A Clinical Pathway to Improve Surgical Risk Assessment and Use of Perioperative β Blockade in Noncardiac Surgery Patients

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Abstract

• Objective: To assess the impact of a clinical pathway for operative risk assessment designed to increase the appropriate use of perioperative β blockers.
• Design: Retrospective cohort study.
• Patients and setting: Charts of patients who underwent outpatient perioperative risk assessment at a university primary care clinic 7 days or less before elective surgery were selected and reviewed. Data were obtained from 100 preintervention and 61 postintervention patients.
• Measures: Rates of documentation of surgical risk factors, documentation of risk for perioperative cardiac events, and appropriate use of perioperative β-blocker therapy.
• Results: The postintervention group had higher rates of documentation of surgical risk factors (79% versus 59%; \( P = 0.01 \)) and cardiac event risk factors (82% versus 36%; \( P < 0.001 \)) compared with the preintervention group. Among the 53 patients who met the pathway criteria for β-blocker therapy, those in the postintervention group were more likely to have β-blocker therapy initiated at the time of the risk-assessment visit (42% versus 0% preintervention; \( P < 0.001 \)) and to receive perioperative β-blocker therapy overall (73% versus 41% preintervention; \( P = 0.013 \)).
• Conclusion: This clinical pathway improves documentation of surgical risk and recognition of patient risk factors for perioperative cardiac events and increases appropriate use of perioperative β blockers in patients who undergo elective noncardiac surgery.

Myocardial ischemic events are important causes of morbidity and mortality in patients who undergo major noncardiac surgery. These events appear to be related to perioperative neurohormonal changes that increase myocardial oxygen consumption and coronary plaque rupture, which can lead to thrombus formation [1–4]. Antagonism of perioperative neurohormonal surges with β-adrenergic blocking agents (β blockers) has been shown to reduce perioperative cardiac complications in high-risk patients [5–7]. The American College of Cardiology/American Heart Association (ACC/AHA) guidelines for perioperative cardiovascular evaluation for noncardiac surgery recommend administration of β blockers for patients at risk for postoperative cardiac complications [8].

Despite this evidence, β blockers are administered in only 27% to 54% of eligible surgical patients, and only 9% of surveyed hospitals have a protocol to ensure that perioperative β blockers are used appropriately [9–11]. Surveys have indicated that controversy exists regarding patient selection, timing, duration, and efficacy of perioperative β-blocker therapy [9,10,12]. These uncertainties along with practical concerns, such as which physician will be responsible for the management of β-blocker therapy, contribute to the underutilization of β blockers [9]. Some authors have predicted that interventions to increase appropriate perioperative β-blocker use would reduce morbidity, mortality, and health care costs [10,13].

Clinical pathways are knowledge translation tools that help clinical decision makers translate research into practice [14]. Studies have demonstrated that pathways effectively increase utilization of evidence-based therapies for a variety of medical conditions [15,16]. Improved perioperative β-blocker utilization has been demonstrated in a cohort study that used a multidisciplinary hospital-based clinical pathway to identify high-risk surgical patients [17].

We developed a clinical pathway to improve physician recognition and documentation of surgical risk and to increase utilization of perioperative β blockers in patients undergoing noncardiac surgery. The pathway was based on criteria that had been shown to predict surgical and cardiac risk in randomized controlled trials and to identify patients...
eligible for β blockers [6,18]. The purpose of this study was to determine if this clinical pathway improves documentation of risk factors and increases the use of appropriate perioperative β-blocker therapy.

Methods

Clinical Pathway Development
The Southern Illinois University (SIU) Physicians and Surgeons Internal Medicine Clinic is a primary care clinic staffed by the 15-member Division of General Internal Medicine of SIU School of Medicine in Springfield, IL. This clinic is a training site for residents and medical students. We developed an operative risk assessment clinical pathway incorporating elements of the revised cardiac risk index [18] and predictors of cardiac risk from Mangano et al [6] to identify patients who may benefit from perioperative β-blocker therapy (Table 1). The pathway included an algorithm to determine if a patient is a β-blocker candidate (Figure). The pathway was intended to supplement the ACC/AHA guidelines. This clinical pathway was provided to the members of the division as an Adobe Acrobat PDF (Adobe Inc., San Jose, CA) file downloadable from the division Web site (Available at www.siumed.edu/medicine/DGIM/PreOperativeAssessment.pdf).

