IMPORTANCE High-dose glucocorticoids (GCs) are routinely given to surgical patients with a history of GC exposure to prevent perioperative acute adrenal insufficiency, but this practice is not well supported.

OBJECTIVE To evaluate the variability of perioperative GC dosing among patients with inflammatory bowel disease (IBD) undergoing major abdominal surgery.

DESIGN, SETTING, AND PARTICIPANTS This was a retrospective study of 49 patients with IBD undergoing colorectal surgery at a single institution between July 2010 and August 2011. Data on patient comorbidities, intraoperative risk factors, surgical site infections, and 30-day readmission rates were prospectively collected from the National Surgical Quality Improvement Program. Preoperative GC exposure at the time of the index admission and perioperative GC therapy during admission were collected by review of the medical records. Patients were divided into 3 groups at the time of surgery: (1) 1 week or more of prior GC exposure, not receiving maintenance therapy (n = 15); (2) currently receiving budesonide (n = 10); and (3) currently receiving oral prednisone (n = 24).

MAIN OUTCOMES AND MEASURES Perioperative GC exposure was the main outcome. Qualitative comparisons of perioperative exposure stratified by preoperative GC exposure were done. A multivariate logistic regression analysis was performed to determine significant differences in surgical site infection and 30-day readmission rates among patients with and without perioperative GC exposure.

RESULTS Overall, 38 of 49 patients (78%) received perioperative GCs; intraoperative GCs were administered to 35 of 49 patients (71%), and 33 of 49 patients (67%) received postoperative GCs. Patients received intraoperative and postoperative GCs, respectively, as follows: 8 patients (53%) and 7 (47%) in group 1, 7 (70%) and 3 (30%) in group 2, and 20 (83%) and 23 (96%) in group 3. The median intraoperative GC dose was 100 mg (range, 50-267 mg of hydrocortisone or hydrocortisone equivalent for dexamethasone); the median total postoperative GC dose for the first 5 days after surgery was 485 mg (range, 50-890 mg of hydrocortisone or hydrocortisone equivalent for prednisone). The median duration of postoperative GC administration was 3 days for group 1, 6 days for group 2, and 7 days for group 3. No statistically significant difference in surgical site infection and 30-day readmission rates was detected in the GC exposure vs no-exposure groups.

CONCLUSIONS AND RELEVANCE Perioperative GC dosing among patients with IBD undergoing colorectal surgery is highly variable even within a single center. Additional studies are needed to define the risk of postoperative adrenal insufficiency and establish standardized practices for perioperative GC therapy, which may have the benefit of reducing GC overuse.
Syste
cmic glucocorticoids (GCs) are widely prescribed for chronic autoimmune and inflammatory conditions, such as rheumatoid arthritis, systemic lupus erythema
sus, asthma, myasthenia gravis, and inflammatory bowel disease (IBD). More than 25 million prescriptions were dispensed for prednisone, an oral GC, in the United States during 2010. Moreover, patients with chronic diseases such as IBD fre
quently undergo surgical procedures for disease control requiring cessation of oral GC therapy at the time of surgery. Be
cause of the concerns about adverse effects of GC withdrawal relating to hypothalamic-pituitary-adrenal axis suppression, these patients are often given high-dose perioperative GC re
placement therapy (stress-dose corticosteroids) to prevent sec
ondary adrenal insufficiency during the perioperative or im
mediate postoperative window. The potential danger of perioperative secondary adrenal insufficiency was first reported in the 1950s with 2 cases of postoperative mortal
ity from presumed adrenal crisis in GC-dependent surgical pa
tients in whom GCs were withheld at the time of the opera
tion. Subsequently, high-dose perioperative GC therapy ad
ministration has become a routine practice and is standard of care in many institutions.

