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January 2012

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Surgical Patients with Do-Not-Resuscitate (DNR) Orders:

An Analysis of Characteristics and Short-term Outcomes Among 8256 Patients

A Thesis Submitted to the

Yale University School of Medicine

in Partial Fulfillment of the Requirements for the

Degree of Doctor of Medicine

by

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2012

Surgical Patients with Do-Not-Resuscitate (DNR) Orders:

An Analysis of Characteristics and Short-term Outcomes Among 8256 Patients

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Objective: Using data obtained from more than 120 hospitals participating in the American College of Surgeons-National Surgical Quality Improvement Program (ACS-NSQIP, 2005-08), the characteristics and outcomes of patients who underwent surgery with a DNR order were examined.

Methods: Patients with a DNR order were matched by age and procedure, to those without a DNR order. The main outcomes of interest were occurrence of postoperative complication(s) and mortality ≤30 days of surgery. The χ^2 test was used to analyze categorical variables and the Student's *t* and Wilcoxon tests were used for continuous variables. Multivariate logistic regression was performed to determine independent risk factors associated with mortality among DNR patients.

Results: There were 4128 DNR patients and 4128 age-matched and procedure-matched non-DNR patients in the study. Most DNR patients were white (81.5%), female (58.2%), and elderly (mean age, 79 years). Compared to non-DNR patients, DNR patients had a higher complication (26.4 vs. 31%, p<0.001) and mortality rate (8.4 vs. 23.1%, p<0.001). Nearly 63% of DNR patients underwent non-emergent procedures; they sustained a 16.6% mortality rate, which was 3-fold higher than that of non-DNR patients (p<0.001). After controlling for > 40 risk factors in multivariate analysis, DNR status remained independently associated with mortality (odds ratio 2.2, 95% confidence interval: 1.8-2.8, p<0.001). ASA class 3-5, age >65 years, and preoperative sepsis were among risk factors independently associated with mortality among DNR patients.

Conclusions: Surgical patients with DNR orders have significant comorbidities; many sustain postoperative complications, and nearly one in four die ≤30 days of surgery. DNR status appears to be an independent risk factor for poor surgical outcome.

ACKNOWLEDGEMENTS

To my **Parents**: Thank you for your inexhaustible affection, and your unshakeable belief in me.

To **Mrs. D.L Mohammed, Dr(s) Edward Gruberg** and **Richard Gusberg**: Thank you for your tireless guidance and inspiration.

To **Yale University School of Medicine**: Thank you for the "Yale System", the "Fifth year", the incredible, hearts and minds, ears and eyes that are the faculty and staff. I bleed blue.

To **Dr(s) Sanziana A. Roman and Julie Ann Sosa**: Merely knowing that you exist, that you do what you do, and are what you are, has profoundly changed my life, and will forever mean much to me. Thank you.

NOTE

- Accompanied by a JAMA-Archives press release titled "Do-Not-Resuscitate Orders Associated With Poor Surgical Outcomes Even for Non-Emergency Procedures", with subsequent media coverage in Reuters, US News, and the like, and followed later by an article in "Yale Medicine" titled "DNR orders emerge as a risk factor in surgery", a modified version of the work presented in this thesis was published in the *JAMA* surgical journal "*Archives of Surgery*": **Kazaure HS**, Roman SA, Sosa JA. "High mortality in surgical patients with Do-Not-Resuscitate (DNR) orders: Analysis of 8,256 patients". *Arch Surg.* 2011 Aug;146(8):922-8. Epub 2011 Apr 18.

- Funding for the study was provided by the Yale School of Medicine, Office of Student Research Fellowship (short-term funding).

- Matching of patients by age and procedure in this study was performed by Sunkyung Yu, MS, and Fangyong Li, MPH of the Yale Center for Analytic Sciences.

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INTRODUCTION

DNR orders and the medical culture:

There are few things harder for a health care professional than not intervening when a patient suffers cardiac arrest [1]; a Do-Not-Resuscitate order (DNR[1]) precludes the use of cardiopulmonary resuscitation (CPR) in a clinically unresponsive, pulseless patient [2] in arrest. The question of who should decide whether to perform or withhold resuscitation was once easily answered: the physician made the decisions about life and death [3]. The introduction of the DNR order into the medical culture marked a pivotal change in the delivery of medical care; it evolved to diminish a physician's exclusive powers to determine recipients of resuscitation in favor of greater respect for patient self-determination and autonomy [4,5]. Instead of instructing a caregiver to deliver treatment, the DNR order is indeed the first legally sanctioned patient order to their caregiver to *withhold* treatment [1,5].

The establishment of the DNR order in the medical culture did not occur without much ado (Appendix 1). Recommendations from a President's Commission, a raft of court rulings, several guidelines from respected medical groups, and a federal law proved essential to not only empower patients to institute DNR orders based on their expressed wish, but to prioritize also a concept once quite abstract to the medical profession that "medical decisions should be based on the informed preferences of individual patients and on considerations of the expected outcomes of the therapies of interest" [6]. Largely because of the introduction of DNR orders into the medical culture, "patients in the United States now have a well-established right to determine the

[1] DNR is sometimes referred to as "do-not-attempt-resuscitation (DNAR)", "No emergent CPR", "No code". This paper uses the term DNR.

goals of their medical care and to accept or decline any medical intervention that is recommended to them by their treating physician” [7].

Historical background of DNR orders

The history of the DNR order began with that of CPR, the latter, an astonishing product of ingenuity [8] and serendipity [9]. For eons, noting the onset of death was simple-when the signs of life were absent, death was everlasting [8]. Then a half-century ago, thanks in part to fortuitous discoveries in electrophysiology, a retired professor of engineering, a surgical resident, and an engineering student combined external electrical shock, mouth-to-nose ventilation, and closed chest compressions to jump-start life [8,9]. The team named their method “cardiopulmonary resuscitation”, and reported their success in a landmark paper titled “Closed Chest Cardiac Massage” [10] in 1960. CPR as we know it was thus ushered into the clinical world. Due to its simplicity and non-invasiveness, CPR was rapidly implemented in the clinical setting as an emergency procedure routinely administered to patients who experienced cardio-pulmonary arrest [11].

It became swiftly evident that the routine application of resuscitation efforts to *any* patient experiencing cardiopulmonary arrest may be a questionable act [5,12]. Responsible stewardship of finite hospital resources was at stake, for resuscitation was often futile and futile care provided to one patient inevitably diverted staff time and other resources away from other patients who may benefit more [4,7]. Complications such as rib fractures, permanent neurological deficits, and impaired functional status were common among the few patients who were successfully resuscitated [13-15]. For resuscitated patients who did not survive to hospital discharge, CPR transiently restored physiologic stability but prolonged patient suffering before death [1,4,12]. By the late 1960s, articles began appearing in the medical literature describing the agony many terminally ill patients experienced from repeated resuscitations that only protracted their death [5,8,9,16].

"Secretive resistance" [1] to the administration of CPR to all patients in cardio-pulmonary arrest soon took root; "secret codes" sprang forth: In situations in which hospital staff believed that CPR would not be beneficial, it became increasingly common for staff to either refuse to call a "code[2] blue" or to perform a less than full resuscitation. Partial or sham resuscitation attempts became more pervasive, and new terms, such as "chemical code," "show code", "Hollywood code", and "slow code," entered hospital parlance [1,5]. Covert codes embodied in peculiar ways to communicate who would not receive a full resuscitation attempt in the event of cardiopulmonary arrest were developed at the institutional level. At some institutions, these decisions were concealed as purple dots on the medical record or written as cryptic initials in the patient's chart; at other institutions, decisions to withhold CPR were simply communicated as verbal orders passed on from shift to shift [5].

The use of clandestine codes to discourage the administration of CPR to select patients was greeted with controversy and unease. Accusations of paternalism and covert decision-making were made, and concerns were raised regarding an erosion of trust between health care workers and the public [1]. Disenchantment grew regarding the absence of an established mechanism for advanced decision-making about resuscitation [5].

In 1974, the American Medical Association became the first professional organization to propose that decisions to not resuscitate a patient should be formally documented in progress

[2] Within the hospital setting, "code teams" of physicians and nurses are organized to respond to cardio-pulmonary arrest.

notes and communicated to all attending staff [17]. The position of the American Medical Association regarding DNR orders was followed by a widespread movement towards the development of explicit DNR policies at the hospital level. Overall, these policies helped fill the void that had existed within healthcare institutions regarding the decision-making process relating to assignment of DNR status and the communication of these decisions [5] .