The clinical pathway was implemented on 1 July 2003. Use of the clinical pathway was voluntary. Alternative therapies with the potential to attenuate the cardiac risks of surgery (eg, α2 agonists) were not promoted by this pathway.

Study Population
To assess the impact of this clinical pathway, the outpatient records of patients who underwent outpatient risk assessment no more than 7 days prior to elective surgery (ICD-9 codes V72.81, V72.82, V72.83, and V72.84 for preoperative risk assessment) were randomly selected from the clinic administrative database and reviewed. Records from a 12-month preintervention period (1 January 2002 to 31 December 2002) and a 6-month postintervention period (1 July 2003 to 11 December 2003) were selected and reviewed. Patients undergoing cataract surgery were excluded, and charts from all providers in the division were reviewed for both phases of the study.

Outcome Measures
Primary measures were documentation of surgical risk factors, documentation of risk for perioperative cardiac events, and appropriate use of perioperative β-blocker therapy, including initiation of therapy and continuation or titration of current therapy. Complete documentation of surgical risk factors was defined as a notation in the medical record made during the preoperative examination documenting the presence or absence of each major and minor predictor of surgical risk (Table 1). Documentation of risk for perioperative cardiac events was defined as a notation in the medical record at the time of the preoperative examination classifying the patient as being at low or high risk for cardiac complications during surgery. Appropriate perioperative β-blocker therapy was defined as initiation or continuation of β blockers in β-blocker candidates. β-Blocker candidates were identified as

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**Table 1. Major and Minor Predictors of Surgical Risk**

<table>
<thead>
<tr>
<th>Major predictors [18]</th>
<th>Yes</th>
<th>Defer surgery. Treat or refer to cardiology for evaluation and/or treatment.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ischemic heart disease</td>
<td></td>
<td></td>
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<tr>
<td>Cerebrovascular disease</td>
<td></td>
<td></td>
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<tr>
<td>Diabetes requiring insulin therapy</td>
<td></td>
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<tr>
<td>Serum creatinine level ≥ 2 mg/dL (≥ 153 µmol/L)</td>
<td></td>
<td></td>
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<tr>
<td>Congestive heart failure</td>
<td></td>
<td></td>
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<tr>
<td>High-risk surgery*</td>
<td></td>
<td></td>
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<tr>
<td>Minor predictors [6]</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Age ≥ 65 years</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total cholesterol level ≥ 240 mg/dL (≥ 6.21 mmol/L)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Current smoker</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Diabetes not treated with insulin</td>
<td></td>
<td></td>
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<tr>
<td>Hypertension</td>
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</tbody>
</table>

*Surgeries defined as high risk in Table 3 of the American College of Cardiology/American Heart Association guidelines on perioperative cardiovascular evaluation for noncardiac surgery [8].

**Figure. Determination of β-blocker candidates.**

Does the patient have an unstable cardiac condition? Yes

Low-risk surgery? Yes

Proceed to surgery with no new β-blocker therapy

No

Poor functional status? Yes

Consider pharmacologic stress test

No

Any major predictor of cardiac risk? Yes

Initiate β blocker

No

Proceed to surgery with no new β-blocker therapy
patients who met the criteria in the Figure and had no documented contraindications to β-blocker therapy. Any major or minor predictors of surgical risk that were not clearly documented were assumed not to be present for the purpose of determining if a patient was a β-blocker candidate. New β-blocker therapy was defined as the initiation of β-blocker therapy at the time of operative risk assessment, and β-blocker dose titration was defined as a change in a preexisting β-blocker dose at the time of operative risk assessment.