Few cohort studies and randomized clinical trials have analyzed the need for supplemental high-dose perioperative GCs in surgical patients, mostly solid-organ transplant recipi
ents, maintained on their baseline immunosuppressive regi
men; these studies, along with a 2008 systematic review, have suggested that there is no difference in postoperative hemo
dynamics in patients continuing maintenance GC doses com
pared with those receiving additional high-dose GCs. Among patients with IBD undergoing major colorectal surgery, there is retrospective evidence suggesting that care of patients receiving GCs at the time of the operation can be managed safely with low-dose perioperative GCs and that care of pa
tients with a history of GC exposure alone within 1 year of sur
gery can be managed safely without perioperative GCs. Fur
thermore, several publications have suggested a variety of perioperative GC supplementation regimens in patients with different GC indications undergoing surgery. In many in
stances, a history of brief exposure to corticosteroids (ie, 1-2 weeks) was enough to prescribe perioperative high-dose GCs using arbitrary criteria lacking evidence-based studies sup
porting this practice. On the other hand, systemic GC use is a risk factor for hyperglycemia and poor wound healing, which may lead to significant complications and morbidity in the perioperative period. Therefore, standardization and guide
lines on the appropriate use of perioperative GCs may reduce surgical morbidity. Little is known about current perioperative GC prescribing practices outside of clinical studies. To ad
dress this knowledge gap, the aim of this study was to ana
lyze the variability in perioperative GC dosing practices at a single university hospital.

Methods

All patients undergoing elective colon or rectal resections at The Johns Hopkins Hospital between July 12, 2010, and Au
gust 30, 2011, with an underlying diagnosis of IBD (ulcerative colitis, International Classification of Diseases, Ninth Revision [ICD-9] codes 556.0, 556.1, 556.3, 556.6, 556.8, and 556.9; or Crohn disease, ICD-9 555.0, 555.1, 555.2, and 555.9) were identified in the American College of Surgeons’ National Surgical Quality Improvement Program–targeted procedure colon and rectal modules. Selected colorectal procedures included open and laparoscopic colectomies and proctectomies with inclusion of only major index operations (eg, ileostomy reversals after an index procedure were excluded). Patient comorbidities, intraoperative risk factors, 30-day readmissions, and surgical site infection (SSI) rates were abstracted from hospital electronic medical records and patient follow-up telephone calls by National Surgical Quality Improvement Program clini
cal reviewers.

Preoperative GC use and perioperative stress-dose GC ad
ministration were determined by independent medical record review (R.F.L., E.M.H.). Patients were included if they had been exposed to at least 1 week of oral and/or intravenous GCs for treatment of IBD within the year before surgery. None of the study patients had medical comorbidities requiring immu
nosuppressive medication. Patients were excluded if they had a preexisting infection at the time of surgical admission. Patients were stratified into 3 groups based on preoperative GC use on admission: (1) 1 week or more of prior GC exposure but not currently receiving therapy, (2) receiving oral budesonide therapy, and (3) receiving oral prednisone therapy. Budes
onide is a potent, topically acting GC with minimal untoward systemic adverse effects because of extensive liver metabo
lism compared with standard GCs, such as prednisone. Peri
operative GC exposure or therapy was defined as GCs admin
istered intraoperatively and/or postoperatively. Glucocorticoids given immediately preceding or during the operation were considered intraoperative, and GCs given after the operation were considered postoperative. A postoperative GC taper was defined as consecutively decreasing total daily GC doses until a baseline dose was achieved. The baseline GC dose was defined as the lowest total daily inpatient dose given before hos
dial discharge. Intraoperative GC prescribing habits were sur
geon and/or anesthesiologist dependent; any formal communication or interaction between surgery and anesthesi
ology teams before the index operation was unknown. Post
operative GCs were prescribed at the discretion of the pri
mary surgical team. All GC doses (except for budesonide) are expressed as milligrams of hydrocortisone or hydrocortisone equivalents (ie, prednisone 1 mg = hydrocortisone 4 mg). In addi
tion, the presence of postoperative hyperglycemia was as
sessed on the first 7 postoperative days and was defined as a fasting morning glucose level of 180 mg/dL or more (to con
vert to millimoles per liter, multiply by 0.0555). The Fisher ex
act test was performed to determine significant differences in SSI and 30-day readmission rates among patients with and without perioperative GC exposure. Subsequently, multivar
iate, stepwise logistic regression analyses were performed to determine significant differences in factors contributing to SSIs and 30-day readmissions, respectively. This study was ap
proved by the institutional review board of The Johns Hop
kins University Hospital.
Results

