The Use of Low Dosage X-Ray (Lodox/Statscan) in Major Trauma: Comparison Between Low Dose X-Ray and Conventional X-Ray Techniques

Kenneth D. Boffard, MD, FRCS, FRCS(Edin), FRCPs(Glas), FCS(SA), FACS, Jacques Goosen, MD, FCS(SA), Elias Degiannis, MD, FCS(SA), FACS, and Herman Potgieter, PhD

Background: Patients presenting with major trauma normally require resuscitation, usually carried out according to techniques laid down by the Advanced Trauma Life Support (ATLS) Program of the American College of Surgeons. Techniques normally suggested include the routine radiology of the cervical spine, chest, and pelvis. This can sometime be time consuming and may not return helpful information in all cases.

Methods: This paper describes the use of a new low dose X-ray technique (Lodox/Statscan) to perform these X-rays, and compares their interpretation by both radiologists and trauma surgeons with images obtained from conventional X-rays. The time taken for the respective images to be obtained was measured.

Results: There was no difference in the amount of information obtained.

Conclusion: The use of the Lodox allowed a substantial reduction in the time taken for resuscitation, without prejudice to diagnostic radiology.

Key Words: Low dose X-ray, Resuscitation X-rays, Digital X-rays.

The Journal of TRAUMA® Injury, Infection, and Critical Care

Submission for publication November 23, 2005.
Accepted for publication March 7, 2006.
Copyright © 2006 by Lippincott Williams & Wilkins, Inc.
From the Department of Surgery, Milpark Hospital and Johannesburg Hospital (K.D.B., J.G., F.P.), Chris Hani Baragwanath Hospital (E.D.), University of the Witwatersrand, Johannesburg, South Africa; and the Lodox Systems (Pty) Ltd., Johannesburg, South Africa (H.P.).
Presented at the 64th Annual Meeting of the American Association for the Surgery of Trauma, September 22–24, 2005.
Address for Reprints: K. D. Boffard, Professor and Clinical Head, Department of Surgery, University of the Witwatersrand, PostNet Suite #235, Private Bag x2600, Houghton, Johannesburg 2146, Republic of South Africa; email: trauma@mweb.co.za.
DOI: 10.1097/01.ta.0000220393.26629.6c

Studies of preventable trauma deaths have shown that delayed surgery is one of the major contributing factors to both mortality and morbidity following major trauma.1-3 Driscoll and Vincent examined resuscitation times in 4 major trauma centers in the US and South Africa using multiple regression analysis with survival as the dependent variable, and demonstrated that resuscitation time was a predictor of the patient’s eventual outcome.4 Scalea et al. showed that increased resuscitation times and delay in definitive care were detrimental to the quality of trauma care.5

Patients presenting with major blunt or penetrating trauma requiring resuscitation, normally would be taken from entry to the trauma center, directly to a resuscitation area, and then resuscitated according to the principles laid down by the Advanced Trauma Life Support (ATLS) Program of the American College of Surgeons.6 This would, after the primary survey was complete, include routine radiology of the cervical spine, chest, and pelvis. In addition, extensive further plain radiology may be required to examine for fractures, or the presence of metal fragments.

This can be time consuming and may not return helpful information in all cases. This paper describes the use of a new low dose X-ray technique (Lodox/Statscan), and compares both the quality of the images obtained, compared with conventional X-ray images, and the times taken for resuscitation.

THE LODOX/STATSCAN

The Lodox/Statscan is a digital X-ray machine, originally developed as a very-low-dose X-ray unit for the diamond mining industry to assist in the detection of smuggled diamonds. It produces a whole body skeletal and soft tissue scan. Any part of the scan can be enlarged and digitally enhanced.

The machine makes use of an X-ray tube mounted on one end of a C-arm. This emits a low dose collimated fan-beam of X-rays. Fixed to the other end of the C-arm is the X-ray detector unit, comprising scintillator arrays optically linked to charge-coupled-devices (CCDs). The detectors have a 60 μm size, and are generally used in combination, providing up to 5800 along the length of the detector arm. Variations of spatial resolution from 1.04 to 5 line-pairs per millimeter are possible, and able to record 14 bits of contrast resolution. The C-arm travels along the table length at speeds of up to 138 mm/sec, and a full body pass (scan) takes 13 seconds (Fig. 1). The C-arm is able to rotate axially around the patient to any angle up to 90 degrees. If desired, a second pass can be made to give a whole body lateral scan, permitting horizontal-beam, shoot-through lateral, erect, and oblique views (Fig. 2).

