

have a "negative" physical examination but "positive" local wound exploration. A red blood cell count of greater than 50,000 in the lavage fluid is predictive of organ injury. Counts between 1,000 and 50,000 suggest the presence of hollow organ injury. Counts less than 1,000 justify nonoperative management. Application of this plan for management of abdominal stab wounds should result in less than 10% nonproductive laparotomies and no missed injuries.

### References

- Hopson WB, Sherman RT, Sanders JW. Stab wounds of the abdomen: A 5-year review of 297 cases. *Am Surg* 1966; 32:213-218.
- Risberg B. Abdominal stab wounds. *Acta Chir Scand* 1976; 142:289-291.
- Freeark RJ. Penetrating wounds of the abdomen. *N Engl J Med* 1974; 291:185-188.
- Lowe RJ, Boyd DR, Folk FA, et al. The negative laparotomy for abdominal trauma. *J Trauma* 1972; 12:853-860.
- Rothchild PD, Treiman RL. Selective management of abdominal stab wounds. *Am J Surg* 1966; 111:382-387.
- McAlvanah MJ, Shaftan GW. Selective conservatism in penetrating abdominal wounds: A continuing reappraisal. *J Trauma* 1978; 18:206-212.
- Cornell WP, Ebert PA, Greenfield LJ, et al. A new nonoperative technique for the diagnosis of penetrating injuries of the abdomen. *J Trauma* 1967; 7:307-314.
- Thal ER. Evaluation of peritoneal lavage and local exploration in lower chest and abdominal stab wounds. *J Trauma* 1977; 17:642-648.
- Thompson JS, Moore EE, Duzer-Moore SV, et al. The evolution of abdominal stab wound management. *J Trauma* 1980; 20:478-484.
- Root HD, Hauser CW, McKinley CR, et al. Diagnostic peritoneal lavage. *Surgery* 1965; 57:633-637.
- Olsen WR, Redman HC, Hildreth DH. Quantitative peritoneal lavage in blunt abdominal trauma. *Arch Surg* 1972; 104:536-543.
- Civetta JM, William MJ, Richie RE. Diagnostic peritoneal irrigation; a simple reliable technique. *Surgery* 1970; 67:874-877.
- Powell DC, Bivins BA, Bell RM. Diagnostic peritoneal lavage. *Surg Gynecol Obstet* 1982; 155:257-264.
- Galbraith TA, Oreskovich MR, Heimbach DM, et al. The role of peritoneal lavage in the management of stab wounds to the abdomen. *Am J Surg* 1980; 140:60-64.
- Talbert J, Gruenberg JC, Sy G, et al. Peritoneal lavage in penetrating thoracic trauma. *J Trauma* 1980; 20:970-981.
- Silverstein M, Gambino R. How good should a lab test be? *Lab Med Practicing Phys* 1978; 20.
- Oreskovich MR, Carrico CJ. Diagnosis and management of colon injuries. In Najarian JJ, ed. *Emergency Surgery*. Chicago: Year Book Medical Publishers, 1982, 33-41.
- Haygood FD, Polk HC Jr. Gunshot wounds of the colon. A review of 100 consecutive patients with emphasis on complications and their causes. *Am J Surg* 1976; 131:213-218.
- Kirkpatrick JR, Rajpal SG. The injured colon: Therapeutic considerations. *Am J Surg* 1975; 129:187-191.
- Arango A, Baxter CR, Shires GT. Surgical management of traumatic injuries of the right colon: Twenty years of civilian experience. *Arch Surg* 1979; 114:703-706.
- Chilimindris C, Boyd DR, Carlson LE, et al. A critical review of management of right colon injuries. *J Trauma* 1971; 11:651-660.

### DISCUSSION

DR. GEORGE JORDON, JR. (Houston, Texas): It was really not too many years ago that most surgeons explored all patients who had a wound that penetrated the anterior fascia, but it has become obvious that selective treatment of these patients is desirable, as many of them do not have intra-abdominal organ injuries.