Preoperative GC Exposure and Perioperative GC Dosing Practices

We identified 50 patients with IBD who underwent colorectal resection performed by 4 surgeons (M.R.M., S.L.G., J.E.E., and E.C.W.) with 36 different attending physicians providing anesthesia. One patient died during admission from complications of septic shock and multiple organ system failure and was removed from our analysis. Among the 49 remaining patients, 55% were male (n = 27) and 53% (n = 26) had a diagnosis of Crohn disease (Table 1). The median age was 38 years (range, 18-68 years), with a median body mass index of 25.4 (range, 16.9-47.2 [calculated as weight in kilograms divided by height in meters squared]). Ninety-six percent of the operations (n = 47) were colectomies and 59% of the procedures (n = 29) were laparoscopic. The median length of the operation was 4.1 hours (range, 0.8-12.1 hours). Seventy-eight percent of the 49 patients (n = 38) received perioperative GCs during the index admission. Fifteen patients (31%) had received at least 1 week of GC therapy within 1 year before surgery but were not receiving maintenance therapy on admission (group 1). Ten patients (20%) were receiving budesonide at the time of the admission (group 2) and 24 (49%) were receiving prednisone at the time of admission (group 3) (Table 2).

Table 1. Characteristics and Outcomes for Patients With and Without Perioperative GC Therapy

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>No. (%): All Patients</th>
<th>No. (%): No Perioperative GC Therapy</th>
<th>No. (%): Perioperative GC Therapy</th>
<th>P Value*</th>
</tr>
</thead>
<tbody>
<tr>
<td>No. of patients</td>
<td>49 (100)</td>
<td>11 (22)</td>
<td>38 (78)</td>
<td></td>
</tr>
<tr>
<td>Age, median (range), y</td>
<td>38 (18-68)</td>
<td>42 (21-66)</td>
<td>37 (18-68)</td>
<td>.93</td>
</tr>
<tr>
<td>Male sex</td>
<td>27 (55)</td>
<td>6 (54)</td>
<td>21 (55)</td>
<td>.06</td>
</tr>
<tr>
<td>BMI, median (range)</td>
<td>25.4 (16.9-47.2)</td>
<td>25.4 (17.7-34.2)</td>
<td>25.4 (17.4-47.2)</td>
<td>.21</td>
</tr>
<tr>
<td>Preoperative albumin, median (range), g/dL</td>
<td>4.0 (1.8-4.8)</td>
<td>3.8 (3.0-4.5)</td>
<td>4.0 (1.8-4.8)</td>
<td>.78</td>
</tr>
<tr>
<td>Underlying diagnosis</td>
<td></td>
<td></td>
<td></td>
<td>.67</td>
</tr>
<tr>
<td>Crohn disease</td>
<td>26 (53)</td>
<td>9 (82)</td>
<td>17 (45)</td>
<td>.34</td>
</tr>
<tr>
<td>Ulcerative colitis</td>
<td>23 (47)</td>
<td>2 (18)</td>
<td>21 (55)</td>
<td></td>
</tr>
<tr>
<td>Surgical resection</td>
<td></td>
<td></td>
<td></td>
<td>.42</td>
</tr>
<tr>
<td>Colon</td>
<td>47 (96)</td>
<td>11 (100)</td>
<td>36 (95)</td>
<td>&gt;.99</td>
</tr>
<tr>
<td>Rectal</td>
<td>2 (4)</td>
<td>0</td>
<td>2 (5)</td>
<td></td>
</tr>
<tr>
<td>Surgical approach</td>
<td></td>
<td></td>
<td></td>
<td>.22</td>
</tr>
<tr>
<td>Laparoscopic</td>
<td>29 (59)</td>
<td>5 (46)</td>
<td>24 (63)</td>
<td>.62</td>
</tr>
<tr>
<td>Open</td>
<td>20 (41)</td>
<td>6 (54)</td>
<td>14 (37)</td>
<td></td>
</tr>
<tr>
<td>Length of operation, median (range), h</td>
<td>4.1 (0.8-12.1)</td>
<td>4.2 (2.5-5.1)</td>
<td>4.1 (0.8-12.1)</td>
<td>.20</td>
</tr>
<tr>
<td>ASA class</td>
<td></td>
<td></td>
<td></td>
<td>.41</td>
</tr>
<tr>
<td>I</td>
<td>2 (4)</td>
<td>0</td>
<td>2 (5)</td>
<td>.55</td>
</tr>
<tr>
<td>II</td>
<td>29 (59)</td>
<td>8 (73)</td>
<td>21 (55)</td>
<td></td>
</tr>
<tr>
<td>III</td>
<td>18 (37)</td>
<td>3 (27)</td>
<td>15 (40)</td>
<td></td>
</tr>
<tr>
<td>Wound classification</td>
<td></td>
<td></td>
<td></td>
<td>.51</td>
</tr>
<tr>
<td>Clean/contaminated</td>
<td>31 (63)</td>
<td>6 (54)</td>
<td>25 (66)</td>
<td>.48</td>
</tr>
<tr>
<td>Contaminated</td>
<td>12 (25)</td>
<td>4 (36)</td>
<td>8 (21)</td>
<td></td>
</tr>
<tr>
<td>Dirty</td>
<td>6 (12)</td>
<td>1 (9)</td>
<td>5 (13)</td>
<td></td>
</tr>
<tr>
<td>Surgical site infection</td>
<td>10 (20)</td>
<td>1 (9)</td>
<td>9 (24)</td>
<td>.42b</td>
</tr>
<tr>
<td>Superficial incisional</td>
<td>6 (12)</td>
<td>0</td>
<td>6 (16)</td>
<td>.32b</td>
</tr>
<tr>
<td>Deep incisional</td>
<td>1 (2)</td>
<td>0</td>
<td>1 (3)</td>
<td>&gt;.99b</td>
</tr>
<tr>
<td>Organ space</td>
<td>3 (6)</td>
<td>1 (9)</td>
<td>2 (5)</td>
<td>.54b</td>
</tr>
<tr>
<td>30-d Readmissions</td>
<td>8 (16)</td>
<td>1 (9)</td>
<td>7 (18)</td>
<td>.67b</td>
</tr>
</tbody>
</table>