Promotion of patient autonomy was at the core of the bioethical revolution that occurred in the final 25 yrs of the 20th century [5]. This issue was the thrust of the influential report of the 1983 President's Commission for the Study of Ethical Problems in Medicine and Bioethical Behavioral Research [18]. Titled "Deciding to forego life-sustaining treatment: Ethical, medical, and legal issues in treatment decisions", the Commission supported DNR protocols based on three value considerations: self-determination, well-being and equity[13,18]; it concluded that it is permissible for competent patients to refuse life-sustaining treatment. It added that "any DNR policy should ensure that the order not to resuscitate has no implications for any other treatment decisions [4,13,18,19]. .

After percolating in the clinical and ethical realms, the DNR discourse soon entered the legal domain. In 1988, New York became the first state to pass a statute governing DNR orders[1,5,20]. Under the statute, every patient was presumed to have consented to CPR unless there is consent to the issuance of a DNR order [20]. At present, presumed consent to CPR is the norm nationally but almost all states have statutes with a well-characterized provision for a DNR order [5]. For example, Connecticut law (Section 19a-580d) defines a DNR order "..as an order written by a Connecticut licensed physician to withhold cardiopulmonary resuscitation, including chest compressions, defibrillation, or breathing or ventilation by any assistive or mechanical means including, but not limited to, mouth-to-mouth, mouth-to-mask, bag-valve mask, endotracheal tube, or ventilator” [21].

DNR orders: Reality check

The DNR order was introduced as a means to provide competent patients the chance to express their right to refuse treatment [22,23]. However, numerous studies published in the late 1980s and early 1990s found that the reality of practice regarding resuscitation decisions fell well short of this ideal of promoting patient self-determination. Most of the studies found that physicians dominated the decision-making process, and that decisions were often made without either patient or family input [4,12,22,24,25] .

In response to what was then a growing perception in the healthcare community that there were substantial ethical shortcomings in the sensitive matter of executing advanced directives, the Patient Self-Determination Act (PSDA) was passed in 1991. This US federal law required that healthcare institutions receiving any type of federal funding (Medicare and Medicaid) inform their patients about their medical decision-making rights, including the right to refuse life-sustaining care such as CPR [22].

After the passage of the PSDA, a large scale, two-phased $29 million Study to Understand Prognoses and Preferences for Outcomes and Risks of Treatments (SUPPORT) was conducted from 1989 to 1994. Some aims of the study were to improve communication and shared end-of-life decision-making between seriously ill patients and their physicians [13,26]. Using a subset of over 6000 patients, the SUPPORT investigators examined the association between patients' preferences for resuscitation (along with other patient and physician characteristics) and the frequency and timing of DNR orders. The investigators found that physician-related factors were still highly influential in decisions regarding DNR status, and that discussions relating to a DNR status were often late and infrequent despite well-designed interventions targeting physicians about the implementation of DNR orders [6].

Epidemiology of DNR orders among hospitalized and surgical patients:

Approximately 70% of patients in the United States die with a DNR order, which is often written within the 3 days immediately preceding death [4,22]. The use of DNR orders has been increasing over the past decades [27]. The rate of issuance of DNR orders increases with greater severity of illness at admission [28,29]. These orders are generally associated with advanced disease [6,30] and may be surrogate markers of impending death [2,4,22]. So prevalent are DNR orders around the time of death that one author opined that "…the DNR order, a peculiarity of the Western World at the close of the 20th century, has become a ritual acknowledgement of impending death - a secularized, medicalized, technologized ceremony of "last rites""[31].

Clemency and Thompson found that up to 83% of patients queried in a survey would consider surgery with a preexisting DNR order [32]. It has been estimated that up to 15% of patients with a DNR order undergo surgery [23,24,33,34]. Patients with a DNR order consent to a variety of surgical procedures ranging from palliative surgery to aggressive attempts at extension of life, which include but are not limited to insertion of tracheostomy or gastrostomy tubes, bowel resections to relieve obstructions and vascular access surgery [32,35,36,37]. Indeed, surgical management of clinical problems of seriously or terminally ill patients to alleviate the acute sequelae, pain, and suffering associated with their illness has become an important component of palliative care for such patients [39].The goals of surgical interventions in such patients include gaining “additional time” [1], improving quality of life, decreasing pain, or treating isolated problems, such as a fracture [38].

DNR orders in the operative setting: The controversy

There has been considerable debate regarding the appropriateness of a DNR order in the operating room; infact, most studies of surgical patients with DNR orders have focused on the ethical implications of a DNR order in the perianesthesia period [34,36,38,40,41]. Examples of ethical conundrums that arise in the perioperative period of surgical patients with DNR orders include “should a DNR be suspended when a patient who is terminally ill undergoes a palliative surgical procedure for debulking a tumor or relieving an obstruction? If the DNR order is suspended, how soon after the procedure should it be reinstated?”[36,42] .

Three courses of action may be taken when a DNR patient enters the operating room: (1) strict adherence to the DNR order (2) automatic suspension of the DNR order, and (3) “required reconsideration” of the DNR order [33,39]. Proponents of honoring DNR orders in the operating room center their argument on the ethical principle of respect for patient autonomy; those in favor of rescinding the DNR order argue that intraoperative arrest of a seriously or terminally ill patient should be considered a correctable side-effect of anesthesia and not a function of the patient’s underlying disease or injury. In the latter view, CPR should be administered to the DNR patient who experiences intraoperative arrest [4,33,39] .

Controversy over the perioperative management of patients with DNR orders has culminated in a position of "required reconsideration" promoted by esteemed groups such as the American College of Surgeons [43] and the American Society of Anesthesiologists [44] .

According to “ST-19: Statement on Advance Directives by Patients: Do-Not-Resuscitate Orders in the Operating Room” released by the American College of Surgeons [43]:

> “When such (DNR) patients undergo surgical procedures and the accompanying sedation or anesthesia, they are subjected to new and potentially correctable risks of cardiopulmonary arrest. Furthermore, many of the therapeutic actions employed in resuscitation (for example, intubation, mechanical ventilation, and administration of vasoactive drugs) are also an integral part of anesthetic management, and it is appropriate that the patient be so informed. The DNR status of such patients during the operative procedure and during the immediate postoperative period may need to be modified prior to operation...The best approach is a policy of "required reconsideration" of previous advance directives. The patient and the physicians who will be responsible for the patient's care should discuss the new risks and the approach to potential life-threatening problems during the perioperative period. The results of such discussions should be documented in the record…The operative and anesthetic permit should indicate that the patient or the duly authorized patient's representative has had the opportunity to discuss and reconsider any advance directive. An example follows: *In preparation for your operative procedure and the immediate postoperative period, your advance directive (such as "Do Not Resuscitate") may need to be modified. If you currently have such an advance directive, it should be discussed with your surgeon and anesthesiologist prior to the operative procedure.”*

STATEMENT OF PURPOSE

Whereas vibrant debate persists regarding the ethical component of DNR orders in the perioperative period, there is a paucity of literature describing the characteristics of patients with DNR orders who undergo surgery. Likewise, detailed outcome data for patients with DNR orders who undergo surgery have thus far been sparse.

Wenger et al's [35] subanalysis of DNR patients enrolled in the SUPPORT study may be the only recent study on the outcomes of adult DNR patients who underwent surgery. The study was published more than a decade ago and involved just 57 DNR patients. The aims of the study were to evaluate whether patients with DNR orders were less likely to receive operations, and to describe the characteristics, preferences and outcomes of patients with DNR orders who undergo surgery. The authors found that DNR orders do not appear to hinder access to surgery and that many patients with poor short-term prognoses choose and receive a wide variety of surgical procedures; about half of the patients survived to hospital discharge.

Considering the scarcity of data, the overarching aims of our study were to examine the characteristics and outcomes of surgical patients with DNR orders. Given the general understanding that DNR status often indicates severe (if not terminal) illness on one hand [2,31,45], and the theoretical expectation that DNR orders affect only outcomes of CPR on the other hand, the hypotheses of this study are as follows:

- Surgical patients with pre-existing DNR orders have multiple comorbid conditions
- Surgical patients who undergo surgery with DNR orders have worse outcomes than those without a DNR order; however, the DNR order itself is not independently associated with poor outcomes.

In order to explore these hypotheses, we performed a retrospective, cross-sectional analysis of adult patients with a pre-existing DNR status who underwent surgery at more than 120 U.S. hospitals participating in the American College of Surgeons - National Surgical Quality Improvement Program (ACS-NSQIP) captured in the Participant Use File for years 2005-08.

