Preoperative Status and Risk of Complications in Patients with Hip Fracture

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BACKGROUND: Limited information is available on preoperative status and risks for complications for older patients having surgery for hip fracture. Our objective was to identify potentially modifiable clinical findings that should be considered in decisions about the timing of surgery.

METHODS: We conducted a prospective cohort study with data obtained from medical records and through structured interviews with patients. A total of 571 adults with hip fracture who were admitted to 4 metropolitan hospitals were included.

RESULTS: Multiple logistic regression was used to identify risk factors (including 11 categories of physical and laboratory findings, classified as mild and severe abnormalities) for in-hospital complications. The presence of more than 1 (odds ratiol [OR] 9.7, 95% confidence interval [CI] 2.8 to 33.0) major abnormality before surgery or the presence of major abnormalities on admission that were not corrected prior to surgery (OR 2.8, 95% CI 1.2 to 6.4) was independently associated with the development of postoperative complications. We also found that minor abnormalities, while warranting correction, did not increase risk (OR 0.70, 95% CI 0.28 to 1.73).

CONCLUSIONS: In this study of older adults undergoing urgent surgery, potentially reversible abnormalities in laboratory and physical examination occurred frequently and significantly increased the risk of postoperative complications. Major clinical abnormalities should be corrected prior to surgery, but patients with minor abnormalities may proceed to surgery with attention to these medical problems perioperatively.

KEY WORDS: preoperative assessment; complications; elderly; noncardiac surgery; hip fracture.
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Clinicians frequently evaluate the preoperative risk status of their patients facing possible surgery. Recent studies of preoperative risk have focused on cardiovascular risk stratification and on risk factors for selected complications.[1–6] However, little is known about the preoperative clinical and laboratory findings that increase the risk of urgent surgery and should be considered in decisions to delay surgery. This is particularly important for older patients with chronic conditions in that they are at a higher risk of surgical complications.[7]

Acute hip fracture is a frequent clinical scenario of an older patient being considered for urgent surgery. More than 350,000 persons 65 years and older are hospitalized for hip fractures annually. During recovery, patients risk a wide spectrum of complications, including cardiopulmonary events, thromboembolism, infections, bleeding, delirium, and decubiti.[8–11] Mortality in the Medicare population for those who sustain a hip fracture is estimated to be 13% at 3 months and 24% at 12 months.[12] For patients who survive to 6 months, only 60% recover their prefracture walking ability.[13] In this study: we (1) identify the types and frequency of complications in patients with hip fracture; (2) develop clinical measures that might be used to assess preparedness for surgery; and (3) evaluate whether some clinical variables increase the risk of complications.

METHODS

Trained clinical interviewers reviewed hospital admission logs to identify 804 admissions for hip fracture from 4 New York City metropolitan hospitals during the period from August 1997 to August 1998.[14] We excluded cases with (a) major concomitant trauma; (b) a fracture incurred while an inpatient; (c) a pathologic fracture resulting from malignancy; (d) a fracture limited to the pelvis, acetabulum, or distal femur; (e) bilateral hip fractures; (f) previous hip fracture or surgery on the affected hip; or (g) patient age under 50. Of those screened, 81% were eligible for inclusion. Informed consent was obtained from 88% of eligible patients. The study was approved by the institutional review board, and procedures were followed in accordance with institutional guidelines.

The clinical interviewers collected data at each of the 4 sites during the acute hospitalization. Baseline characteristics were obtained from structured interviews with the patient and/or proxy and supplemented by chart review. A 10% random sample of medical records was reviewed to verify agreement. The only disagreements identified were considered insignificant (e.g., normal temperature readings that differed because they were taken from 2 different sources). Daily visits were made to collect information on the hospital course, treatments received, and complications. We also collected information on fracture type, comorbidities, presence of delirium using the confusion assessment method,[15] and laboratory and physical examination findings on admission and prior to surgery. The aggregate impact of chronic conditions was measured using a modification of the RAND comorbidity score.[14,16] We also obtained the acute physiology and chronic health evaluation (APACHE II) score (without the Glasgow Coma Scale, which was not considered relevant for patients with hip fracture), which consists of a weighted summary of the patient's vital signs, laboratory studies, and mental status.[17]

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Functional status prior to fracture was measured using the motor subscales of the functional independence measure.[18] Its 13 motor items measure a patient's ability to perform activities in: (a) self-care; (b) sphincter control; (c) transfers; and (d) locomotion. The locomotion subscale rates the patient's independence in walking 150 ft and in going up and down 12 to 14 stairs.