Abbreviations: ASA, American Society of Anesthesiologists; BMI, body mass index (calculated as weight in kilograms divided by height in meters squared); GC, glucocorticoid. SI conversion factor: To convert albumin to grams per liter, multiply by 10. *Values determined using multivariate, stepwise logistic regression analysis. bValues determined using the Fisher exact test.

Table 2. Preoperative Glucocorticoid Use History at the Time of Index Admission

<table>
<thead>
<tr>
<th>Group</th>
<th>Patients, No. (%)</th>
<th>Medication History, Median (Range) [IQR]</th>
</tr>
</thead>
<tbody>
<tr>
<td>Group 1: ≥1 wk of prior GC therapy within past year (not currently receiving GC)</td>
<td>15 (31)</td>
<td>Duration of GC, 46 (4-365) [97] d</td>
</tr>
<tr>
<td>Group 2: oral budesonide therapy</td>
<td>10 (20)</td>
<td>Total daily dose, 9 (3-27) [0] mg</td>
</tr>
<tr>
<td>Group 3: oral prednisone therapy</td>
<td>24 (49)</td>
<td>Total daily dose, 45 (10-240) [51] mg a</td>
</tr>
</tbody>
</table>

Abbreviations: GC, glucocorticoid; IQR, interquartile range. aExpressed as hydrocortisone equivalent of prednisone (ie, prednisone 1 mg = hydrocortisone 4 mg).
Overall, intraoperative GCs were administered to 71% of the 49 patients (n = 35) and 67% of the patients (n = 33) received postoperative GCs (Table 3). Among the group 1 sample, 53% of the patients (n = 8) and 47% of the patients (n = 7) received intraoperative and postoperative GCs, respectively. In group 2, 70% of the patients (n = 7) were given GCs intraoperatively compared with 30% postoperatively (n = 3). Among group 3 patients, 83% of the individuals (n = 20) received intraoperative GCs and 96% of the patients (n = 23) received postoperative GCs. The median intraoperative GC doses were 75 mg (group 1), 100 mg (group 2), and 100 mg (group 3), with a range of 50 to 267 mg. The median total postoperative GC dose and median duration of postoperative GC therapy were as follows: 400 mg, 3 days (group 1); 650 mg, 6 days (group 2); and 685 mg, 7 days (group 3) (Table 3). The median total GC dose for the first 5 days after surgery was 485 mg (range, 50-890 mg) (data not shown).