METHODS

Data

ACS-NSQIP collects data on 135 variables, including preoperative risk factors, intraoperative variables, and 30-day postoperative morbidity and mortality for patients undergoing major surgical procedures in both the inpatient and outpatient settings. Baseline demographic and clinical characteristics, anesthesia type, operative details, and postoperative data included in the ACS-NSQIP Participant Use Data File are prospectively collected by trained nurses through chart review and patient follow-up [46] .

Patients

In ACS-NSQIP, a patient is deemed DNR "if the patient has had a DNR order written in the physician's order sheet of the patient's chart, and it has been signed or co-signed by an attending physician in the 30 days prior to surgery; (or) if the DNR order as defined above has been rescinded immediately prior to surgery in order to operate on the patient" [46]. A "DNR" variable is among 135 variables included in ACS-NSQIP database. In this study, adult (≥18 years) DNR patients who underwent surgery in the NSQIP (2005-08) data file were identified using this variable.

DNR patients were matched by age (± 3-year age window) and procedure (using Current Procedural Terminology (CPT) codes) to non-DNR patients. The match ratio was 1:1. Procedure matching was done using the "CPT" variable, which specifies the code of the primary operative procedure included the database [46].

Baseline characteristics

Patient demographic characteristics included age, gender, race (White, Black, Hispanic, unknown or other, which included but was not limited to American Indians, Alaska Natives, Asians, or Pacific Islanders), transfer status (admitted from another care facility or from home) and functional status (independent, partially or totally dependent) prior to their acute illness and surgery.

Clinical characteristics included preoperative laboratory values (white blood cell [WBC] count, hematocrit, albumin, and creatinine); inpatient vs. outpatient procedure; emergent vs. non-emergent surgery; American Society of Anesthesiologists (ASA) classification; prior operation ≤30 days of surgery, intraoperative blood transfusion requirement and occurrences such as CPR; unplanned intubation or myocardial infarction; operative wound classification as defined by the primary surgeon; and involvement of a surgical resident in the case. Preoperative laboratory values were modeled as categorical variables using established laboratory cutoff values [47].

General comorbidities included hypertension requiring medication; diabetes mellitus (on oral hypoglycemic medications or insulin); smoking status during the year prior to surgery; chronic steroid use; and current alcohol use (defined as consumption of >2 drinks per day in the two weeks prior to surgery). Pulmonary comorbidities were preoperative dyspnea at rest or with moderate exertion, ventilator dependence, history of chronic obstructive pulmonary disease

(COPD), and current pneumonia. Cardiovascular comorbidities included newly diagnosed or worsening congestive heart failure (CHF) ≤30 days of surgery, myocardial infarction (MI) six months prior to surgery, history of cardiac surgery or percutaneous coronary intervention (PCI), angina, hypertension (on antihypertensive medications), and peripheral vascular disease, including revascularization and rest pain. Hepatobiliary comorbidities included ascites ≤30 days prior to surgery and preoperative esophageal varices. Renal comorbidities were acute renal failure ≤24 hrs prior to surgery and dialysis dependence (≤2 weeks prior to surgery). Neurologic comorbidities included history of paralysis such as hemiplegia, paraplegia and quadriplegia, impaired sensorium ≤48 hrs prior to surgery, non-"drug-induced" preoperative coma, transient ischemic attack, previous stroke with or without neurologic deficits, and presence of central nervous system tumor. Nutritional/immune/other comorbidities included disseminated cancer, chemotherapy 30 days prior to surgery, radiotherapy ≤90 days of surgery, substantial weight loss (>10% loss in body weight in the six months preceding surgery), history of a bleeding disorder, presence of an open wound prior to surgery, and preoperative sepsis.

Outcomes

Clinical outcomes of interest were occurrence of one or more postoperative complications, reoperation, and death ≤30 days of surgery. Operative and hospital stay measures of interest were total time spent in the operating room and hospital length of stay (LOS).

Complications, recorded as dichotomous outcomes in the dataset, were grouped into major and minor categories as defined by Dimick et al [48]. Major complications included re-intubation, failure to wean or ventilator use >48hrs, pneumonia, pulmonary embolism, myocardial infarction, cardiac arrest requiring CPR, stroke, coma >24hrs , acute renal failure, renal insufficiency, wound dehiscence, deep wound infections, organ space infections, severe sepsis, septic shock, and bleeding requiring ≥ 5units of blood. Minor complications were superficial wound infection, urinary tract infection, deep venous thrombosis/thrombophlebitis, and peripheral nerve injury.

Complications also were grouped by type or body system: respiratory (postoperative pneumonia, pulmonary embolism, failure to wean from ventilator within 48 hours, and unplanned intubation); cardiac (cardiac arrest, myocardial infarction); urologic (postoperative renal insufficiency, renal failure requiring dialysis and urinary tract infection); neurologic (postoperative stroke, coma >24 hrs, neurologic deficits); wound-related (superficial, deep, and organ/space surgical site infections, wound dehiscence); septic (severe sepsis, septic shock); and other (bleeding, deep vein thrombosis/ thrombophlebitis). Mortality rates of DNR and non-DNR patients also were analyzed by the type of surgical procedure performed; procedures were identified by Current Procedural Terminology (CPT) codes (Appendix 2).

Statistical analysis

Bivariate analyses comparing preoperative variables and outcomes of interest of DNR and non-DNR patients were performed using two-tailed χ^2 analysis for categorical variables and two-sided t-test and Wilcoxon rank sum test for continuous variables. Continuous variables were not transformed. All p values < 0.05 were considered significant.

Because the study was based on matched data, conditional logistic regression was used to determine risk factors associated with mortality for the overall sample [49] in multivariate analyses. To further explore the effect of DNR orders on mortality, propensity scores [50] for the probability having a DNR order for all patients in the study based on the demographic and clinical characteristics provided in the database were generated. We then constructed a multivariate model in which the generated propensity scores were included as covariates. Including the propensity scores in the model allowed us to determine whether it was the presence of a DNR order or the characteristics typical of patients with DNR orders that affected mortality.

Separate multivariate stepwise logistic regression models were generated to determine risk factors of 30-day postoperative mortality for DNR and non-DNR patients. For all multivariate analyses, a p value < 0.20 on bivariate analyses was used to identify preoperative variables that should be entered into multivariate regression models. A p value < 0.05 was the significance criterion used to identify independent risk factors in multivariate regression models. Adjusted odds ratios with 95% confidence intervals (CI) were then calculated and reported.

Data management and analyses were performed using SPSS for Windows version 17.0 software program (SPSS Inc, Chicago, Illinois) and SAS version 9.2 (SAS Institute, Cary, NC). Data included in the ACS-NSQIP Participant Use Data File is de-identified; therefore, this study was granted exemption by our institutional review board.

RESULTS:

Between 2005-2008, there were 4,167 cases of DNR patients in the ACS-NSQIP Participant Use Data File database, which represent 0.65 % of cases captured in the database. A 99% match rate yielded 4,128 DNR patients and 4,128 age- and procedure-matched non-DNR patients included in this study. As an example of the matching process, a 75-year old DNR patient who underwent cholecystectomy was matched to one non-DNR patient aged 72-78 years who also underwent cholecystectomy.

Patient characteristics

The average age of the study sample was 79.1 (±1.6) yrs. As shown in Table 1, most DNR patients were female, white, and elderly. Compared to non-DNR patients, DNR patients were more likely to be admitted from an acute/chronic/other facility ($p < 0.001$) and have functional impairment prior to surgery ($p < 0.001$). Approximately 27.1% and 12.8% of DNR and non-DNR patients, respectively, lost their independent functional status in the time between onset of illness and surgery ($p<0.001$).

Table 1. Demographic characteristics of DNR and non-DNR patients, ACS-NSQIP (2005-08)

CHARACTERISTIC[1] (%)	**DNR** (n = 4,128)	**Non-DNR** (n = 4,128)	*p* value
Age, yrs			MATCHED
18-44	4.7	4.7	
45-64	17.0	17.0	
65-79	29.7	29.7	
≥ 80	48.7	48.7	
Gender, female	58.2	54.1	0.001
Race			< 0.001
White	81.5	76.0	
Black	6.8	10.0	
Hispanic	3.2	4.5	
Other/unknown	8.5	9.6	
Transfer status			< 0.001
Home	68.2	87.3	
Acute care facility	8.3	4.7	
Chronic care facility	22.2	7.2	
Other	1.3	0.7	
Functional status prior to surgery			< 0.001
Independent	42.2	71.7	
Partially dependent	35.3	18.8	
Totally dependent	22.5	9.6	

[1]Percentages have been rounded and may not add up to 100

The mean number of comorbidities for the study sample was 3.6. DNR patients had a mean of 4.3 comorbidities, while non-DNR patients had a mean of 3.1 comorbidities ($p<0.001$). As shown in Table 2, DNR patients were more likely to have most of the comorbidities that were analyzed including a recent history of CHF and MI; they also had higher rates of preoperative blood transfusion and sepsis (all $p\leq0.001$). There were no significant differences in rates of history of percutaneous coronary intervention and previous cardiac surgery based on the presence or absence of a preexisting DNR order.