**Analysis**

Differences in preintervention and postintervention patient characteristics were assessed using the chi-square test or Fisher’s exact test for categorical variables and the t test for numeric values. We judged that a 33% improvement in the study outcomes (eg, improved documentation or improved β-blocker use) would be relevant to clinical practice. Power calculations indicated that pre- and postintervention group sizes of 40 or more patients would have greater than 80% power to detect this degree of improvement in outcomes between the groups using a 2-sided chi-square test with a significance level of 0.05 or less. Based on this information, we selected a preintervention sample size of 100 to ensure adequate power to detect a significant difference in study outcomes between the 2 groups. All tests used to calculate P values were 2-sided; a P value of 0.05 or less was considered statistically significant.

**Data Gathering**

Data were extracted from existing medical records to a pilot-tested data-gathering sheet, entered into an Excel XP (Microsoft Corporation, Redmond, WA) form, and exported to SPSS version 11.5 (SPSS Inc, Chicago, IL) for analysis. Data extraction was done by members of the division of general internal medicine, and accurate data entry was confirmed by comparing numbered information on the data-gathering sheets with information in the database. The study protocol was approved by the local institutional review board.

**Results**

Data were obtained from 100 preintervention and 61 postintervention patients. The study population was 62% female and 83% white with a mean (SD) age of 63 (14) years (Table 2). The postintervention group contained a higher number of active smokers and patients with documented contraindications to β-blocker therapy. No other significant demographic differences were found between the groups.

At the time of risk assessment, 24% of patients were already on β-blocker therapy for another indication. The operative risk assessment form was used for 82% of the postintervention operative risk assessments. The rate of documentation of surgical risk factors increased from 59% during the preintervention period to 79% postintervention (P = 0.01) (Table 3). Similarly, the postintervention group had higher rates of documentation of operative risk (82% versus 36% preintervention; P < 0.001), initiation of β-blocker therapy at the time of the operative risk assessment (18% versus 1% preintervention; P < 0.001), and overall use of perioperative β-blocker therapy (43% versus 24% preintervention; P = 0.015). No patient in either group with a documented contraindication to β-blocker therapy was started on β-blockers.

A total of 53 patients were identified as β-blocker candidates (Table 4). Postintervention β-blocker candidates were
more likely to have β-blocker therapy initiated at the time of
the operative risk-assessment visit (42% versus 0% preinter-
vention; \( P < 0.001 \)) and had a higher overall rate of periop-
erative β-blocker therapy (73% versus 41% preintervention;
\( P = 0.013 \)).

Subgroup analysis indicated that smoking status, race,
gender, and age 65 years or older were not significantly asso-
ciated with frequency of preevaluation β-blocker therapy,
new β-blocker therapy, or β-blocker contraindications. White
race was associated with a lower rate of preoperative
β-blocker therapy (27% versus 52%; \( P = 0.01 \)) and a lower
rate of appropriate β-blocker therapy (17% versus 37%; \( P = 0.02 \)). Male patients met the β-blocker candidate criteria
can be more frequently (48% versus 29%; \( P = 0.017 \)). Additionally,
patients who were age 65 years or older (a minor risk factor)
were more likely to have β-blocker dose changes (6% versus
0%; \( P = 0.03 \)) and be candidates for β-blocker therapy (52%
versus 25%; \( P < 0.001 \)).

Discussion

In this study, implementation of an operative risk-
assessments clinical pathway in a primary care clinic im-
proved documentation of surgical risk and cardiac risk fac-
tors and increased appropriate utilization of perioperative
β blockers in patients undergoing elective noncardiac
surgery.

Several important study limitations must be noted. First,
this study was a retrospective, nonrandomized, single-
center cohort study that did not include adverse drug event
rates and surgical outcome data. Thus, it was not possible to
assess whether patients had achieved adequate β blockade
at the time of surgery or were compliant with the prescribed
β blocker. In addition, the postintervention group had high-
er proportions of patients who were active smokers (a minor
risk factor), were β-blocker candidates, and had document-
ed contraindications to β-blocker therapy. These differences
may be due to actual differences between the 2 groups or
may reflect the increase in complete surgical risk factor doc-
umentation after implementation of the clinical pathway.
The classification of patients as candidates for β-blocker ther-
apy would be sensitive to incomplete documentation be-
cause risk factors were assumed to be absent when undocu-
mented. This assumption may lead to underrecognition of
patients who could benefit from β-blocker therapy. A de-
crease of β-blocker candidates in a group due to incom-
plete documentation would improve the rate of approp-
riate β-blocker therapy in that group. Smoking status
did not appear to influence the rates of β-blocker therapy.