There was significant variability in postoperative GC dosing practices, particularly in patients who were receiving prednisone at the time of admission (group 3), as demonstrated in the Figure. The median duration of a postoperative GC taper was 3 days but ranged from 2 to 10 days (interquartile range [IQR], 2 days), reflecting the length of hospital stay. During GC tapering, the median total daily dose per patient was 100 mg (range, 15-400 mg). Thirty-nine percent of the patients (13 of 33) were not given true tapering regimens because the total daily dose was either increased during the taper (8 patients in group 3 and 1 patient in group 1) or the baseline dosing period (3 patients in group 3 and 1 patient in group 2). The median duration of the inpatient baseline GC dose was 3 days (range, 1-18 days; IQR, 3 days) with a median total daily dose of 80 mg (range, 4-80 mg). Twenty-two of 33 patients (67%) who received postoperative GCs were discharged home receiving GCs at a median dose of 80 mg (range, 20-80 mg) (Table 4); 20 of these patients (91%) were receiving prednisone (group 3) at the time of surgery.

Perioperative GC Exposure and Postoperative Outcomes

Among the 35 patients who received intraoperative GCs, 30 individuals (86%) received postoperative tapers. Among the 5 patients (14%) who did not receive tapers, 1 patient was in group 1 (limited preoperative GC exposure) and 4 were in

Table 3. Perioperative GC Therapy During Index Admission

<table>
<thead>
<tr>
<th>Group, Perioperative GC Therapy</th>
<th>No. of Patients (%)</th>
<th>Total Hydrocortisone Dose (Range), mg*</th>
<th>Median (IQR)</th>
<th>Duration of Administration, d</th>
<th>LOS, d</th>
</tr>
</thead>
<tbody>
<tr>
<td>Group 1: ≥1 wk of prior GC therapy within past year (not currently receiving GC) (n = 15)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Intraoperative GC therapy</td>
<td>8 (53)</td>
<td>75 (50-100)</td>
<td>1</td>
<td>NA</td>
<td></td>
</tr>
<tr>
<td>Postoperative GC therapy</td>
<td>7 (47)</td>
<td>400 (50-590)</td>
<td>3 (5)</td>
<td>6 (2.5)</td>
<td></td>
</tr>
<tr>
<td>Group 2: oral budesonide therapy (n = 10)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Intraoperative GC therapy</td>
<td>7 (70)</td>
<td>100 (75-213)</td>
<td>1</td>
<td>NA</td>
<td></td>
</tr>
<tr>
<td>Postoperative GC therapy</td>
<td>3 (30)</td>
<td>650 (155-820)</td>
<td>6 (1)</td>
<td>7 (2)</td>
<td></td>
</tr>
<tr>
<td>Group 3: oral prednisone therapy (n = 24)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Intraoperative GC therapy</td>
<td>20 (83)</td>
<td>100 (50-267)</td>
<td>1</td>
<td>NA</td>
<td></td>
</tr>
<tr>
<td>Postoperative GC therapy</td>
<td>23 (96)</td>
<td>685 (100-1490)</td>
<td>7 (3.5)</td>
<td>8 (7.25)</td>
<td></td>
</tr>
</tbody>
</table>

Abbreviations: GC, glucocorticoid; IQR, interquartile range; LOS, length of stay; NA, not applicable.

* Includes hydrocortisone doses and dose equivalents of hydrocortisone (ie, prednisone 1 mg = hydrocortisone 4 mg).

Figure. Variability in Postoperative Glucocorticoid (GC) Dosing Practices

A, A GC taper of 3 days or less (n = 17). B, A GC taper longer than 3 days (n = 14). Patient number indicators correspond to the patients listed in Table 4. Patients No. 2 and 32 were removed because they did not receive a taper. X indicates the baseline GC dose.
There was rarely any medical record documentation of perioperative GC administration; thus, it is uncertain why patients did not receive tapers after having received intraoperative GCs. In addition, there was no indication of clinical concerns for symptoms of secondary adrenal insufficiency or mention of hemodynamic instability requiring fluid resuscitation and/or vasopressor support among these 5 patients.