Table 2. Comorbidities of DNR and non-DNR patients, ACS-NSQIP (2005-08)

CHARACTERISTIC (%)	**DNR** (n = 4,128)	**Non-DNR** (n = 4,128)	*p* value
General			
Diabetes	27.5	21.2	< 0.001
Hypertension	70.9	69.0	0.058
Current smoking	16.5	13.6	< 0.001
Alcohol use	4.5	2.5	< 0.001
Chronic steroid use	8.8	5.0	< 0.001
Cardiovascular			
Congestive heart failure	9.4	4.5	< 0.001
Myocardial infarction	4.5	2.4	< 0.001
Percutaneous coronary intervention	10.0	10.3	0.635
History of cardiac surgery	14.7	13.9	0.299
Angina	2.6	1.6	0.002
Peripheral vascular disease	14.1	12.8	0.087
Rest pain	12.7	11.4	0.063
Pulmonary			
Ventilator-dependent	4.8	3.5	0.002
Chronic obstructive pulmonary disease	17.0	9.5	< 0.001
Pneumonia	5.9	2.3	< 0.001
Dyspnea	24.9	18.1	< 0.001
Hepatobiliary			

Table 2 (cont'd). Comorbidities of DNR and non-DNR patients, ACS-NSQIP (2005-08)

CHARACTERISTIC (%)	**DNR**	**Non-DNR**	*p* value
Ascites	6.7	3.6	< 0.001
Esophageal varices	0.7	0.2	0.001
Renal			
Renal failure	3.8	1.7	< 0.001
Dialysis	7.8	4.8	< 0.001
Neurologic			
Impaired sensorium	9.5	3.9	< 0.001
Transient ischemic attack	9.2	7.2	0.001
Stroke with neurologic deficits	14.3	6.3	< 0.001
Stroke without neurologic deficits	6.5	5.7	0.108
Paralysis[1]	9.0	3.2	< 0.001
Nutritional/ Immune/ Other			
Disseminated cancer	8.1	3.6	< 0.001
Recent chemotherapy	3.3	1.4	< 0.001
Recent radiotherapy	1.5	0.8	0.008
Substantial weight loss	8.9	5.1	< 0.001
Bleeding disorder	21.1	14.9	< 0.001
Preoperative transfusion	2.4	0.9	< 0.001
Open wound	23.0	15.5	< 0.001
Preoperative sepsis	34.4	20.9	< 0.001

[1]: Paralysis includes quadriplegia, hemiplegia, paraplegia

As highlighted in Table 3, analysis of clinical and operative variables showed that DNR patients were more likely to have low hematocrit levels ($p<0.001$), abnormal white blood cell counts ($p< 0.001$), high serum creatinine ($p = 0.001$) and low serum albumin levels ($p<0.001$) than non-DNR patients. DNR patients were more likely to have a higher ASA class ($p < 0.001$). About 63% of DNR patients underwent non-emergent surgery, but as a group they were more likely to have an emergent procedure than non-DNR patients ($p<0.001$). DNR patients were more likely to receive an intraoperative blood transfusion than non-DNR patients (5.5% vs. 3.8%

received 1 unit of blood, and 10% vs.7.5% received >1 unit of blood, respectively). Intra-operative MI, unplanned intubation, and cardiac arrest requiring CPR were rare (0.7%), and occurrence of such intraoperative events in the groups was comparable (0.8% DNR and 0.6% non-DNR, p=0.43). DNR patients had higher rates of contaminated or dirty operative wounds (30.9% vs. 26.1%, p<0.001), and surgery without assistance of a surgical resident (45.3% vs. 37.0%, p<0.001).

Table 3. Clinical and operative characteristics of DNR and non-DNR patients

CHARACTERISTIC[1] (%)	**DNR** (n = 4,128)	**Non-DNR** (n = 4,128)	*p* value
Preoperative laboratory values			
Albumin (<3.5g/dl)	71.3	50.3	< 0.001
Creatinine (>1.2mg/dl)	33.4	30.0	0.001
Hematocrit (<30%)	23.6	15.9	<0.001
White blood cell count (cells/µL)			< 0.001
< 4000	5.1	4.8	
4000-11000	58.9	68.2	
>11000	36.0	27.0	
Operative			
Emergent surgery	34.6	24.1	< 0.001
ASA class			< 0.001
≤2	11.1	22.7	
3	48.7	55.8	
4	37.5	20.3	
5	2.7	1.2	
Intraoperative blood transfusion			< 0.001
None	84.4	88.8	
1 unit	5.5	3.8	
>1 unit	10.1	7.5	

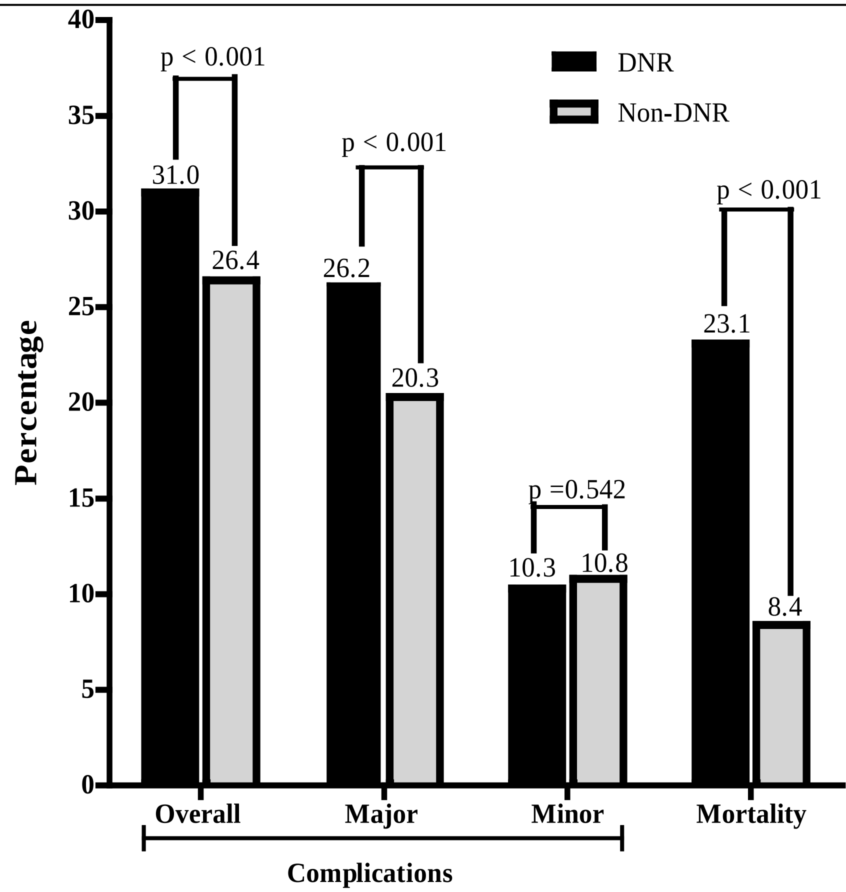
[1]: Percentages have been rounded and may not add up to 100
ASA: American Society of Anesthesiologists

Outcomes:

Unadjusted Outcomes

Unadjusted clinical outcomes are depicted in Figure 1. The overall complications rate was 28.6%. DNR patients were 17% more likely to sustain ≥1 complication than non-DNR patients (31% vs. 26.4%, p<0.001). There was no significant difference in the mean number of complications DNR patients sustained compared to non-DNR patients (1.9 vs. 2 complications, respectively; p = 0.70).

Figure 1. Unadjusted clinical outcomes of DNR vs. non-DNR patients, ACS-NSQIP (2005-08)



As shown in Table 4, DNR patients were more likely to experience prolonged ventilator use, septic complications and significant post-operative bleeding complications than non-DNR patients (p<0.05). There were no significant differences in rates of re-operation when DNR patients were compared to non-DNR patients (10.5% vs. 9.3%, p = 0.055).

