Hypotheses: The results of ruptured abdominal aortic aneurysm repairs from a solo community hospital–based practice are comparable to those reported from large university referral medical centers. Patients younger than 70 years, arriving in the emergency department with stable hemodynamics, and undergoing prompt operation have better outcome.

Design: A retrospective review from an ongoing vascular surgery registry.

Setting: Two midsized (300-bed) community hospitals. One hundred one consecutive patients with ruptured abdominal aortic aneurysms who were undergoing open surgical repair by a single surgeon (S.S.H.) during a 21-year period were reviewed.

Main Outcome Measures: Operative mortality; cardiac, pulmonary, renal, and gastrointestinal complications; and coagulation abnormalities were recorded. Iatrogenic complications and length of hospital stay were noted. Preoperative and intraoperative factors affecting mortality were studied.

Results: Fifty-three patients survived ruptured abdominal aortic aneurysm repair (operative mortality, 47.5%). A favorable outcome was observed in patients (1) younger than 70 years, (2) with a hematocrit of more than 35% at presentation, and (3) with emergency department to operating room times of less than 120 minutes. Increasing experience of the surgeon did not result in improved survival.

Conclusion: The results of ruptured abdominal aortic aneurysm repairs from community-based practice are comparable to those reported from university referral medical centers.
formed. Continuous variables were reported as mean±SD. All analyses were conducted using Statistical Product and Service Solutions, version 10 (SPSS Inc, Chicago, Ill).

One hundred patients were operated on via a midline abdominal incision. One patient with a leaking AAA had extension of the aneurysm up to the superior mesenteric artery and underwent a thoracoabdominal retroperitoneal approach for repair. In 3 patients, a medial visceral rotation was performed (for a ruptured type IV thoracoabdominal aneurysm in 2 and for an RAAA with a ureterolysis in 1).

Three patients had free rupture of an AAA. Ninety-eight patients had a retroperitoneal hematoma. Proximal control was obtained by supraceliac clamping of the aorta at the diaphragm in 4 patients. Intraluminal control with a large Foley balloon catheter (30-mL balloon capacity) passed through an aneurysmal sac was obtained through the infrarenal AAA in 16 patients. Suprarenal clamping between the superior mesenteric and the renal artery was performed in 20 patients. After obtaining proximal control, the clamp was applied below the renal arteries. An infrarenal clamp was placed in the remaining 61 patients. Two patients had a rupture associated with an inflammatory aortic aneurysm.

### RESULTS

Ninety-five patients experienced an infrarenal rupture of an AAA. Three patients experienced a rupture of the iliac aneurysm, but these patients had an associated large unruptured AAA. Three patients had a suprarenal AAA; in 1 patient, the upper extent of the aneurysm was up to the superior mesenteric artery, and in the remaining 2 patients, there was involvement of the celiac, superior mesenteric, and renal arteries (Crawford type IV thoracoabdominal aneurysm). Forty-eight patients died during the perioperative period, including 5 in whom the repair of the RAAA could not be completed (operative mortality, 47.5%). Perioperative morbidity was high, with a predominance of pulmonary complications (60 patients [59.4%]), renal failure (41 patients [40.6%]), and coagulation abnormalities (32 patients [31.7%]). There were also cardiac (25 patients [24.8%]), gastrointestinal (25 patients [24.8%]), neurological (2 patients [2.0%; paraparesis in one and basilar artery stroke in the other]), and iatrogenic (9 patients [8.9%]) complications. The length of hospital stay was 14.97±14.42 days, and the OR time was 3.88±0.63 hours.

Certain preoperative and intraoperative factors were significant in relation to perioperative mortality (Table 1 and Table 2). Patients younger than 70 years had a significantly better outcome by univariate and multiple regression analyses. Female patients did not have a worse outcome than their male counterparts. Patients with an Hct of more than 35% at presentation to the ED had a significantly better outcome. The presence of chronic obstructive pulmonary disease, the presence of coronary artery disease, and a history of congestive heart failure did not influence the outcome of the RAAA repair. Patients taken to the OR within 120 minutes of presenting in the ED had a much better outcome (P=.02). Patients whose lowest blood pressure was higher than 90 mm Hg, either in the ED or the OR, had a better outcome by univariate analysis. When the data were analyzed by a stepwise multiple logistic regression analysis, however, this did not have any influence on mortality rate. Patients receiving less than 17 U of packed cells during the operative procedure did not have better outcomes.