To describe clinical variables that may increase the risk of complications, we reviewed the literature of preoperative risk indices and guidelines and identified 11 categories of physical and laboratory findings commonly used to determine risk of proceeding with surgery.[1–5,19–22] We tabulated the most commonly used criteria. For example, we presented the items and cutoff values (e.g., $pO_2 < 60$ mmHg) from the cardiac risk index.[5] Five physicians independently reviewed and classified findings as either minor or major abnormalities. A minor abnormality was an observation that would less likely require correction before surgery. A major abnormality was defined as one that would more likely require correction before surgery (Fig. 1). Differences among the reviewers were resolved by voting until a consensus was obtained. In some cases, the final criteria and cutoff values were similar to those that had been shown to confer risk in other studies (e.g., the presence of an S3 gallop, rhythm other than sinus, and the values for pO_2, potassium, bicarbonate, and blood urea nitrogen were similar to those in the cardiac risk index).[5] Because this study population (exclusively urgent surgery) differed from that of other studies, the frequency and severity of abnormalities were expected to be greater. Therefore, additional and more extreme cutoff values were used to identify more extreme abnormalities. For example, the cardiac risk index defined an abnormal potassium as less than 3.0 mEq/dL. This cutoff was retained for a minor abnormality, and an additional cutoff value of less than 2.5 mEq/dL was used to define a major abnormality. For each patient, we determined from the medical record whether any minor or major abnormality was present on initial evaluation (i.e., the first 24 hours) and also on the last evaluation performed before surgery.

Clinical abnormalities could theoretically increase the risk of complications by way of either their severity, additive effect, or change over time. Therefore, we derived 3 summary measures of these 11 categories of abnormalities. The "most severe abnormality" measure categorized each case based on the most extreme (minor or major) abnormality observed among the 11 categories at each time point (admission or before surgery). The "additive abnormality" measure categorized each case based on the number of minor and major abnormalities observed at each time point. The "change in abnormalities measure" was based on change, if any, in minor and major abnormalities on admission and before surgery.

Definition of Postoperative Complications

The clinical interviewers observed each patient daily and reviewed the medical record to identify perioperative complications. Complications that were identified were reviewed by 2

	Minor Abnormalities*	Major Abnormalities†
Blood pressure (BP)	Systolic BP ≥181; diastolic BP ≥111	Systolic BP ≤ 90
Rate and rhythm	Atrial fibrillation (AF) or supraventricular tachycardia (SVT) 101-120; sinus tachycardia ≥121; or heart rate (hr) 46-50 bpm	AF or SVT ≥121; Ventricular tachycardia (VT); 3rd degree heart block or hr ≤ 45 bpm
Infection/pneumonia	Temperature (T) ≥ 38.5 C; clinical diagnosis of pneumonia; or infiltrate on chest x-ray (CXR)	T <35 C; T ≥ 38.5 C with clinical diagnosis of pneumonia or infiltrate on CXR
Chest pain	Chest pain but normal electrocardiogram (EKG)	Any new myocardial infarction (MI) on EKG; or chest pain with abnormal EKG ‖
Congestive heart failure (CHF)	Dyspnea or pulmonary rales or S3 but a normal CXR; or CHF on CXR with a normal exam and no dyspnea	pulmonary edema on CXR; or CHF on CXR with dyspnea and/or abnormal exam
Respiratory failure	46 mmHg < pCO2 < 55 mmHg	Pulse oximetry < 90 %; pO2 < 60 mm Hg; or pCO2 ≥55 mm Hg
International normalized ratio (INR)	1.4-1.6	>1.6
Electrolytes	Sodium (Na) = 126-128 or 151-155 mEq/L; Potassium (K) = 2.5-2.9 or 5.6-6.0 mEq/L; or Bicarbonate (HCO3) = 18-19 or 35-36 mEq/L	Na ≤125 or >155 mEq/L; K <2.5 or >6.1 mEq/L; or HCO3 <18 or >36 mEq/L
Glucose	451-600 mg/dL	>600 mg/dL
BUN/creatinine	BUN 41-50 mg/dL; or Creatinine 2.1-2.5 mg/dL without h/o ESRD	BUN>50 mg/dL ; or Creatinine ≥ 2.6 mg/dL without h/o ESRD
Anemia	Hemoglobin (Hgb) 7.6-8 g/dL	Hgb ≤ 7.5 g/dL

