly high (28.9%), which reflects the physiologic derangement driving respiratory failure.

The incidence and risk factors associated with reintubation have been previously examined.[1,14,15] Snyder et al[15] identified several risk factors for unplanned reintubation including severe chronic obstructive pulmonary disease, previous cardiac surgery, peripheral vascular disease, emergency procedure, dependent functional status, smoking within the past year, alcohol intake greater than 2 drinks per day, prior operation within the past 30 days, and transfer from an acute care hospital. Nafiu et al[14] reported that among all patients requiring emergent reintubation after elective surgery, 3.3% were elderly. However, this classification reflected chronologic age only and not patients' overall fitness and physiologic reserve.

For the present study, a frailty index modified from the CSHA-FI was developed using the 11 variables that are tracked in the NSQIP database. Multiple studies have shown that fewer variables may still yield an adequate assessment of a patient's frailty. Rockwood et al[16] studied the CSHA-FI and showed that using any 10 variables of that index resulted in comparable predictive value in frailty.

Respiratory failure within the first 72 hours after surgery has been related to hypoxemia and analgesic therapy.[17,18] Ramachandran et al[1] examined the incidence of early unplanned reintubation and found that one-half of all reintubations within a 30-day period occurred during the first 3 days, which was associated with a 9-fold increase in mortality. When adjusting for preoperative risk factors, these authors established a mortality rate of 9.7% to 30.6% in the first 3 days.[1] These data, although similar to our findings, represent a patient population much more diverse than ours, because we focused on an older age group.

Several protective measures can be undertaken to potentially avoid the significant morbidity and mortality associated with unplanned reintubation. Early tracheostomy in patients who are anticipated to have a protracted respiratory failure has been advocated, but it remains controversial. The advantages include reduced rates of ventilator-associated pneumonia and decreased hospital length of stay. Several recent studies have tried to compare the outcomes between performing an early vs late tracheostomy, but the data remain controversial. The present study showed an incremental increase in the probability of adverse outcomes as the day to reintubation increased. It is possible that early tracheostomy in people who are anticipated to have a protracted ventilatory need and difficulty weaning off the ventilator would reduce the hypoxia and physiologic stress of an unplanned reintubation and would potentially result in fewer adverse events. It is possible that calculating a patient's mFI will provide clinicians with a risk assessment tool regarding the probability of reintubation-associated mortality and will serve as a guide to patients and family counseling regarding early tracheostomy.

… the prognosis of reintubation depends on several factors including frailty, ASA class, age, and time to reintubation.

There are several limitations to this study. The first is the inability to know the details surrounding the indications for reintubation. This information may extend our knowledge of patients' physiologic deterioration surrounding the event requiring reintubation. Second, NSQIP tracks reintubation as an event in a 30-day postoperative period, but it is not clear on which day a patient was initially extubated. Furthermore, NSQIP data include accidental extubations that require reintubation, and such events would potentially confound the results. The patient population requiring delayed extubation is likely more acutely ill and has an inherently higher mortality. This may be an area for future research. Another limitation to this study is that although NSQIP variables for preoperative risk assessment are collected prospectively, the mFI was applied retrospectively to these variables.

CONCLUSION

Despite the aforementioned limitations, this study was conducted using the NSQIP database, which is a robust nationwide database comprising data from diverse participating institutions and surgeons. Our overall mortality rate of 29.4% is consistent with prior studies that found 30-day mortality among reintubated patients to be 29.4%.[15] We identified several patient variables that were predictive of mortality in reintubated patients: age, ASA score, time to reintubation, and frailty. Of these variables, frailty had the highest OR of 2.57.

This large, cross-sectional study of reintubated surgical patients found that despite the low overall incidence of postoperative reintubation, it is fraught with significant mortality, especially among older patient populations. ❖

Disclosure Statement

The author(s) have no conflicts of interest to disclose.

Acknowledgment

Kathleen Louden, ELS, of Louden Health Communications provided editorial assistance.

How to Cite this Article

Karamanos E, Schmoekel N, Blyden D, Falvo A, Rubinfeld I. Association of unplanned reintubation with higher mortality in old, frail patients: A National Surgical Quality-Improvement Program analysis. Perm J 2016 Fall;20(4):16-017. DOI: http://dx.doi.org/10.7812/TPP/16-017.