We, some years ago, began to use local wound exploration, as indicated by these authors, to exclude the group that did not have penetration of the peritoneal cavity, and we continue to do so. We also began a similar, though not identical, study to this, under the direction of Dr. David Feliciano, of our department, approximately 3 years ago, and in 1981 and 1982 we treated 531 patients who had penetrating wounds of the abdominal cavity.

As in this group, 55% of these patients had clinical evidence of difficulty within the abdomen, leading to immediate exploration, and the remaining were subjected to peritoneal lavage. There were 244 such patients.

We did not break our patients down quite as specifically as this group did. We used the same parameters, but explored the patients only if they had red cell counts more than 100,000/mm<sup>3</sup>, an elevated white count, an elevated amylase, or a positive Gram's stain. Using these modalities, we immediately identified 87 patients who did go to operation, and who did have intra-abdominal injuries.

We had six patients, however, in whom the lavages on these criteria, were negative, and who subsequently came to operation because of development of clinical abdominal findings. We, therefore, have continued to use a higher level of red cell count than the current authors as an indication for surgery, and believe that in our 531 patients there has only been one patient who may have been operated on unduly late, on the basis of the protocol that we have followed.

We agree, therefore, that peritoneal lavage is an important aspect of the evaluation of patients with stab wounds of the anterior abdominal wall, and that it will result in more prompt entry into the surgical suite for patients who have severe injuries.

DR. ERWIN THAL (Dallas, Texas): We support Dr. Oreskovich's and Carrico's clinical approach utilizing physical examination, local wound exploration, and peritoneal lavage. This combination serves as an excellent compromise between those who advocate mandatory exploration and those recommending selective management. We would, however, question the necessity of using such a low cell count as an indication for operation.

Initially, the authors suggested using 50,000 cells. In Brooklyn it is 20,000; in Denver it is 5000. Today we have been told it should be 1000. Are we putting too much emphasis on a simple adjunctive procedure? The authors stated that 60% of patients with cell counts between 1000 and 50,000 with visceral injuries had hollow organ involvement, an impressive list. It is noted, however, that 57% of the patients in this group, 1000 to 50,000, had no evidence of injury at operation.

We recently reviewed our experience with 328 patients, using 100,000 red cells as the indication for celiotomy. Of the 185 patients who were lavaged, there were eight false negatives, or 4.3%. There were two hollow viscus injuries, and neither involved the colon. 2 patients, 1.1%, had complications due to a delayed operation. It is of interest that two of the eight patients with injuries had cell counts of 42 and 286, well below the authors' recommended 1000.

We had 36 patients with anterior stab wounds and cell counts between the 1000 and 50,000, with only 2 false negatives. The negative celiotomy rate for this group was 9.6%, as compared with the 57% reported today.

Two of our patients with negative celiotomies have already returned with small bowel obstruction. The average length of hospitalization for patients operated upon without injury was 4.2 days, as compared to only 1.8 for those observed. In the past 15 years, we have had one death from a negative celiotomy, and one death which was due to a delayed recognition of injury.

The real question, then, revolved around how many negative procedures are necessary to assure the lowest possible morbidity and mortality. It would seem from our data that close observation of the patients with cell counts less than 100,000 will detect most injuries early enough to prevent serious sequelae. There will always be an exception, an occasional false negative, balanced by a complication from a negative procedure. A negative celiotomy rate of 10 to 20% seems acceptable to assure that most injuries will be detected. However, a 57% rate seems a bit excessive.

Peritoneal lavage is simply an adjunctive procedure, and should be kept in that context. It should not be overemphasized, but, rather, used in conjunction with good, sound clinical evaluation and judgment.

In closing, I would like to ask the authors if (1) they have any data on a group of patients who were closely observed with cell counts between 1000 and 50,000; (2) what is the morbidity and long-term follow-up in their patients with negative celiotomies; and (3) did the one patient who initially refused an operation have any postoperative complications?