Table 4. Rates of complications among DNR and non-DNR patients by system or type

COMPLICATION	**DNR** (n = 4,128)	**Non-DNR** (n = 4,128)	*p* value
Cardiac			
Cardiac arrest requiring CPR	1.2	1.5	0.337
Myocardial infarction	0.8	0.6	0.254
Pulmonary			
Failure to wean/ventilator > 48hrs	9.0	7.4	0.026
Re-intubation	3.6	4.4	0.121
Pneumonia	6.7	5.3	0.039
Urologic			
Renal insufficiency	1.3	0.9	0.138
Acute renal failure	2.0	1.4	0.034
Urinary tract infection	5.1	4.6	0.498
Central nervous system			
Stroke	0.9	1.0	0.495
Coma > 24hrs	1.0	0.4	0.002
Wound			
Surgical site infections[1]	6.1	7.9	0.002
Dehiscence	1.3	1.1	0.368
Septic	12.3	9.7	< 0.001
Other			
Bleeding requiring ≥ 5 units of blood	1.7	1.0	0.017
DVT/thrombophlebitis	2.3	2.2	0.186

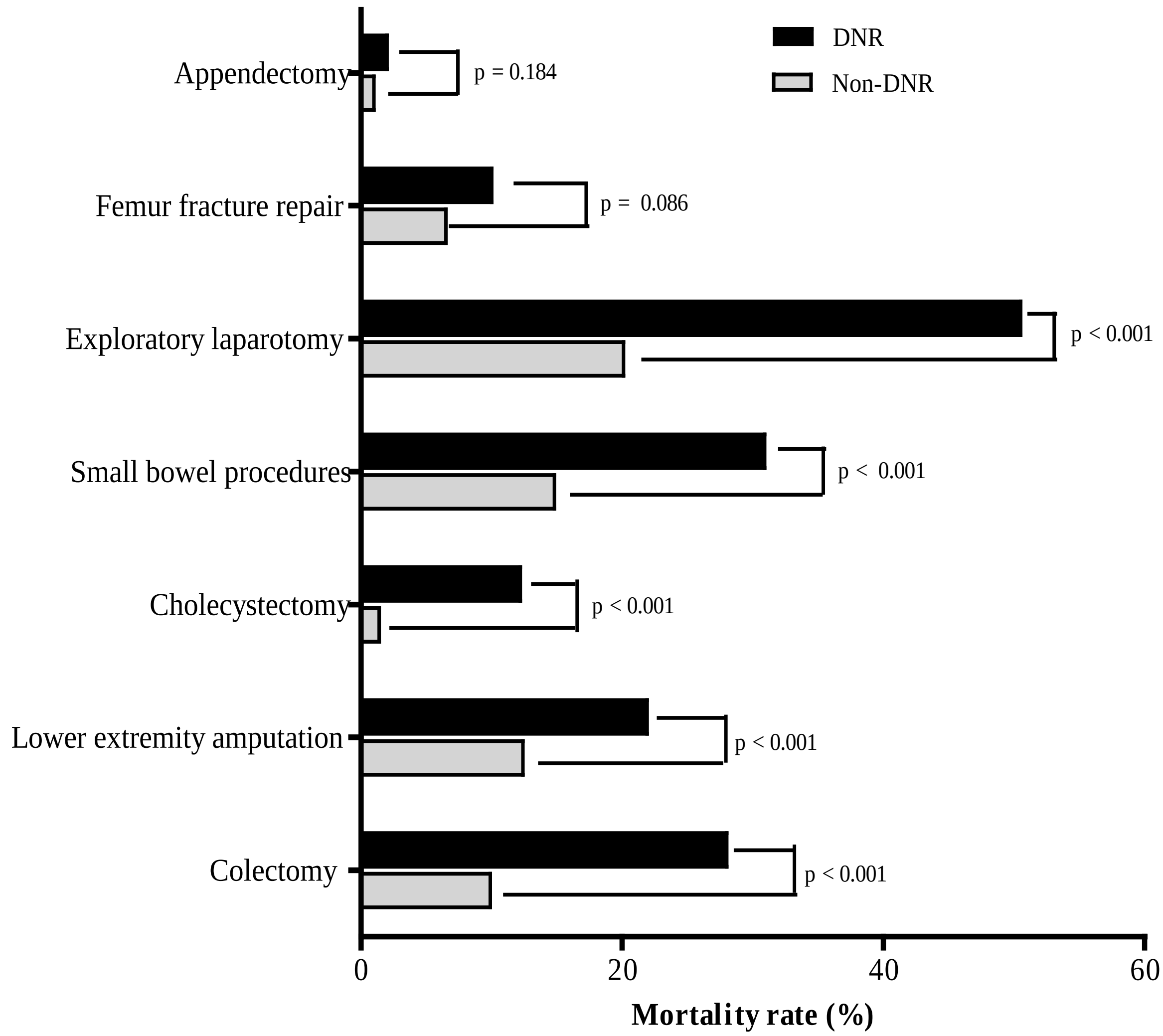
[1]: Surgical site infections include superficial, deep and organ space wound infections.
CPR: cardiopulmonary resuscitation; DVT: deep venous thrombosis

The overall mortality rate was 15.3%. Compared to non-DNR patients, more than twice as many DNR patients died ≤30 days of surgery (8.4% vs. 23.1%, p < 0.001). DNR patients were more likely to die than non-DNR patients regardless of the urgency of the surgical procedure (35.5% vs. 17.8% for emergent procedures; 16.6% vs. 5.5% for non-emergent procedures, p <0.001 for both). CPR was rare (1.7%), but more than 85% of DNR patients who received CPR intra- or postoperatively died ≤30 days of surgery. The incidence of CPR and the association between CPR and death (88% DNR vs. 83.3% non-DNR; p=0.489) were not significantly different when DNR patients were compared to non-DNR patients.

The most common surgical specialties involved in the care of DNR patients were general surgery (68.1%), followed by vascular surgery (25.1%), and orthopedics (4.1%). As shown in Figure 2, colectomy (16.8%), lower extremity amputation (11%), and cholecystectomy (9.1%) were the most common procedures performed in the study sample. Compared to non-DNR patients, DNR patients had higher mortality rates after every procedure analyzed. Mortality rates were highest after exploratory laparotomy for DNR and non-DNR patients (50.5% vs. 20.1%, respectively); however, only about 4% of the study sample underwent this procedure.

Analyses of operative and hospital stay measures showed that DNR patients were more likely to spend statistically longer total time in the operating room (157 vs. 151 minutes, p =0. 015) and have longer hospital LOS than non-DNR patients (14 vs.10 days, p <0.001). There was no difference in the proportion of patients who were still in-hospital 30 days after their surgery (3.8% DNR vs. 3.3% non-DNR, p = 0.213). Among patients discharged ≤ 30 days of surgery, DNR patients were more likely to be discharged on a later post-operative day than non-DNR patients (mean: 9.5 vs. 7.7 days, p < 0.001). Among patients who died ≤ 30 days of surgery, DNR patients died earlier than non-DNR patients (mean: 10.1 vs. 12.7 days, p = 0.006).