* Minor = mildly abnormal but less likely to require correction prior to surgery
† Major = markedly abnormal and more likely to require correction prior to surgery
‖ Abnormal EKG defined as ST depressions or elevations

FIGURE 1 Minor and major clinical abnormalities in patients awaiting surgery.

physicians and categorized as described below; where there was disagreement, a third physician reviewed the complications and the majority decision was used. We included only complications that were deemed to pose a threat to life or bodily functions, and that were typically treated with parenteral medications, procedures, or intensive monitoring. Examples of complications include: (1) pneumonia if both respiratory symptoms and/or hypoxia were documented; and (2) arrhythmias if their occurrence increased the risk of ischemia or hemodynamic compromise (e.g., atrial fibrillation with rapid ventricular response). Postoperative complications were defined as complications that occurred during or after surgery but were not present prior to surgery. We grouped complications into the following categories: cardiac (including congestive heart failure [CHF], and arrhythmias), infectious (e.g., wound infections, urinary tract infections, and pneumonia), hemorrhagic (e.g., wound hematoma and gastrointestinal bleed), thromboembolic (e.g., deep venous thrombosis [DVT], pulmonary embolus), and miscellaneous (including urinary retention, renal failure, bowel obstruction, pressure ulcers, allergic reactions, fluid/electrolyte abnormalities, and other fractures). We focus largely on all-cause complications rather than specific types of complications because we found that elderly patients with hip fracture often experience complications from multiple causes (57% of patients experiencing a complication for any specific cause also experienced 1 or more other complications in our study).

Analysis

The bivariate association between preoperative patient characteristics and the presence of postoperative complications was examined by calculating odds for the occurrence of complications for patients with each individual characteristic relative to the odds of a complication for patients without the characteristic.

To examine the combined effect on complications of patient characteristics and clinical findings, significant variables with a bivariate association ($P<.15$) were considered in stepwise logistic regression with backward selection with a P-value cutoff of .20 for variable removal. Models were created for clinical abnormalities summarized using the 3 methods noted previously. For each model, we estimated the area under the receiver-operator characteristics curve.

RESULTS

We enrolled 571 patients with a mean age of 83 (range 52 to 105), 81% of whom were female. Approximately half (49%) had femoral neck fractures (vs intertrochanteric). Twelve percent of patients came from a nursing home. Dementia was present in 23% of patients, 14% had a history of chronic obstructive pulmonary disease (COPD), 16% a history of CHF, and 18% a history of diabetes mellitus. The 17 patients who did not have surgery (compared with those who had surgery) were more likely to have a history of CHF (35.3%, $P=.03$), and there was a trend (all NS) for them to be more likely male, younger, less dependent, and to have a history of dementia or chronic obstructive lung disease. We focus on the 554 patients who were treated with surgery.