Eleven of the 49 patients (22%) with IBD were not exposed to perioperative GC therapy during the index admission. Of these 11 patients, 3 individuals (27%) were receiving budesonide, 1 patient (9%) was receiving prednisone, and 7 patients were unexposed to perioperative GC therapy during the index admission.

### Table 4. Postoperative GC Dosing Variability Among All Surgical Patients

<table>
<thead>
<tr>
<th>Patient No.</th>
<th>Age, y</th>
<th>Total Daily GC Dose on Admission, mg</th>
<th>LOS, d</th>
<th>Duration of Taper, d</th>
<th>Total Daily GC Dose During Taper, Median (Range), mg</th>
<th>Duration of Baseline GC Dose, d</th>
<th>Discharged With GC, Yes/No</th>
<th>Total Daily GC Dose on Discharge, mg</th>
</tr>
</thead>
<tbody>
<tr>
<td>Group 1a</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>27</td>
<td>18</td>
<td>0</td>
<td>6</td>
<td>3</td>
<td>150 (350-90)</td>
<td>0</td>
<td>NA</td>
<td>40</td>
</tr>
<tr>
<td>28</td>
<td>25</td>
<td>0</td>
<td>15</td>
<td>7</td>
<td>25 (200-25)</td>
<td>0</td>
<td>NA</td>
<td>NA</td>
</tr>
<tr>
<td>29</td>
<td>26</td>
<td>0</td>
<td>6</td>
<td>1</td>
<td>50</td>
<td>0</td>
<td>NA</td>
<td>NA</td>
</tr>
<tr>
<td>30</td>
<td>32</td>
<td>0</td>
<td>7</td>
<td>1</td>
<td>75</td>
<td>0</td>
<td>NA</td>
<td>NA</td>
</tr>
<tr>
<td>31</td>
<td>35</td>
<td>0</td>
<td>4</td>
<td>3</td>
<td>150 (200-50)</td>
<td>0</td>
<td>NA</td>
<td>NA</td>
</tr>
<tr>
<td>32</td>
<td>42</td>
<td>0</td>
<td>14</td>
<td>0</td>
<td>NA</td>
<td>12</td>
<td>20</td>
<td>Yes</td>
</tr>
<tr>
<td>33</td>
<td>56</td>
<td>0</td>
<td>7</td>
<td>5</td>
<td>50 (300-25)</td>
<td>2</td>
<td>4</td>
<td>No</td>
</tr>
<tr>
<td>Median values</td>
<td>35</td>
<td>40a</td>
<td>8</td>
<td>3</td>
<td>100</td>
<td>3</td>
<td>80</td>
<td>NA</td>
</tr>
</tbody>
</table>

Abbreviations: GC, glucocorticoid; LOS, length of stay; NA, not applicable.

a All GC doses are expressed in milligrams of hydrocortisone or hydrocortisone equivalents (ie, prednisone 1 mg = hydrocortisone 4 mg) except the total daily GC dose on admission for group 2 patients who were receiving oral budesonide at the time of surgery.

b Range is provided from the largest postoperative GC dose to the lowest postoperative GC dose during the taper.

c Group 3 includes patients receiving oral prednisone at the time of surgery.

d Group 2 includes patients receiving oral budesonide at the time of surgery.

e Group 1 includes patients with prior GC exposure but not receiving GCs at the time of surgery.

f Median dose on admission reflects only patients receiving prednisone on admission (group 3).
patients (64%) had a history of prior GC exposure alone at the time of the operation. None of these patients had documentation of postoperative hemodynamic instability requiring fluid resuscitation and/or vasopressor support. Nine of 38 patients (24%) who received perioperative GCs developed postoperative SSIs; 6 of these patients (67%) were in group 3 (receiving prednisone at the time of the operation) with 3 superficial SSIs, 1 deep incisional SSI, and 2 organ space SSIs, and 3 patients (33%) were in group 1 (limited preoperative GC exposure) with 3 superficial SSIs (data not shown). In contrast, only 1 of 11 patients (9%) who did not receive perioperative GC developed an organ space SSI (P = .054). Overall, 3 of 49 patients (6%) had at least 1 laboratory value consistent with hyperglycemia; all of these patients were in group 3 (receiving prednisone at the time of the operation) and received perioperative GCs. One patient with hyperglycemia (33%) developed postoperative pneumonia and 1 patient (33%) had a postoperative organ space SSI. Eight of 49 patients (16%) were readmitted within 30 days. Of 38 patients administered perioperative GCs, 7 individuals (18%) were readmitted compared with 1 of 11 patients (9%) without perioperative GC exposure (P = .07) (Table 1).