Figure 2. Unadjusted mortality rates of DNR vs. non-DNR patients by procedure

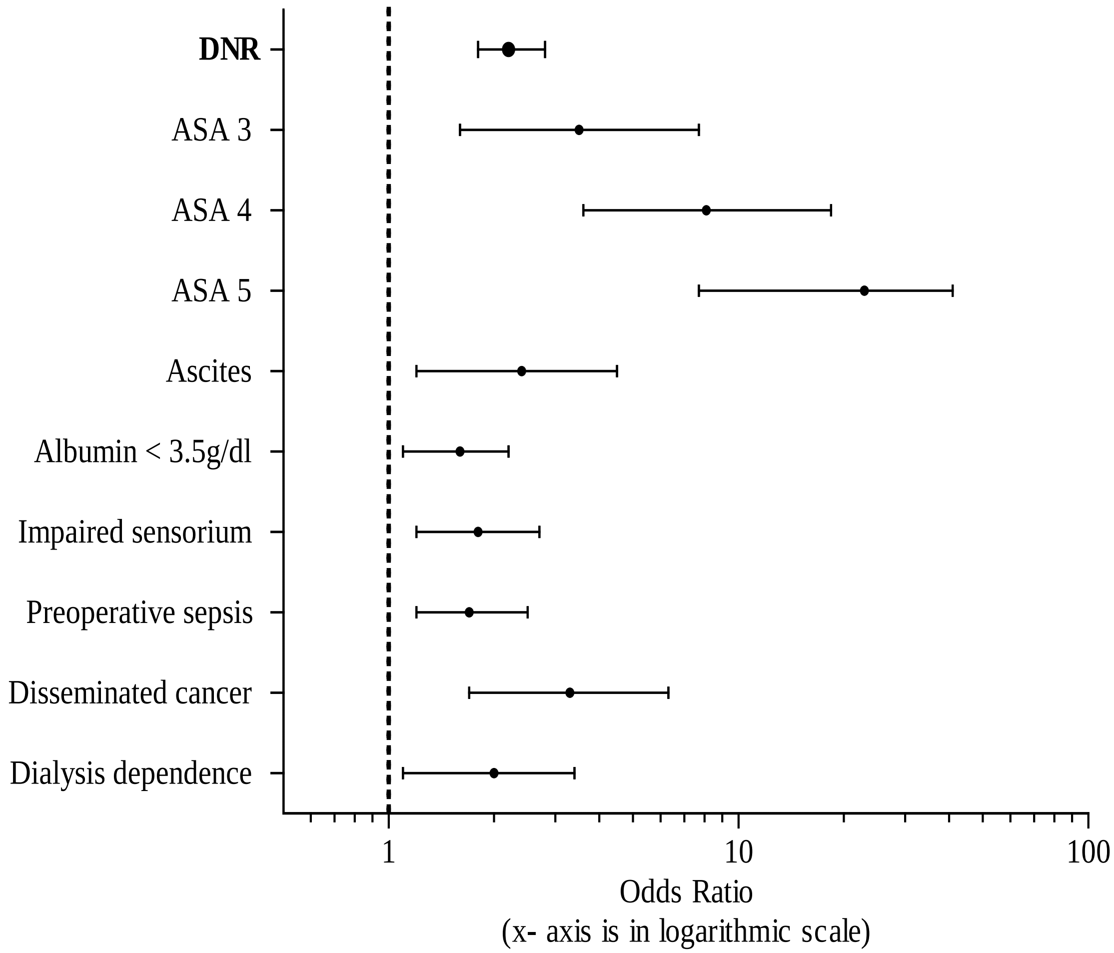


Procedures done in ≥2% of the study sample (shown in decreasing frequency from bottom to top of y-axis

Adjusted Outcomes

After adjusting for more than 40 risk factors in multivariate analyses, a DNR order remained an independent risk factor associated with death (adjusted odds ratio 2.2, 95% confidence interval [CI]:1.8-2.8, $p<0.001$)(Figure 3). Results of our second multivariate model in which propensity scores were included as a covariate were similar to the results found in the conditional logistic regression model; DNR orders remained independently associated with mortality (adjusted odds ratio 2.1, 95% CI: 1.6-6.6, p<0.001) after controlling for the propensity scores.

Figure 3. Multivariate analysis of factors independently associated with mortality among 8256 DNR and non-DNR patients, ACS-NSQIP (2005-08)



ASA class 3-5, disseminated cancer, preoperative sepsis, impaired sensorium, and low serum albumin were associated with death in DNR and non-DNR patients (Table 5). Although ASA class remained the strongest predictor of mortality in both groups, this risk factor was more strongly associated with mortality in DNR patients than in non-DNR patients.

Table 5. Independent[1] risk factors associated with mortality in DNR and non-DNR patients

	DNR		Non-DNR	
RISK FACTOR	OR	95% CI	OR	95% CI
ASA class				
3	3.8	1.9-7.6	3.4	1.6-7.1
4	6.8	3.4-13.7	7.2	3.4-15.3
5	18.5	8.1-42.5	11.6	4.2-32.2
Age (years)			Not an independent risk factor	
65 - 79	1.6	1.2-2.1	-	-
≥ 80	2.0	1.6-2.6	-	-
Disseminated cancer	2.1	1.6-2.9	3.1	1.9-5.0
Ventilator dependence	2.3	1.6-3.4	Not an independent risk factor	
Preoperative sepsis	1.8	1.5-2.2	2.2	1.6-3.0
Ascites	1.8	1.3-2.4	Not an independent risk factor	
Impaired sensorium	1.7	1.3-2.2	1.9	1.3-3.0
Albumin (< 3.5g/dl)	1.8	1.4-2.3	2.2	1.6-3.0
Creatinine (> 1.2mg/dl)	1.7	1.4-2.0	Not an independent risk factor	
Dialysis dependence	Not an independent risk factor		2.4	1.6-3.7
Emergent surgery	Not an independent risk factor		1.9	1.4-2.6

[1]: Separate multivariate regression models (with death as dependent variable) were created for DNR and non-DNR patients. Both models adjusted for > 40 risk factors.

OR: (adjusted) odds ratio; CI: Confidence Interval; ASA: American Society of Anesthesiologists

Referents: ASA class 1-2; Age < 65 yrs; Albumin > 3.5g/dl; Creatinine < 1.2mg/dl; “No/not present” for all other of risk factors.

DISCUSSION

We found that pre-existing DNR orders are relatively rare among surgical patients. The prevalence of DNR orders increased with age; almost half of the patients in the study were aged 80yrs or older. Consistent with our hypothesis, surgical patients with DNR orders were more likely to have multiple comorbid conditions; they also had higher rates of functional impairment than age- and procedure-matched non-DNR surgical patients. These findings conform to the observation that a DNR order is often a proxy for poor baseline health [2,4,5,30,31,45]. In addition, we found that almost one in four DNR patients who underwent surgery in the ACS-NSQIP dataset died within 30 days of surgery; the mortality rate of DNR patients was more than twice the mortality rate of age and procedure matched non-DNR patients. After adjusting for several demographic, clinical, and operative factors, we found that contrary to our hypothesis, a DNR order was independently associated with an increased risk of 30-day post-operative mortality.

The relatively high mortality rate of hospitalized DNR patients in this study echoes results of the few prior studies in the literature. Wenger et al [35] analyzed outcomes of 57 patients with DNR orders who underwent surgery; the authors found that 52% died within 30 days of surgery. The most common procedure in their cohort was tracheostomy, which suggests critical illness with possible prolonged ventilator dependence. This might explain the high mortality rate observed in that study. The authors did not evaluate whether a DNR order was independently associated with postoperative death.

In another study involving more than 12,000 Medicare patients, Wenger et al [30] compared the outcomes of DNR patients ≥ 65 years (n=1,468) vs. non-DNR patients admitted to a medical service for treatment of congestive heart failure, acute myocardial infarction, pneumonia, cerebrovascular accident, or hip fracture. The authors stratified DNR patients based on when the DNR order was written (early [written on day 1 or 2] or late [written on day 3 or later]). They found that sicker patients were assigned earlier DNR orders. After risk adjustment, the authors found that DNR patients were 2-4 times more likely to die than non-DNR patients; outcomes were relatively worse for patients whose DNR orders were written "late".

Similarly, using a cohort of over 13,000 consecutive stroke patients admitted to 30 hospitals between years 1991-1994, Shepardson and collegues [45] explored the relationship between DNR orders and in-hospital mortality. The authors found an increased risk of death for DNR patients (*n*= 2,898) compared to non-DNR patients. After adjusting for multiple risk factors using propensity scores, the odds ratio of mortality for DNR patients compared to non-DNR patients in their study ranged from 2.4-34, depending on when the DNR order was written during hospitalization. It is notable that both Wenger et al [30] and Shepardson et al [45] found an approximate 2-fold adjusted risk of death for DNR patients with pre-existing DNR orders or those whose orders were written around the 1^{st} day of hospitalization. This suggests that at baseline, hospitalized DNR patients have an increased risk of death compared to hospitalized non-DNR patients.

The finding that DNR status remained *independently* associated with mortality even after controlling for more than 40 risk factors in multivariate analyses, is the most striking result of this study. Why does the presence of a DNR order correlate with an increased mortality risk? Four possible explanations are worthy of consideration: The first is that a *DNR order causes death.* Due to the inherent limitations of retrospective studies such as ours [51,52], it must be emphasized that the independent association of DNR status with an increased risk of death found in our multivariate analysis, cannot imply causation. To prove a causal relationship between DNR orders and mortality, a randomized controlled trial in which suitably matched surgical patients who are arbitrarily assigned either a DNR order or a “no-DNR order”, and whose outcomes are prospectively followed, will need to be conducted [31,52]. Such a study will be ethically problematic.