Having a minor abnormality on admission (34.3%) was more common than having a major abnormality (22.6%). The most frequent minor abnormalities on admission were because of CHF (16.6%) and blood pressure abnormalities (17%). Most minor abnormalities were corrected before surgery. The most frequent major abnormalities on admission were because of respiratory failure (7.4%) and coagulopathy (6.5%). Reductions in the frequency of major abnormalities occurred before surgery, but 15% of patients underwent surgery with major abnormalities. Of the 50 people who had major abnormalities corrected prior to surgery, the most common corrections were: electrolyte and blood urea nitrogen (BUN) disturbances,[16] respiratory failure,[11] coagulopathy,[9] and heart failure.[8]

Postoperative Complications

There were a total of 73 complications, 61 of which were postoperative. The in-hospital mortality rate was 0.9%, and all of the patients who died also experienced complications. The most frequent type of postoperative complication was cardiopulmonary (5.8%), followed by thromboembolic (1.8%), infectious (1.6%), miscellaneous (1.2%), and hematologic (0.4%). Because the vast majority of complications were postoperative and cardiopulmonary, the remaining analyses focus on these complications. We did not model how clinical abnormalities affected the risk of mortality because of the small number of deaths.

The relationship between clinical characteristics and the risks of developing complications is presented in Table 1. The odds of developing any postoperative complication and a postoperative cardiopulmonary complication were significantly increased in patients with a history of COPD, a history of CHF, a RAND comorbidity score equal to or greater than 4, presence of delirium, and dependency in selected subscales.

Postoperative Complications and Clinical Abnormalities

Because of the low frequency of many of the individual minor and major abnormalities, estimates of their individual effects on complications had wide confidence intervals where they could be estimated. In general, the risk of postoperative complications was greater with major rather than minor abnormalities. Significant associations with complications were observed for major abnormalities related to chest pain, heart failure, respiratory failure, electrolyte, and BUN/creatinine abnormalities.

Using the most severe abnormality definition, the OR of having a complication was increased only when a major abnormality was present either on admission or prior to surgery (Table 1). Having only a minor abnormality was not associated with an increased risk of complications. Because having at most minor abnormalities did not increase the risk of complications, we evaluated the additive effect of abnormalities by comparing the effect on complications of the various major abnormality combinations compared with having no major abnormalities. Patients with any combination of major findings prior to surgery had an elevated risk of having a postoperative complication (Table 1), particularly if 2 or more major abnormalities were present.

In the case of change in abnormalities between admission and surgery (Table 1), having major abnormalities at both times increased the risk of complications, while complications

Table 1. Relationship of Baseline Patient Characteristics With the Number of Overall and Cardiopulmonary Complications