Discussion

Our study confirms that the decision to administer stress-dose GCs to patients with IBD undergoing major abdominal surgery is common. However, we noted highly variable intraoperative and postoperative GC dosing practices. Two patients (6%) with a history of budesonide exposure (group 1) and 4 (11%) receiving prednisone (group 3) received intraoperative hydrocortisone doses of 200 mg or more, well beyond the recommendations suggested by Lewis and colleagues.3 The remaining 29 patients (83%) who received intraoperative GCs were administered doses of 107 mg or less. Among all patients, the total daily dose of GCs during the postoperative taper ranged from 15 mg to 400 mg, and the total postoperative dose ranged from 50 mg to 1490 mg. Nearly 40% (n = 13) of the patients did not receive true postoperative GC tapers. In addition, 5 patients (15%) (group 1, 1 patient; group 2, 1 patient; and group 3, 3 patients) did not receive any GC during a 24- to 48-hour period during their taper for unknown reasons. Five (33%) additional patients either missed a dose or received an extra dose of a GC because of errors such as multiple orders timed closely together or inappropriate timing of order entry (data not shown).

Overall, 38 of 49 patients (78%) received perioperative GCs irrespective of the type of preoperative GC exposure (budesonide vs systemic) as well as the total daily GC dose and duration of use. There were several patients identified in our study cohort who received perioperative GCs who likely did not need them. Nine patients who were either exposed to budesonide in the year before surgery (2 [22%], group 1) or receiving budesonide on admission (7 [78%], group 2) received intraoperative GCs; 4 of these 9 patients (44%) were also given postoperative GCs. Ten study patients (20%) were receiving oral extended-release budesonide preoperatively. Oral budesonide is a topicaly acting GC with low systemic bioavailabil-


ty (9%-21%) because of extensive biotransformation in the liver.24 A randomized, double-blind crossover study25 in healthy young adults demonstrated that 5 days of oral budesonide therapy (dosing ranged from 3 to 15 mg/d) resulted in statistically significantly less plasma cortisol suppression compared with prednisolone (20 mg/d). Moreover, budesonide has demonstrated26 fewer GC-related adverse effects compared with systemic GCs, such as prednisolone. In addition to those 9 patients, 7 who were either exposed to prednisone in the year before surgery (n = 1, group 1) or receiving prednisone at the time of admission (n = 6, group 3) were receiving total daily doses of 5 mg or less. Daily doses of 5 mg or less of prednisone for any duration are unlikely to markedly suppress the hypothalamic-pituitary-adrenal axis.24 Using these criteria within our surgical cohort, we conservatively identified 16 of 49 patients (33%) who may not have required perioperative GC therapy based on their GC dosing preoperatively. Arguably, patients with remote exposure to systemic GCs within 1 year of surgery (ie, 1 week of prednisone alone 11 months before surgery) are also unlikely to need high-dose supplemental perioperative GCs. Given that all operations in our surgical cohort were elective, these patients may have benefited from preoperative assessment of adrenocortical function to determine the clinical necessity for perioperative GC supplementation, including a morning serum cortisol level and/or a cosyntropin (corticotropic) stimulation test. A random morning cortisol level is a good first-line test for assessing adrenal insufficiency in otherwise healthy adults with GC exposure. Serum cortisol levels less than 3 μg/dL (to convert to nanomoles per liter, multiply by 27.588) indicate abnormal adrenal function, whereas levels greater than 18 μg/dL rule out adrenal insufficiency.25 Patients with intermediate serum cortisol concentrations (≥3 μg/dL and ≤18 μg/dL) require further dynamic testing of adrenal function, such as the conventional or low-dose corticotropic test or the insulin tolerance test when not contraindicated.