One hundred one patients were divided into 2 categories: the early group (July 1980 to December 1990 [n=46]) and the late group (January 1991 to February 2001 [n=55]). There was no statistical difference in the mortality between the 2 groups (P=.88), although the

### Table 1. Univariate Analysis of Preoperative and Intraoperative Variables and Their Association With Mortality

<table>
<thead>
<tr>
<th>Variable</th>
<th>Mortality, No. (%)</th>
<th>Odds Ratio</th>
<th>P Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age, y</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>≥70</td>
<td>38/62 (61)</td>
<td>4.59</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>&lt;70</td>
<td>10/39 (26)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sex</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>37/85 (44)</td>
<td>0.35</td>
<td>.06</td>
</tr>
<tr>
<td>Female</td>
<td>11/16 (69)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hematocrit, %</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>≤35</td>
<td>35/55 (64)</td>
<td>4.44</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>&gt;35</td>
<td>13/46 (28)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Preoperative pulmonary disease</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Present</td>
<td>29/58 (48)</td>
<td>1.07</td>
<td>.03</td>
</tr>
<tr>
<td>Absent</td>
<td>19/43 (44)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Preoperative coronary artery disease</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Present</td>
<td>39/74 (53)</td>
<td>2.22</td>
<td>.08</td>
</tr>
<tr>
<td>Absent</td>
<td>9/27 (33)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>ED to OR time, min</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>&gt;120</td>
<td>18/34 (53)</td>
<td>1.38</td>
<td>.46</td>
</tr>
<tr>
<td>≤120</td>
<td>30/67 (45)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lowest BP, mm Hg</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>In the ED</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>≤90</td>
<td>35/58 (60)</td>
<td>4.10</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>&gt;90</td>
<td>12/43 (45)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>In the OR</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>≤90</td>
<td>48/95 (51)</td>
<td>NA</td>
<td>.03*</td>
</tr>
<tr>
<td>&gt;90</td>
<td>0/6 (0)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Blood transfused, U</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>&gt;17</td>
<td>3/4 (75)</td>
<td>3.47</td>
<td>.26</td>
</tr>
<tr>
<td>≤17</td>
<td>45/97 (46)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Abbreviations:** BP, blood pressure; ED, emergency department; NA, data not applicable; OR, operating room.

*Fisher exact test.

### Table 2. Multiple Logistic Regression Analysis of Variables Associated With Mortality of RAAA Repair

<table>
<thead>
<tr>
<th>Variable</th>
<th>Odds Ratio</th>
<th>P Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age</td>
<td>4.10</td>
<td>.008**</td>
</tr>
<tr>
<td>Sex</td>
<td>0.53</td>
<td>.34</td>
</tr>
<tr>
<td>Hematocrit</td>
<td>0.26</td>
<td>.02*</td>
</tr>
<tr>
<td>Preoperative pulmonary disease</td>
<td>0.68</td>
<td>.52</td>
</tr>
<tr>
<td>Preoperative coronary artery disease</td>
<td>1.18</td>
<td>.78</td>
</tr>
<tr>
<td>ED to OR time</td>
<td>3.45</td>
<td>.03*</td>
</tr>
<tr>
<td>Lowest BP</td>
<td></td>
<td></td>
</tr>
<tr>
<td>In the ED</td>
<td>0.44</td>
<td>.18</td>
</tr>
<tr>
<td>In the OR</td>
<td>0.01</td>
<td>.75</td>
</tr>
<tr>
<td>Blood transfused</td>
<td>4.22</td>
<td>.30</td>
</tr>
</tbody>
</table>

**Abbreviations:** BP, blood pressure; ED, emergency department; OR, operating room; RAAA, ruptured abdominal aortic aneurysm.

*Significant.
operative time was significantly shorter in the late group
vs the early group (3.73 ± 0.58 vs 4.05 ± 0.67 hours; P = .01)
(Table 3). The 9 iatrogenic complications included a
laceration to the right renal artery (n = 1), injury to the
right common iliac vein (n = 1), injury to the left renal
vein (n = 2), right renal artery occlusion (n = 1), ureter necrosis (n = 1), tarring of the suprarenal aorta from a clamp
injury (n = 1), a splenic laceration (n = 1), and tension
pneumothorax from a central line insertion (n = 1). There
was no difference in iatrogenic complications between
the early and late groups.

There were 13 patients who were younger than 70
years, had a presenting Hct of more than 35%, and had
ED to OR times of less than 120 minutes. Eleven sur-
vived the RAAA repair, but 2 died (the first of multiple
organ failure secondary to a descending colon infarc-
tion, and the second of renal failure [in a patient who
underwent renal artery reimplantation with a solitary kid-
ney associated with an RAAA]).

Thirty-four patients died during the late follow-up
period (follow-up, 7.93 ± 0.98 years). Late graft-related
complications occurred in 3 patients. Graft infection oc-
curred in 2 patients at 6 months and 3 years following
RAAA repair. Graft removal and axillofemoral recon-
struction resulted in perioperative mortality. A left-
sided iliac limb–ileum fistula developed in one patient
3½ years following the RAAA repair. The graft limb was
excised, the small intestine was resected, and a cross-
over femoral–femoral graft was placed. The patient died
1 year later of metastatic carcinoma of the bile duct.

Tube grafts were used sparingly (in 7 patients). In the
remaining patients, most of the grafts were aor-
toiliac; a few aortofemoral grafts were used.