	Overall Frequency, % (overall *N*=554)	Unadjusted Odds for all Postoperative Complications, 95% CI (*n*=49)	Unadjusted Odds for Cardiopulmonary Complications, 95% CI (*n*=33)
Female	452 (81.6)	1.39 (0.61 to 3.19)	1.28 (0.48 to 3.40)
Age > 85	242 (43.7)	0.73 (0.40 to 1.34)	0.83 (0.40 to 1.70)
Femoral neck fracture	271 (48.9)	1.00 (0.56 to 1.80)	0.86 (0.43 to 1.75)
Dementia	139 (25.1)	0.85 (0.42 to 1.72)	0.95 (0.42 to 2.16)
History of chronic obstructive pulmonary disease	77 (13.9)	3.15* (1.62 to 6.12)	2.95‡ (1.34 to 6.46)
History of congestive heart failure	85 (15.3)	2.17‡ (1.10 to 4.29)	2.59‡ (1.18 to 5.65)
History of myocardial infarction	130 (23.5)	1.06 (0.54 to 2.11)	1.05 (0.46 to 2.38)
History of diabetes	101 (18.2)	1.17 (0.56 to 2.42)	1.22 (0.52 to 2.90)
RAND comorbidity score ≥ 4	231 (41.7)	2.39† (1.31 to 4.36)	2.59† (1.25 to 5.38)
APACHE ≥ 4	170 (30.7)	1.35 (0.73 to 2.49)	1.51 (0.73 to 3.11)
Nursing home residence prefracture	67 (12.1)	1.24 (0.53 to 2.88)	1.68 (0.67 to 4.22)
Preoperative delirium	44 (7.9)	3.02† (1.36 to 6.73)	4.31* (1.82 to 10.24)
Preoperative complications	6 (1.1)	5.33 (0.95 to 29.87)	8.34‡ (1.47 to 47.30)
Dependent§ in			
Locomotion (with stairs)	96 (17.3)	1.43 (0.70 to 2.91)	1.87 (0.84 to 4.16)
Locomotion (ambulation)	22 (4.0)	3.26‡ (1.15 to 9.26)	2.64 (0.74 to 9.43)
Transfers	53 (9.6)	2.36‡ (1.07 to 5.18)	2.78‡ (1.14 to 6.76)
Sphincter control	28 (5.1)	1.78 (0.59 to 5.36)	1.98 (0.57 to 6.95)
Self-care	28 (5.1)	1.78 (0.59 to 5.36)	1.23 (0.28 to 5.41)
Any motor task (total of above)	124 (22.4)	1.44 (0.75 to 2.77)	2.09‡ (1.00 to 4.37)
Most severe abnormality measure			
On admission			
None	239 (43.1)	Referent	
Minor	190 (34.3)	0.88 (0.41 to 1.89)	0.91 (0.36 to 2.31)
Major	125 (22.6)	2.49† (1.25 to 4.94)	2.62‡ (1.15 to 5.95)
Prior to surgery			
None	359 (64.8)	Referent	
Minor	112 (20.2)	0.93 (0.39 to 2.22)	1.07 (0.38 to 3.02)
Major	83 (15.0)	3.87* (1.99 to 7.53)	4.26* (1.94 to 9.35)
Additive abnormality measure			
On admission			
No major abnormalities	429 (77.4)	Referent	
One major abnormality and no minor abnormalities	45 (8.1)	2.12 (0.83 to 5.42)	2.11 (0.68 to 6.49)
One major abnormality plus minor abnormalities	53 (9.6)	2.01 (0.87 to 5.06)	1.76 (0.58 to 5.39)
> 1 major abnormality	27 (4.9)	4.83* (1.89 to 12.35)	6.17* (2.23 to 17.05)
Prior to surgery			
No major abnormalities	471 (85.0)	Referent	
One major abnormality and no minor abnormalities	49 (8.8)	2.77‡ (1.20 to 6.42)	2.56 (0.92 to 7.16)
One major abnormality plus minor abnormalities	21 (3.8)	3.34‡ (1.06 to 10.53)	3.76‡ (1.02 to 13.81)
> 1 major abnormality	13 (2.4)	12.16* (3.85 to 38.40)	14.09* (4.23 to 46.97)
Change in abnormalities			
No abnormalities on admission and prior to surgery	230 (41.5)	Referent	
Minor abnormalities on admission and/or prior to surgery but no major abnormalities	191 (34.5)	0.96 (0.44 to 2.11)	1.07 (0.41 to 2.84)
No or minor abnormalities on admission but major abnormalities prior to surgery	8 (1.4)	4.78 (0.89 to 25.73)	8.19‡ (1.45 to 46.33)
Major abnormalities on admission but no or minor abnormalities only prior to surgery	50 (9.0)	1.25 (0.40 to 3.93)	1.57 (0.41 to 6.01)
Major abnormalities on admission and major abnormalities prior to surgery	75 (13.5)	3.89* (1.82 to 8.32)	4.22† (1.68 to 10.63)

*P ≤ .001; †P ≤ .01; ‡P ≤ .05.

§*Dependent—performing less than 25% of any task on FIM scale or subscale.*

CI, confidence interval; FIM, functional independence measure; APACHE, Acute Physiology And Chronic Health Evaluation.

were not increased for those having major abnormalities on admission but either no or only minor abnormalities before surgery. For all 3 definitions, similar results were obtained when analyses were limited to cardiopulmonary complications.