The unit includes a special integrated docking resuscitation table, to eliminate the need to transfer the patient to another gurney, allowing easier scanning and patient access. Trendelen-
burg tilting of either end of the table is possible. The table can then be used for the ongoing resuscitation of the patient.

The images are available immediately, accessed from a conventional personal computer, displayed on a 21 in. PC high resolution monitor. Hard copy, produced either as X-ray films, or hard copy prints is immediately available from a conventional PC inkjet printer. A whole body image is initially displayed (Fig. 3), and any part of this image can be enlarged and viewed (Fig. 4).

Metal fragments are clearly visible in the whole body scan (Fig. 5).

**Dose**

Relative digital radiation dose compared with the conventional varied from 72% (chest) to 2% (pelvis) with a simple average of 6%. Radiation skin entry dose averaged 36.3 mrem (range, 17.8–66.8 mrem) compared with a conventional radiologic dose of 591 mrem (range, 20–2280 mrem).
Ethics

All stages to the project were carried out according to the Good Clinical Practice (GCP) norms, laid down by the Ethics Committees of the Milpark Hospital and University of the Witwatersrand. Informed consent according to Helsinki Guidelines of GCP was obtained from all patients.11

Methods

The Milpark Hospital is a South African hospital which is a major trauma center, matching the standards laid down by the American College of Surgeons Committee on Trauma for a Level I trauma center.12 The Center has a separate entrance specifically for major trauma admissions. The Lodox/Statscan unit is mounted 5 meters inside the entrance door, with the resuscitation area 5 meters further inside.

Patients presenting with major trauma, arriving via Emergency Medical Services (EMS), and who by virtue of their prehospital triage were expected to be admitted via the resuscitation area according to existing protocols, were taken via the trauma entrance of the hospital, to the dedicated Lodox/Statscan area and placed on the X-ray table. A single routine AP scan was performed, and the patient was then immediately transferred to the resuscitation area where a routine resuscitation according to ATLS principles was performed. All X-rays as required by the resuscitation team were performed using a conventional X-ray gantry-mounted Philips Unit. A consultant trauma surgeon was present throughout the entire process.

By nature of the study, all Lodox/Statscan imaging was performed in the full EMS “packaging” of Scoop stretcher or spine board, head immobilizer and/or rigid cervical collar, spider harness, and monitoring devices. The conventional X-rays were performed with the patient fully exposed, and all prehospital equipment already removed.

The images obtained using the conventional gantry mounted X-ray system were compared with those obtained from the Lodox/Statscan and the total times taken for the conventional diagnostic radiology to be completed, was measured. “Conventional X-rays” were defined as a cervical spine (AP and lateral), supine chest, and pelvis. In addition, the time taken for “additional” X-rays, such as limb views, was measured.

The study was powered for 100 patients, divided into two phases. For phase 1, in 50 patients, all clinical and diagnostic decisions were made from the Lodox/Statscan image, as if conventional X-rays had not been performed. After the resuscitation was deemed complete, the consultant trauma surgeon reviewed the Lodox/Statscan images, and documented the findings, which were then compared with the conventional X-rays, and the following noted:

1. Any findings on the Lodox/Statscan image, not subsequently visible on the conventional image.
2. Any findings on the conventional image not previously visible on the Lodox/Statscan image.
3. Any clinical decisions that were altered as a result of the above.

For phase 2, in 50 patients, all clinical and diagnostic decisions were made from the Lodox/Statscan image, as if conventional X-rays had not been performed. After the resuscitation was deemed complete, the consultant trauma surgeon reviewed the Lodox/Statscan images, and documented the findings, which were then compared with the conventional X-rays, and the following noted:

1. Any findings on the Lodox/Statscan image, not subsequently visible on the conventional image.
2. Any findings on the conventional image not previously visible on the Lodox/Statscan image.
3. Any clinical decisions that were altered as a result of the above.