DR. DONALD D. TRUNKEY (San Francisco, California): I rise primarily to ask the authors a few questions regarding their protocol. We have a protocol that is not too dissimilar. We explore the wound under local, but we explore down to the peritoneum, and if the peritoneum has been violated the patient would get a laparotomy. We have not used peritoneal lavage as an adjunctive procedure. Using this methodology, with just anterior wounds, the negative exploration rate is around 10%. I agree with Dr. Thal's comments on that being an acceptable one.

Specifically in regards to this study, you have 83% follow-up in those with local wound exploration. That means 17% were not followed, and my concern is: Were there any false negatives in this group? I ask this because we admit those patients. After we have explored the wound, and if it does not penetrate the peritoneum, we admit these patients and observe them for 24 hours, with the idea that the local wound exploration is not foolproof.

Conspicuous by its absence in your discussion is the diaphragm. It is my impression that peritoneal lavage may miss diaphragmatic injuries, and I wonder if even your 1000 red cells is reasonable.

Another question is: What is your definition of the anterior abdomen? The reason for this question is that once you get into flanks, we get into another problem of missed injuries, particularly those of the retroperitoneal colon.

And, finally, what is your definition of a hollow viscus injury? Was this penetration, or was this simply a contusion or a scratch along a hollow viscus?

DR. FRANCIS C. NANCE (New Orleans, Louisiana): I agree that one-third of these patients are easily identified. The very sick patients are easily identified when they first present. But we have had trouble finding a place for peritoneal lavage in these patients with, penetrating wound and have limited peritoneal lavage for those patients whose evaluation really cannot be made *i.e.*, if they are in a coma, etc. or if they are about to undergo an anesthetic for another injury.

We have continued to rely on clinical criteria to decide whether or not these patients should be explored, and this method has allowed us to identify virtually all of the patients within the first 6 hours, and we have not seen significant complications in those patients who have had delayed laparotomy.

I would like to ask the authors one question. That is, do they have enough confidence in their algorithm to apply it to a hypothetical gunshot wound patient who comes in with a wound of the flank, in which peritoneal lavage reveals less than 1000 cells/mm<sup>3</sup>? Would they explore those patients, or watch them?

We are using clinical criteria for selective management of gunshot wound patients, and feel that this group of patients can be managed in essence, the same way as stab wounds.

DR. H. HARLAN STONE (Baltimore, Maryland): In a prospective trial, patients who had criteria of obvious or unexplained blood loss, peritoneal signs (particularly by rebound), escape of contents from hollow viscera (such as gas or urologic contrast dye on x-ray study), or exposed viscera appeared to demand immediate exploration. Few would argue with this.

All other patients with stab wounds were randomized to immediate exploration or observation according to final digit in the hospital number. Those who had negative examinations had negative abdomens on immediate exploration. Those who had randomization to observation and subsequently developed peritoneal signs and, thus, were explored also had negative abdomens.

Before, I firmly believed all of these patients should be explored, but I now find myself in the opposite corner. It appears that merely observation and a few clinical signs are very, very effective means of sorting out who should or should not be subjected to operation.

Second, I question the safety of peritoneal lavage in the hands of people in an emergency room who are not necessarily trained or resident surgeons. A few of our very able residents have had misadventures on rare occasions. One then wonders what will be the case for the less experienced individual. Exactly what was your complication rate with this procedure? Did you have any patients to sustain an injury from this North American form of large bore diagnostic acupuncture?

DR. GILBERT S. CAMPBELL (Little Rock, Arkansas): The strongest proponents for nonoperative or local wound exploration for management of stab wounds of the abdomen are girdled with corpulence. An earlier discussant, Dr. Carter Nance pioneered the so-called conservative management of stab wounds of the abdomen. If one measured the distance from the skin of Dr. Nance's anterior abdominal wall to the Golgi apparatus in the anterior-most cell of his peritoneum, most stabs would not even dent it. For patients padded with a stab resistant protective abdominal panniculus, "conservative" therapy may be acceptable. However, most stab wound recipients are flat or scaphoid bellied—many are underfed—some rob convenience grocery stores.

A razor blade scratch suffered by a sylphic sorcerer may extend into the peritoneal cavity. Therefore, the thickness of the abdominal wall and the length of the stabbing weapon must have some role in the decision-making process.