Table 2 shows the results of logistic regressions focusing on abnormalities prior to surgery (for the most severe and additive definitions) and on change in abnormalities. For the most severe abnormality measure, having major abnormalities before surgery increased the risk of complications (and cardiopulmonary complications) even after adjustment for other clinical variables. For the additive abnormalities measure, adjustment for other clinical variables attenuated the association of abnormalities with complications; however, having more than 1 major abnormality before surgery increased the risk of both overall and cardiopulmonary complications. When change in abnormalities was examined, complications increased if major abnormalities were present both at admission and prior to surgery, and no increased risk was observed if major abnormalities on admission were corrected.

Table 2. Independent Effect of Clinical Abnormalities on Complications

	All Complications, 95% CI[§]	Cardiopulmonary Complications, 95% CI[‖]
Adjusted effect of most severe abnormality measure		
Adjusted odds for no abnormalities before surgery	Referent	Referent
Adjusted odds for minor abnormalities before surgery	0.70 (0.28 to 1.73)	0.80 (0.27 to 2.33)
Adjusted odds for major abnormalities before surgery	2.82[†] (1.38 to 5.79)	2.61[‡] (1.11 to 6.12)
Model *c*-statistic	0.7079	0.7326
Adjusted effect of additional abnormalities:		
Adjusted odds for no major abnormalities before surgery	Referent	Referent
Adjusted odds for 1 major abnormality and no minor abnormalities before surgery	2.50[‡] (1.04 to 6.00)	1.91 (0.65 to 5.60)
Adjusted odds for 1 major abnormality plus minor abnormalities before surgery	2.50 (0.75 to 8.32)	2.50 (0.63 to 9.91)
Adjusted odds for >1 major abnormality before surgery	9.66* (2.83 to 32.99)	8.14[†] (2.11 to 31.34)
Model *c*-statistic	0.7156	0.7314
Adjusted effect of changes in abnormalities between admission and time of surgery		
Adjusted odds for no abnormalities on admission and prior to surgery	Referent	Referent
Adjusted odds for minor abnormalities on admission and/or prior to surgery but no major abnormalities	0.86 (0.38 to 1.92)	0.89 (0.33 to 2.41)
Adjusted odds for no or minor abnormalities on admission but major abnormalities prior to surgery	3.28 (0.55 to 19.54)	6.09 (0.97 to 38.17)
Adjusted odds for major abnormalities on admission but none or minor abnormalities only prior to surgery	0.82 (0.24 to 2.74)	0.87 (0.21 to 3.60)
Adjusted odds for major abnormalities on admission and major abnormalities prior to surgery	2.79[‡] (1.22 to 6.37)	2.32 (0.85 to 6.34)
Model *c*-statistic	0.7185	0.7124

*P ≤ .001; †P ≤ .01; ‡P ≤ .05.
[§]*Model adjusted for COPD, CHF, delirium, and dependent in transfers. Locomotion and RAND not retained in model by stepwise procedure.*
[‖]*Model adjusted for COPD, delirium, and locomotion. RAND, dependent in transfers, and CHF not retained in model by stepwise procedure.*
CI, confidence interval; FIM, functional independence measure; APACHE, Acute Physiology And Chronic Health Evaluation.

Sensitivity Analyses

We tested the sensitivity of our results in 2 ways. First, to test our definitions of cutoff values for normal, minor, and major abnormalities, we examined all complications that had no or only minor abnormalities identified. Based on this review, we tested modifications of a number of definitions and cutoff values for abnormalities. Modifying the criteria did not substantially change the findings that we observed.

Second, to determine whether the risk of complications was attributable to any 1 of the individual clinical abnormalities, each of the 11 individual clinical abnormalities (e.g., abnormal blood pressure findings) was removed from the summary measures in serial analyses. The effect of clinical abnormalities on the risk of complications was not substantively altered when any 1 of the individual abnormalities was removed. The OR of a complication when only minor abnormalities were present before surgery (relative to no abnormalities, and 0.93 in the base case) ranged from 0.76 to 1.2 (all P=NS) in the 11 serial analyses. The OR of a complication when major abnormalities were present before surgery (relative to no abnormalities, and 3.87 in the base case) ranged from 3.02 to 4.62 (all $P<.005$) in the 11 serial analyses.