The marked variability of perioperative GC prescribing within our institution has led to the development of an initiative aimed to standardize perioperative GC prescribing habits among our multidisciplinary IBD team and facilitate improved communication between the surgery and anesthesiology teams. A postoperative colorectal surgery GC taper order set was implemented in July 2011, which rapidly tapers GC dosing in patients from the stress dose to their baseline dose during a 30-day period. The taper is intended for patients who have received intraoperative GCs and are clinically stable with no signs of adrenal insufficiency. On days 0 to 1 of the taper, hydrocortisone, 50 mg, is administered intravenously every 8 hours for 3 doses (first dose 8 hours after intraoperative dose); days 1 to 2: hydrocortisone, 25 mg, intravenously every 8 hours for 3 doses; days 2 to 3: hydrocortisone, 25 mg, intravenously every 12 hours for 2 doses; the baseline dose is then initiated. Select patients who are considered at low risk for secondary adrenal insufficiency have preoperative serum cortisol levels determined on the morning of surgery; this includes patients who receive oral budesonide or have a history of GC exposure within 12 months of surgery but who are not receiving GC therapy at the time of admission. Ultimately, patients with nor-
Perioperative Glucocorticoid Prescribing Habits

Statistical analysis: because of the unreliability of postdischarge medication rec
set. Furthermore, only in-hospital tapers were evaluated
higher postoperative morbidity among the GC-exposed sub-
cally significant difference in patient outcomes with and with-
out perioperative GC exposure; however, our data suggest
higher postoperative morbidity among the GC-exposed sub-
set. Furthermore, only in-hospital tapers were evaluated
because of the unreliability of postdischarge medication rec

Conclusions

Administration of high-dose perioperative GC therapy is a
common practice among patients with IBD undergoing
major abdominal surgery at a single academic center, but
physician prescribing habits are highly variable. Many of
the patients who received perioperative stress-dose GCs had a
very low clinical risk for postoperative adrenal crisis. These
patients may have avoided unnecessary exposure to GCs
with a standardized approach to perioperative GC prescribing
and/or preoperative assessment of adrenocortical func-
tion. Many patients in our study likely had unnecessary peri-
operative GC exposure; prospective studies are needed to
assess the role of perioperative GC dosing in patients with
IBD undergoing major colorectal surgery. Furthermore, addi-
tional research is required to determine whether standard-
ized perioperative practices, including a preoperative serum
cortisol measurement and postoperative GC order set, will
result in decreased GC exposure.

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**Time to Put Another Surgical Dogma to Sleep?**

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**Good outcomes after surgery** require scrupulous attention to detail: careful patient selection, thorough preoperative evaluation, meticulous surgery and intraoperative anesthesia management, and comprehensive postoperative care. However, numerous perioperative practices based on few or no data—surgical dogma—may do little to help and may even harm patients. For example, routine use of mechanical bowel preparation before colon surgery, nasogastric tubes after gastrointestinal surgery, and antibiotic irrigation of the abdomen remain common practices. Still another example is routine high-dose perioperative glucocorticoid therapy in patients with inflammatory bowel disease.

Lamore et al1 highlight the almost whimsical use of high-dose perioperative glucocorticoid therapy in patients with inflammatory bowel disease undergoing major abdominal surgery at their institution. Such practice is likely not limited to this major academic medical center, but is certainly widespread. At the least, surgeons and anesthesiologists should realize that there are patients at very low risk of postoperative adrenal crisis for whom high-dose perioperative glucocorticoid therapy can be avoided, such as those receiving budesonide, which has low systemic bioavailability, or those receiving a low dose (≤5 mg/d) of prednisone, which is unlikely to suppress the hypothalamic-pituitary-adrenal axis. In fact, some data2-3 suggest that patients who receive long-term glucocorticoid therapy do not require stress doses of glucocorticoids; rather, their usual daily dose of the glucocorticoid is sufficient.

More important, this study emphasizes the need to standardize glucocorticoid use in this patient population to potentially minimize glucocorticoid-related complications and emphasizes the need for more data. As for other surgical dogma, a well-designed clinical trial is needed to determine whether high-dose perioperative glucocorticoid therapy is necessary.