The second logical explanation for the increased mortality risk associated with DNR orders is that *more patients with DNR orders died because CPR was not administered following cardiac arrest.* This line of reasoning is important given that DNR simply means “do not resuscitate in the event of cardiac arrest”. In this study, CPR incidence and outcome fall well short of explaining the mortality disparity between DNR and non-DNR patients. First, overall incidence of cardiac arrest requiring CPR for DNR patients in this study was very low and comparable to the incidence in non-DNR patients. Second, there was no significant difference in the mortality rate of DNR patients who received CPR compared to that of non-DNR patients who received CPR. Therefore, the outcome of CPR contributed only minimally to the mortality difference observed between DNR patients and non-DNR patients. It is noteworthy that some DNR patients received CPR in the course of their surgical care. CPR may have been performed in patients who rescinded their DNR order but were still coded as DNR in the NSQIP dataset. As has been mentioned earlier, honoring a DNR order in the perioperative period remains a matter of debate [1,33,38,40,41,53].

The third explanation for the independent association between DNR orders and mortality is that *overall, DNR patients are clinically more complex patients than non-DNR patients.* In other words, *a DNR order is a marker of clinical complexity that is not easily measurable*. A number of findings support this line of thought. These include the dramatic deterioration in the functional independence of DNR patients between illness and surgery, the finding that DNR patients were more likely to be admitted from another care facility, the higher mean number of comorbidities for DNR patients despite matching of patients, and the higher likelihood of DNR patients to experience major post-operative complications such as prolonged ventilator use or failure to wean off a ventilator. The fact that the mortality disparity between DNR patients and non-DNR patients transcended procedure type, and was considerable despite a significant overlap in the factors associated with mortality of DNR vs. non-DNR patients also buttresses this point.

Overall, the aforementioned results and observations point to a poor physiologic reserve or the frailty of DNR patients to withstand the rigors of surgical recuperation. Frailty is generally considered a state of increased vulnerability to health-related stressors [54]. The definition and application of the clinical syndrome of frailty as identified by assessment of a patient's gait speed, weight loss, grip strength, physical activity and exhaustion, continues to be subject of debate [55]. Although there are currently no standardized measures of clinical factors such as physiologic reserve or frailty [54-57], in congruence with other data [29,30,35,35,45], our results do suggest that a DNR order, being an easily assessable categorical variable, is a proxy for a set of unquantifiable or even unmeasurable vulnerability that compromises survival.

The fourth explanation for the mortality disparity between DNR and non-DNR patients is that *a DNR order negatively affects other treatment decisions*. Although DNR literally means do-not-resuscitate and not do-not-treat, the myriad treatment decisions that often surround a DNR order may lead to its exportation to other aspects of care. Conscious or subconscious extension of the preclusive meaning of a DNR order to other medical treatments or even nursing attention and care, may result in potentially inappropriate decisions to withhold or withdraw other life-sustaining treatments. Studies have found that this is sometimes the case [7,12,58-65].

Beach et al [58] examined the effect of DNR orders on the decisions of 241 physicians to provide life-prolonging treatments other than CPR for patients near the end of life. The authors found that the presence of a DNR order was negatively associated with physicians' intent to provide life-prolonging treatments unrelated to CPR. In a study of acute heart failure patients, Chen et al [59] showed that DNR patients were less likely to receive any quality assurance measures for acute heart failure, including assessment of left ventricular function, anticoagulation, and non-pharmacologic interventions. These findings parallel the results of the third phase of The Realistic Interpretation of Advanced Directives (TRIAD III) survey [63], which was an internet-based study of General Surgery, Family, Internal and Emergency Medicine attendings and residents regarding treatment decisions for patients with advance directives. The survey posed a fictitious living will with and without additional clarification of code status; the TRIAD III investigators found that adding "DNR" status to the clinical scenarios in the survey significantly increased respondents' rate of incorrectly withholding life-saving interventions by 40%.

DNR patients may also endorse a global reduction in the intensity of their care. In a study of DNR patients in a hospice setting, Hickman et al [62,66] found that up to 23% of DNR patients did not want antibiotic therapy, and up to 89% did not want interventions involving the use of feeding tubes or intravenous fluids. Using data captured in the Physician Orders for Life-Sustaining Treatment (POLST) registry for the state of Oregon, Fromme et al [61] recently examined the preferences for other treatments among persons with DNR orders compared to those without DNR orders. The authors found that compared to persons without DNR orders, those with DNR orders had higher rates of limiting the scope of treatment interventions including a higher likelihood to institute comfort care measures.

DNR patients in our study survived surgical operations i.e. almost all complications and mortality occurred postoperatively. Given the data highlighted so far [58,59,61,62,63], it remains a possibility that patient and provider factors contributed to our finding of increased risk of death soon after surgery among patients with a preoperative DNR order. It is possible, for instance, that higher rates of septic complications among DNR patients in our study are a reflection of poorer infection control measures on the part of caregivers or patient choice against antibiotic therapy (or both). Earlier deaths among DNR patients in this study may suggest rapid clinical deterioration, or indicate a conversion of DNR patients to comfort care measures (or both).

The discussion thus far leads to an important question: “Do DNR patients die because DNR orders increase their likelihood of death, or do they have DNR orders because they are more likely to die?[67]” The evidence-based response to this question is not straightforward. Existing data [19,58,62,68] suggest that a DNR order may have a patient- or physician-driven ripple effect on other aspects of care. Likewise, existing data [30,45], including ours, suggest that DNR status is indeed a good indicator of poor baseline health and overall prognosis.

Most DNR patients in our study underwent non-emergent procedures in spite of their baseline complexity of illness. Interestingly, the mortality difference between DNR and non-DNR patients was higher after non-emergent procedures than emergent procedures (3-fold vs. 2-fold respectively). The relatively high postoperative mortality among DNR patients following non-emergent surgery raises concerns about the appropriateness of some of these procedures. Assessment of the appropriateness of certain non-emergent procedures for the complex patients that DNR patients are requires insight into the surgical judgment that steered the decision in favor of surgery. Exercising sound surgical judgment is a life-long goal of surgeons for which data is sparse and objective assessment difficult. Characterized as the “knowledge, reasoning, conscience or disciplined courage” [69] to know and decide when not to operate [70], the surgical judgment to perform or not perform a non-emergent procedure on a very ill DNR patient demands careful evaluation and discussion with each patient.

Limitations:

The limitations of this study largely stem from the fact that the NSQIP Participant Use Data File is an administrative database: while there may be coding errors, NSQIP has been validated [71]. Nonetheless, notable limitations include:

1. Markers of severity of illness such as cancer stage or type, severity of postoperative complications, and the length of time DNR patients resided or where treated in other care facilities before transfer for surgery are not captured in the database.
2. Potentially relevant comorbidities common among elderly patients such as depression, dementia, malnutrition and Parkinson’s disease are not included; assessment of the ability to perform “Activities of Daily Living”, results of “Mini-Mental Examination”, “Mini-Cog” and timed “Up and Go” tests, all of which are relevant in the care of geriatric patients are not included in ACS-NSQIP.
3. Neither postoperative treatment details nor decisions are captured in NSQIP; also, information regarding legal oversight such as power of attorney and the impact of patient surrogate involvement on treatment decisions, which may be relevant to this study, is not included.

4. NSQIP does not specify whether non-emergent procedures captured in the database were elective or urgent. Thus, our finding of an increased risk of death among DNR patients who underwent non-emergent procedures may have been affected by the possibility that some of these procedures were urgent rather than entirely elective.
5. This study involves a subset of DNR patients who had a DNR order in the 30 days prior to surgery. The expected short-term survival of these patients is not provided in the database. Extrapolation of our results to gain insight into the outcomes of patients who assume DNR status post-operatively or those who survive beyond 30 days of surgery, may lead to flawed conclusions.
6. Information regarding hospital-level characteristics such as location (rural vs. urban), size (bed capacity), type (community vs. academic center; teaching vs. non-teaching setting), case mix and volume, and the availability of intensive care specialists and palliative care resources are not captured in ACS-NSQIP.
7. Analyses of cost of care were not performed because the database does not include any cost-related data.
8. Specific details about discharge destination of patients such as rehabilitation centers or nursing care homes are not captured in the database. Readmission data are also not included.
9. The retrospective, cross-sectional design of this study limits causal inferences.

The strengths of our study include the use of the largest sample size of surgical patients with DNR orders to date, the multi-institutional nature of the study, age- and procedure-matching, and multivariate adjustment using a large number of comorbidities captured in ACS-NSQIP; all of these attenuate biases related to patient and provider characteristics.