DISCUSSION

Hip fracture is a frequent and debilitating occurrence, with significant in-hospital complication rates most commonly caused by cardiovascular events. In this study of older adults with hip fracture, complications occurred in 7% of patients. Potentially reversible abnormalities in laboratory and physical examination occurred frequently on admission. Minor CHF and blood pressure abnormalities each occurred in more than 16% of patients, while major respiratory failure and coagulopathy occurred in 7.4% and 6.5% of patients, respectively. The presence of major abnormalities on admission and, in particular, prior to surgery, was significantly associated with the development of postoperative complications in both bivariate and multivariate analyses. Furthermore, correction of major findings at admission was not associated with an increased rate of postoperative complications. Having minor or no abnormalities prior to surgery was associated with a predicted probability of a postoperative complication of 7%, but those with major abnormalities prior to surgery had a 21% predicted probability.

The mortality and complication results in this cohort are generally consistent with what other investigators have found in studies of patients having surgery.[20,23–26] Although COPD has not been shown to be a significant variable in prior cardiac risk indices, it has been predictive of increased long-term mortality postoperatively.[27] An association between abnormal creatinine or pCO_2 and postoperative cardiac complications has been demonstrated previously.[5] Other studies that have examined the relationship between preoperative functional status and outcome have also found a relationship between severely limited activity and increased risk of mortality.[27,28]

Our study begins to fill a void in the literature on the clinical findings that should be considered in delaying surgery. In the setting of hip fracture, delay can prolong immobility and increase the risk of related complications (e.g., DVT, decubitis ulcer).[8,29,30] At the same time, operating too early on a patient with unstable medical problems is clearly undesirable. Indeed, we found that major findings increased the risk of complications and were more predictive of complications than the APACHE score, which provides a global indication of medical morbidity. By contrast, we also found that minor abnormali-

ties, while also warranting correction, do not increase complications.

Our findings are subject to a few limitations. These results are applicable only to patients with hip fracture who undergo surgery (97% of the cohort). Although we used 4 hospitals with a total sample size comparable with that in other studies of hip fracture that used primary data collection, our sample size still resulted in wide confidence intervals in certain cases. At this time, the results have also not been tested in a validation cohort. Further, the focus of this analysis was on inpatient complications as the outcome. While function and survival are the important long-term outcomes in patients with hip fracture, inpatient complications are common, proximate, and arguably more salient to clinicians at the time of preoperative assessment. Finally, although hip fracture is 1 of the most common reasons for urgent surgery in elderly patients, our findings may not generalize to older patients having urgent surgery for other reasons.

Elderly patients account for more than 20% of all surgical admissions in the U.S.[31] In persons aged 80 years or older, nearly half of these surgeries are emergent/urgent, which can carry up to a 20-fold increased risk of perioperative mortality relative to electively planned surgery.[32,33] The stabilization of medical problems and the timing of surgical interventions are critical issues in the management of these patients. Yet, the clinical evidence to inform these management decisions is quite limited. In this study, patients did proceed to surgery with minor and major abnormalities. We did not evaluate the specific reasons why surgery was not delayed, but several factors potentially contribute to the current practice of allowing patients to proceed to surgery with abnormalities: (1) prior lack of studies documenting poor outcome, (2) belief that postponement of surgery is more detrimental to patient outcome, (3) operating room availability, and (4) variation of practice patterns in the use of medical consultants.

In this study, we have identified some of the clinical findings that are associated with increased complications in a common reason for urgent surgery—hip fracture. Importantly, we show that clinicians should correct major abnormalities prior to allowing patients to proceed with surgery. Conversely, patients with minor abnormalities may proceed to surgery with attention to these medical conditions perioperatively. Clearly, additional research on this topic is needed in hip fracture and in other surgical conditions to assist the surgeon, medical consultant, and anesthesiologist in assessing the risk preceding urgent surgery, and in preventing and managing perioperative complications.

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Supplementary Material

The following supplementary material is available for this article online:

Appendix 1. Relationship of Clinical Findings with the Number of Overall and Cardiopulmonary Complications.