Implementation of a clinical pathway designed to in-
crease drug use is not without risk. β-Blocking agents can
cause adverse events such as bradycardia, bronchospasm,
and hypotension. A systematic review of perioperative
β-blocker trials indicated that bradycardia was the most
common adverse event and occurred in 24.5% of patients [5].
Although our study did not assess adverse event rates, no
patient with a documented contraindication to therapy was
started on a β blocker.

Implementation of this simple, low-cost clinical pathway
resulted in a significant increase in appropriate perioperative
β-blocker therapy (73% postintervention versus 41% prein-
tervention). Data from models estimating hospital costs for
β-blocker therapy before major surgery predict cost savings of
$500 to $658 per patient treated with a β blocker [10,13]. Using
these estimates, the initiation of β-blocker therapy in 11 of the
61 postintervention patients could result in $5500 to $7238 in
hospital cost savings. In addition to producing potential cost
savings, β-blocker therapy can reduce the rate of postoperative
cardiac ischemic events. A systematic review of perioperative
β-blocker therapy estimated that the number needed to treat

### Table 3. Changes in Documentation and Overall β-Blocker Utilization Rates

<table>
<thead>
<tr>
<th></th>
<th>Preintervention (n = 100)</th>
<th>Postintervention (n = 61)</th>
<th>( P ) Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Documentation of surgical risk factors</td>
<td>59 (59)</td>
<td>48 (79)</td>
<td>0.01</td>
</tr>
<tr>
<td>Documentation of risk factors for perioperative cardiac events</td>
<td>36 (36)</td>
<td>50 (82)</td>
<td>&lt; 0.001</td>
</tr>
<tr>
<td>New α-blocker therapy</td>
<td>1 (1)</td>
<td>11 (18)</td>
<td>&lt; 0.001</td>
</tr>
<tr>
<td>β-Blocker dose titration</td>
<td>2 (2)</td>
<td>2 (3)</td>
<td>0.63</td>
</tr>
<tr>
<td>Appropriate α-blocker therapy</td>
<td>13 (13)</td>
<td>19 (31)</td>
<td>0.005</td>
</tr>
<tr>
<td>Perioperative β-blocker therapy</td>
<td>24 (24)</td>
<td>26 (43)</td>
<td>0.015</td>
</tr>
</tbody>
</table>

### Table 4. Changes in β-Blocker Utilization Rates Among β-Blocker Candidates

<table>
<thead>
<tr>
<th></th>
<th>Preintervention (n = 32)</th>
<th>Postintervention (n = 21)</th>
<th>( P ) Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Preevaluation β-blocker therapy</td>
<td>13 (41)</td>
<td>8 (31)</td>
<td>0.437</td>
</tr>
<tr>
<td>New β-blocker therapy</td>
<td>0 (0)</td>
<td>11 (42)</td>
<td>&lt; 0.001</td>
</tr>
<tr>
<td>β-Blocker dose titration</td>
<td>0 (0)</td>
<td>2 (8)</td>
<td>0.197</td>
</tr>
<tr>
<td>Appropriate β-blocker therapy</td>
<td>13 (41)</td>
<td>19 (73)</td>
<td>0.013</td>
</tr>
</tbody>
</table>
with perioperative \( \beta \) blockers to prevent a cardiac ischemic episode is 8 [5]. Thus, the initiation of \( \beta \)-blocker therapy in 11 of the 61 postintervention patients had the potential to prevent 1 ischemic cardiac episode [5].

Studies with larger populations and surgical outcome data are needed to clarify the impact of this clinical pathway on surgical outcomes and health care costs. Larger studies should be coupled with interventions aimed at maximizing the rate of appropriate \( \beta \)-blocker therapy. Interventions that would improve pathway availability or make the pathway mandatory would increase the potential cost savings and further reduce surgical morbidity and mortality. Surgical outcome data also could permit clarification of the role of diabetes and insulin therapy as major or minor risk factors for cardiac events after elective surgery.

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