References

1. Ramachandran SK, Nafiu OO, Ghaferi A, Tremper KK, Shanks A, Kheterpal B. Independent predictors and outcomes of unanticipated early postoperative tracheal intubation after nonemergent, noncardiac surgery. Anesthesiology 2011 Jul;115(1):44-53. DOI: http://dx.doi.org/10.1097/aln.0b013e31821cf6de.
2. Blackburn GL. Metabolic considerations in the management of surgical patients. Surg Clin North Am 2011 Jun;91(3):467-80. DOI: http://dx.doi.org/10.1016/j.suc.2011.03.001.
3. Kause J, Smith G, Prytherch D, Parr M, Flabouris A, Hillman K; Intensive Care Society (UK); Australian and New Zealand Intensive Care Society Clinical Trials Group. A comparison of antecedents to cardiac arrests, deaths and emergency intensive care admissions in Australia and New Zealand, and the United Kingdom—the ACADEMIA study. Resuscitation 2004 Sep;62(3):275-82. DOI: http://dx.doi.org/10.1016/j.resuscitation.2004.05.016.
4. Etzioni DA, Liu JH, Maggard MA, Ko CY. The aging population and its impact on the surgery workforce. Ann Surg 2003 Aug;238(2):170-7. DOI: http://dx.doi.org/10.1097/01.sla.0000081085.98792.3d.
5. Etzioni DA, Liu JH, O'Connell JB, Maggard MA, Ko CY. Elderly patients in surgical workloads: a population-based analysis. Am Surg 2003 Nov;69(11):961-5.
6. Makary MA, Segev DL, Pronovost PJ, et al. Frailty as a predictor of surgical outcomes in older patients. J Am Coll Surg 2010 Jun;210(6):901-8. DOI: http://dx.doi.org/10.1016/j.jamcollsurg.2010.01.028.
7. Dasgupta M, Rolfson DB, Stolee P, Borrie MJ, Speechley M. Frailty is associated with postoperative complications in older adults with medical problems. Arch Gerontol Geriatr 2009 Jan-Feb;48(1):78-83. DOI: http://dx.doi.org/10.1016/j.archger.2007.10.007.
8. Farhat JS, Velanovich V, Falvo AJ, et al. Are the frail destined to fail? Frailty index as predictor of surgical morbidity and mortality in the elderly. J Trauma Acute Care Surg 2012 Jun;72(6):1526-30. DOI: http://dx.doi.org/10.1097/ta.0b013e3182542fab.
9. Obeid NM, Azuh O, Reddy S, et al. Predictors of critical care-related complications in colectomy patients using the National Surgical Quality Improvement Program: exploring frailty and aggressive laparoscopic approaches. J Trauma Acute Care Surg 2012 Apr;72(4):878-83. DOI: http://dx.doi.org/10.1097/ta.0b013e31824d0f70.
10. Khuri SF, Daley J, Henderson W, et al. The National Veterans Administration Surgical Risk Study: risk adjustment for the comparative assessment of the quality of surgical care. J Am Coll Surg 1995 May;180(5):519-31.
11. ACS National Surgical Quality Improvement Program (ACS NSQIP) [Internet]. Chicago, IL: American College of Surgeons; c2016 [cited 2016 May 22]. Available from: www.facs.org/quality-programs/acs-nsqip.
12. Saxton A, Velanovich V. Preoperative frailty and quality of life as predictors of postoperative complications. Ann Surg 2011 Jun;253(6):1223-9. DOI: http://dx.doi.org/10.1097/sla.0b013e318214bce7.
13. Park KU, Rubinfeld I, Hodari A, Hammoud Z. Prolonged length of stay after esophageal resection: identifying drivers of increased length of stay using the NSQIP database. J Am Coll Surg 2016 Mar 31. DOI: http://dx.doi.org/10.1016/j.jamcollsurg.2016.03.029.
14. Nafiu OO, Ramachandran SK, Ackwerh R, Tremper KK, Campbell DA Jr, Stanley JC. Factors associated with and consequences of unplanned post-operative intubation in elderly vascular and general surgery patients. Eur J Anaesthesiol 2011 Mar;28(3):220-4. DOI: http://dx.doi.org/10.1097/eja.0b013e328342659c.
15. Snyder CW, Patel RD, Roberson EP, Hawn MT. Unplanned intubation after surgery: risk factors, prognosis, and medical emergency team effects. Am Surg 2009 Sep;75(9):834-8.
16. Rockwood K, Andrew M, Mitnitski A. A comparison of two approaches to measuring frailty in elderly people. J Gerontol A Biol Sci Med Sci 2007 Jul;62(7):738-43. DOI: http://dx.doi.org/10.1093/gerona/62.7.738.
17. Taylor S, Kirton OC, Staff I, Kozol RA. Postoperative day one: a high risk period for respiratory events. Am J Surg 2005 Nov;190(5):752-6. DOI: http://dx.doi.org/10.1016/j.amjsurg.2005.07.015.
18. Rosenberg J, Oturai P, Erichsen CJ, Pedersen MH, Kehlet H. Effect of general anesthesia and major versus minor surgery on late postoperative episodic and constant hypoxemia. J Clin Anesth 1994 May-Jun;6(3):212-6. DOI: http://dx.doi.org/10.1016/0952-8180(94)90061-2.

Endure

No skill or art is needed to grow old; the trick is to endure it.

— Johann Wolgang von Goethe, 1749-1832, German author and statesman