### Table 3. Analysis of Morbidity and Mortality in 2 Groups*

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Survival</td>
<td>25 (54)</td>
<td>28 (51)</td>
<td>.88</td>
</tr>
<tr>
<td>Morbidity</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pulmonary complications</td>
<td>24 (52)</td>
<td>39 (71)</td>
<td>.08</td>
</tr>
<tr>
<td>Cardiac complications</td>
<td>13 (28)</td>
<td>12 (22)</td>
<td>.61</td>
</tr>
<tr>
<td>Renal complications</td>
<td>22 (48)</td>
<td>19 (35)</td>
<td>.25</td>
</tr>
</tbody>
</table>
| Gastrointestinal complica-
  tions                    | 10 (22)                           | 15 (27)                           | .68     |
| Coagulation abnormalities | 13 (28)                           | 19 (35)                           | .64     |
| Iatrogenic complications  | 3 (7)                             | 6 (11)                            | .67     |

*Data are given as number (percentage) of patients in each group unless otherwise indicated.

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**COMMENT**

The morbidity and mortality of an RAAA remain prohibi-
tive, despite immediate surgical repair and aggressive post-
operative management. The mortality rates of patients ar-
viving at the hospital have ranged from 32% to 80%. Such a
wide range in reported mortality is due to significant varia-
tions in the hemodynamic status of the patient at presen-
tation. In view of the high mortality rate associated with
the repair of RAAAs, several studies have tried to identify
factors predictive of a fatal outcome. A mortality of more
than 92% was identified in patients older than 80 years;
the rate was 68% in patients 80 years and younger. Donaldson et al9 observed that the mortality was higher in
patients older than 76 years. The presence of cardiac
disease, chronic obstructive pulmonary disease, and chronic
renal failure (creatinine levels > 3.0 mg/dL) correlated with
poor outcome. Mortality was also higher in those with
a free intraperitoneal rupture and in those with suprare-
nal extension of the aneurysm. Hypotension on arrival in
the ED (blood pressure < 80 mm Hg) and a low Hct cor-
related with poor outcome as well. A delay in making
the correct diagnosis in the ED and preoperative car-
diac arrest were associated with fatal outcome in many pa-
tients. The mortality was reported to be 47% by Wakefield
et al if the operative procedure took more than 5 hours,
and 33% when the repair could be completed in less than
4 hours. In our series, the operative time was shorter in
the late group, without any improvement in mortality in
this group (P = .02). Intraoperative blood loss of more than
11,000 mL, an intraoperative transfusion of more than 17
U of packed cells, and the administration of more than 7000
mL of fluid in the OR was associated with a mortality of
57%; however, we did not find any difference in the out-
come among patients receiving 17 U or less vs those re-
ceiving more than 17 U of packed cells intraoperatively.
Chen et al, using a multivariate stepwise logistic regres-
sion analysis, found that coagulopathy, ischemic colitis,
persistent shock, delayed transfer to the OR, advanced age,
a perioperative myocardial infarction, and renal failure were
independent predictors for postoperative death. Brad-
bury et al observed that a low platelet count at the comple-
tion of the operation was associated with a poor progno-
sis. By stepwise multiple regression analysis, we observed
that age younger than 70 years, an Hct of more than 35%,
and an ED to OR time of less than 120 minutes were as-
associated with improved survival rates; however, the pres-
ence of a chronic obstructive or a cardiac disease or fe-
male sex was not associated with an adverse outcome.
Rutledge et al, from a statewide review of patients in North
Carolina, reported a mortality of 54% for RAAA repair, and
found that the survival rate was better in larger hospitals
with more than a 100-bed capacity. They also reported an
improved patient survival rate with increasing surgeon ex-
perience (determined by number of cases). Katz et al reported a mortality of 49.8% from a statewide report of
RAAs in Michigan. Dardik et al reported an operative
mortality of 47.4% from a database of 527 patients in
Maryland from 1990 to 1995. Operative mortality rates in-
creased significantly with advancing age; however, the op-
ervative mortality was lower when the repair was performed
by high-volume surgeons (ie, those performing > 10 RAAA
repairs in 5 years). Ouriel et al reported that the sur-
geon’s experience (5 years of practice and 2 aneurysm re-
sections per year) did not affect the mortality associated
with an RAAA repair; however, chronic renal failure,
chronic obstructive pulmonary disease, and unstable he-
modynamic status correlated with poor prognosis. Katz
and Kohl reported an overall in-hospital mortality of 57%
from 3 primary care hospitals in a community setting, and
concluded that surgical experience and avoidance of tech-
nical errors significantly impacted the survival of pa-
tients with an RAAA. They identified 15 major technical

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errors (6 venous injuries, 4 juxtarenal aortic injuries, 4 intraoperative anastomotic failures, and 1 intraoperative graft occlusion), and noted a 43% mortality.

In conclusion, age younger than 70 years, hemodynamic stability, and prompt surgical repair were factors associated with a successful outcome following an RAAA repair. Although an increase in the surgeon’s experience decreased the operative time for the RAAA repair, it did not result in improved morbidity and mortality.

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