DR. MICHAEL R. ORESKOVICH (Closing discussion): Dr. Thal, in response to your three questions—first, a follow-up of our negative laparotomy group: In the last eight years, one patient has returned with a small bowel obstruction, and there have been no deaths.

Second, regarding a control group; a nonoperated 1000 to 50,000 group; we have not done that. That was part of our test hypothesis. We were brought up to explore everyone with a positive wound exploration, and wanted to test out this control group.

The third question is: What about the patient who initially refused operation and was explored 12 hours later? Did he suffer any untoward effect? The answer is, he did not. He had an injury to the jejunum, and not the colon, and that might explain it.

Dr. Jordan, I am familiar with the work by Dr. Feliciano and the group at Ben Taub. Of the six patients who had less than 100,000 who were later explored, the denominator there is 93 patients. The missed injury rate is 6%, and I think that is fairly consistent with other disclosures in the literature.

Dr. Trunkey, the reason that we do not use the peritoneum as the end of the local wound exploration tract is because we usually lose it in the muscle of the anterior rectus. And it brings me to a point which I need to emphasize. This is a surgical procedure. It needs to be done by surgeons. The surgeons need to be scrupulously honest. I do not think either peritoneal lavage or local wound exploration should be done by emergency physicians; and I know that fits your bias.

Regarding the 17% that were not followed, we did not have 30-day follow-up in the 17%; we have 48-hour follow-up. And we had no missed injuries in that group of local wound explorations.

The anterior abdomen was defined as the nipples to the groin creases, and anterior axillary line to anterior axillary line. We remain reticent to make this recommendation regarding flank and back wounds, because that part of our study is not completed.

And our definition of hollow viscus penetration was exactly that. We excluded contusions or serosal lacerations. There had to be an injury through the mucosa.

Dr. Nance, I appreciate your compliments. We did exclude extra-abdominal injuries, and we excluded multiple stab wounds, so we did not apply peritoneal lavage to the patient who was comatose, in which physical examination could not be accurate.

We remain reluctant to use peritoneal lavage for gunshot wounds. I think the experience of Dr. Thal in his report in the *Archives of Surgery* supports that. In our experience, 94% of people who are shot in the abdomen have an internal injury, or an intra-abdominal injury, and it seems that is the very reason not to use peritoneal lavage. Gunshot wounds involve the retroperitoneum, which peritoneal lavage is not accessible to.

Dr. Stone, the question you pose is a critical one. There is a lot of experimental evidence, specifically that of Burke and Miles, that says it takes about 3 hours for the bacteria to set up housekeeping, to move from peritoneal contamination to frank peritoneal infection. That is my concern regarding delayed diagnosis. To date, there is still an absence of control, or human series to really test out that hypothesis, but I think the experimental evidence is strong enough that our concern for delayed presentation, for operating on patients 6, 7, and 8 hours later, is well supported.

Regarding safety, we had no complications of peritoneal lavage. We used the open hemostatic technique, done by surgical residents. We had four infections in the local wound exploration group. We had one patient that returned with a muscle bleeder that required suture ligation; and again, I think this supports the necessity of this procedure being done by surgeons, and not by emergency physicians.

DR. C. JAMES CARRICO (Closing discussion): Dr. Oreskovich, I think, answered all of the questions very precisely and very clearly. The comment I would like to make is: Obviously, this is a controversial area; but, I think we are learning that peritoneal lavage is a quantitative test; that you can not really say you have got a positive or a negative lavage, any more than you have a positive or a negative BUN, or a positive or negative blood sugar. The numbers give you some information. The lower the RBC count, the less likely an organ injury, but the more likely that the injury is to a hollow viscus. So, you end up trying to draw the line where the risk of a negative lap and the risk of morbidity from a missed injury cross.

Where that is, we really do not know. Our feeling, based on our data and supported by reports in the literature (the 5% missed injuries that are in nearly everybody's series, the rare report of a death) is that somewhere around a thousand cells is probably going to be the safest for the most patients with stab wounds of the abdomen.