Implications and Recommendations:

DNR patients may have surgery to gain “additional time” [1], but our study indicates that many die shortly after surgery. In view of our results and the complex legal, ethical, and clinical aspects of having a DNR order, <u>we propose that issues pertaining to DNR status should be anticipated and discussed long before the 30-day period leading to an operation.</u>

Informed consent and elicitation of the goals of surgery, especially as they relate to overall goals of patient care, extent and quality of life, are essential for guiding surgical decisions involving DNR patients and their families. The delicate issue of eliciting informed consent is based on three general requirements: (1) the patient must be given information regarding the nature, alternatives, risks, and benefits of the procedure (2) the patient must be competent to process the information provided and understand the import of their decision; and (3) the patient must be free from coercion [72,73]. Fulfillment of the first requirement could be achieved optimally with objective data, which has been scarce until now. <u>With this study, we provide objective and robust data that could serve as a valuable counseling tool to guide those difficult discussions regarding the risks of surgery for DNR patients who often have severe illness.</u>

These data and results of several other published studies [4,6,30,22,28,29,31] strongly suggest that in addition to a tendency to symbolize being very ill and elderly, in current times, a DNR order is entangled with that sublime euphemism for the beginning of death commonly termed the “end-of life”. A DNR order appears to be an excellent marker for identifying patients at the very end of life, and studying such patients could provide an excellent opportunity to learn about the *quality* of end-of-life surgical care in the hospital [83]. A prospective study comparing the outcomes of clinically similar DNR patients who undergo surgery without rescinding their

DNR order versus those who rescind their DNR order could potentially shed light on how DNR status affects post-operative care. Additional research is certainly needed to (1) evaluate the impact of a preoperative DNR order on postoperative surgical care, (2) determine the long-term outcomes of DNR patients by procedure, and (3) explore the decision-making process surrounding a patient's consent to undergo a non-emergent procedure despite poor baseline health and a pre-existing DNR order.

Optimal patient-provider decision making regarding DNR status, advanced directives, and end-of life care requires skilled communication techniques. One study found that the attitudes, skills, and knowledge of house staff were key determinants of whether such advanced directive decisions were addressed [74]. A number of qualitative studies and literature reviews have indicated that the proficiency of resident physicians in the end-of-life decision-making domain is largely inadequate [74-77]. A study of ACGME Requirements for End-of-life Training in Selected Residency and Fellowship Programs found that surgical specialties had the fewest requirements for end of life care training; infact, most surgical specialties contained no end-of-life training requirement except ethics [78,79]. It appears that the identified deficiency in end-of-life training among surgical residents is being addressed, albeit gradually [79,80]. Considering that residents are the physicians who spend the most time with hospitalized patients and often initiate or assist with the DNR and end-of-life decision-making process[81,82], formal training of surgical residents (as well as other care-providing staff) on issues relating to advance directives and end-of life care remains critical to the delivery of appropriate care to surgical patients with DNR orders.

In response to our published data, one editorial began thus: "Some of the most unpleasant yet memorable conversations we have as surgeons include those conducted in the wee hours of the night with (DNR) patients facing terminal illness plus an acute surgical emergency. Often we experience the all-too-familiar ethical squeeze play-why am I the one to conduct this sad, wrenching conversation when *the patient has already chosen to let death take its course*?[84] *(emphasis with italics mine).*"The prevailing association of DNR status with severe or terminal illness makes the perception of the futility of otherwise indicated interventions for these patients an inherent danger. This danger is especially prominent among house staff physicians. In one survey of 233 physicians (of whom 155 were medicine and surgery residents), 43% of physicians indicated that they would withhold blood products, 32% would not give antibiotics and 21% would not give intravenous fluids to a patient with a DNR order [24]; some residents believe that diagnostic tests including fever work-ups should not be ordered when a patient has a DNR order [85]. Many residents misinterpret DNR status with futility [77]. Medical futility is a poorly understood concept [7,86] for which unilateral assumption could prove unwise [87]; studies are needed to discern the perspectives of surgical patients with DNR orders about their thoughts on what constitutes futility of care as well as their preferences for treatment modalities other than CPR.

Personalized, one-on-one discussion remains the best method to understand the treatment preferences of a surgical patient with a DNR order. Alas, surgical emergencies or urgencies do not represent an ideal time to initiate an extensive discussion on treatment preferences and goals of care. Nonetheless, utilization of the Physician Orders for Life-Sustaining Treatment (POLST) in the surgical world could improve awareness of the treatment preferences of surgical patients with DNR orders. This, especially given that the POLST forms can be filled out well before an intervention is needed, and data is accessible from any point of care by accessing the POLST central registry [61]. Completed by health professionals based on conversations with willing patients, POLST forms capture data for preferences regarding CPR, scope of treatment, artificial nutrition by tube, and in some states, antibiotic use[61]. POLST measures have been shown to be effective in influencing the care that patients receive[62,88] .

The demographic heterogeneity of surgical patients with DNR orders found in this study is worthy of note. Similar to findings of other studies [29,45,68], the majority of DNR patients in this study were elderly, female and white. Some questions arise: Are there demographic variations in patient-physician discussions regarding DNR orders and other issues relating to advanced directives? Are elderly, white women more willing to assume (or be ascribed) a DNR status? Are they more likely to undergo surgery while being DNR compared to non-elderly, non-white, male patients? It is unclear whether the observed demographic variations are a result of demographic disparities in the assumption of DNR status or with respect to undergoing surgery after assumption of DNR status. Moreover, we found that almost half of DNR patients underwent surgery without the assistance of a surgical resident, which was significantly higher than the rate among non-DNR patients. Although attendings in teaching hospitals may operate without resident involvement, a more likely explanation is that a significant proportion of DNR patients receive surgical care from non-teaching hospitals. Disparities in access to surgical care for DNR patients are possible. Investigation of potential disparities relating to demographic factors and access to surgical care for patients with DNR orders is beyond the reach of these data but merits exploration. This is important given that such factors appear to have an impact on outcomes of DNR patients [30,68] as found in this study.

In summary, we found that surgical patients with pre-existing DNR orders are often elderly comorbid patients who undergo a wide variety of surgical procedures, and have a 30-day mortality rate that is significantly higher than predicted by their demographic and clinical characteristics. In this aging population in which patients aged ≥65years comprise the majority of the surgical pool [54,89], in this era geared towards patient-centered care, in this period where injection of the term “death panel”[90] into the health care discourse sent shivers down the spine of reform, the need for better understanding of matters relating to the care of patients with DNR orders has never been greater.As physicians for whom a patient’s consent is sine qua non to the practice of their profession, as critical providers of decisive care and palliative therapy, there is a pressing need for surgeons to prioritize the study of issues relating to the surgical care of patients with DNR orders, so as to uphold their fiduciary obligation to provide care that is consistent with their patients’ preferences within the limits of their professional mandate.

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Appendix 1: Important events in the history of DNR orders in the United States

1960	Koewenhoven et al describe modern CPR
Late 1960's	Articles highlighting the ethical, clinical and legal concerns about the appropriateness of CPR
1970's	DNR status begins to be formalized; respect of patient autonomy begins to take center stage
1974	American Medical Association proposes the formal documentation of DNR orders in patient charts
1976	Introduction of hospital-level policies regarding decisions about resuscitation status, thus ushering an era of explicit DNR policies
1983	Report of the 1983 President's Commission, entitled "Deciding to forego life-sustaining treatment: Ethical, medical, and legal issues in treatment decisions" is published.
1988	The Joint Commission on Accreditation of Health Care Organizations (JCAHO) mandates that formal hospital-level policies regarding the writing of DNR orders will be required as part of the hospital accreditation process. New York becomes the first state to pass a statute governing DNR. Several states follow suit.
1991	Patient Self-Determination Act (PSDA) passed
Late 90's	By 1999, more than 40 states had enacted out-of-hospital DNR statutes or protocols

Appendix 2: Groupings of Current Procedural Terminology (CPT) codes for common[1] procedures done in DNR patients, ACS-NSQIP (2005-08)

Colectomy	44140,44141,44143,44144,44145,44146,44147,44150,44152,44155,44156, 44157, 44158, 44160, 44204, 44205, 44206, 44207, 44208, 44210, 44212,44213
Lower extremity amputation	27590, 27592, 27594, 27596, 27598, 27880, 27881, 27882, 27884, 27886, 27888, 27889
Cholecystectomy	47562,47563,47564,47600,47605,47610,47612,47620
Small Bowel procedures	44050,44010,4020,44021,44050,44055,44110,44120,44121,44125, 44130, 44602, 44603, 44604, 44605 ,44615, 44620, 44625, 44626, 44640, 44661, 44700, 44799, 44800, 44180, 44187, 44188, 44200, 44202
Exploratory laparotomy	49000
Femur fracture repair	27235,27236, 27244, 27245, 27248, 27506, 27507, 27509, 27511, 27513
Appendectomy	44950,44955,44960,44970

[1] Procedures done in >2% of study sample.