Fig. 6. Process flow.
information (e.g. on limb fractures, position of metal fragments, etc.), was required.

In addition to the above, for both phases, the Lodox/Statscan and conventional X-ray images were subsequently read by a specialist radiologist and compared, where the same process (phase 1 and phase 2) was repeated and the same questions were documented as per the protocol above. The detailed Process flow is shown in Figure 6.

For both phases, the resuscitation was timed:

1. Time of entry from the ambulance entrance directly to the resuscitation entrance or
2. Time of entry from the ambulance entrance via the Lodox/Statscan to the resuscitation entrance.
3. Time from entry into resuscitation until the ATLS secondary survey (including all other diagnostic radiology) was deemed complete according to protocol.
4. Time taken from start to finish of conventional radiologic procedures.

A telephonic initial screening process took place where the EMS was in touch with the resuscitation staff, i.e. before the arrival of the patient. Both prehospital, and immediately on arrival, the patient was screened for both inclusion and exclusion criteria to determine eligibility for the study. If the patient’s medical status had changed on arrival, the eligibility for inclusion was reviewed by the trauma surgeon. The trauma surgeon had to be present throughout the patient’s reception and resuscitation.

**Primary Objective**

To determine whether the Lodox/Statscan images obtained were of the same quality as conventional radiologic images, enabling the same information to be obtained as the conventionally obtained images.

**Secondary Objective**

To determine whether the use of Lodox/Statscan would have an impact on the time required to resuscitate a patient.

**Inclusion Criteria**

a. Patients over 18 years of age.
b. Patient hemodynamically stable in the opinion of the attending Trauma Surgeon who had to be present throughout.

d. Any patients who became unstable during the course of their resuscitation in hospital in whom the conventional X-rays normally required would be curtailed as a result of the instability.

**RESULTS**

Over a 5 month period, a total of 266 patients were screened, and 115 were entered into the study. There were 28 (10.5%) patients excluded as being too unstable, and the remainder were excluded as per the exclusion protocols.

A total of 61 patients were entered into phase 1, and 54 patients were entered into phase 2.

**Demographics**

There was no difference in demographics between the two groups, which were representative of our trauma population (Table 1). Based on multivariate linear regression, the intensity of the injuries, gender, age, and other factors were all statistically equivalent between the two groups.

**Qualitative Analysis of Lodox/Statscan Image Quality**

A subjective question was posed independently to the trauma surgeons and to the radiologists: “If only the Lodox/Statscan were to be used, would adequate information be obtained for appropriate treatment?” (Table 2). The primary objective of the question was as a verifier of clinical results. The question also gave an indication of the global attitude toward the Lodox/Statscan images from the trauma surgeons and the radiologists.

In phase 1, 67% of the trauma surgeons felt confident that if only Lodox/Statscan images were used, that sufficient diagnostic information would have been obtained to assist in the resuscitation and assessment of the patient. There were 54% of radiologists who (retrospectively) reviewed the images felt that if only Lodox/Statscan used, that sufficient information would have been obtained to assist in the assessment of the patient.

**Table 1 Demographics**

| Age       | Phase 1 | | Phase 2 |
|-----------|---------| |---------|
| n | % | n | % |
| 18–19 | 1 | 2 | 1 | 2 |
| 20–29 | 11 | 18 | 15 | 8 |
| 30–39 | 24 | 40 | 23 | 43 |
| 40–49 | 8 | 13 | 9 | 17 |
| 50–59 | 9 | 15 | 9 | 17 |
| 60–69 | 3 | 5 | 3 | 6 |
| 70–79 | 2 | 3 | 1 | 2 |
| 80–89 | 2 | 3 | 0 | 0 |
| 90 or older | 1 | 2 | 0 | 0 |
| Total | 61 | 100 | 54 | 100 |
| Male | 57 | 93 | 51 | 94 |
| Female | 4 | 7 | 3 | 6 |
| Total | 61 | 100 | 54 | 100 |
| RTS (mean) | 6.82 | 6.53 |
| ISS (mean) | 14.72 | 16.24 |
In phase 2, 50% of the trauma surgeons felt confident enough that if only Lodox/Statscan images were used, that sufficient diagnostic information would have been obtained that no further similar imaging was necessary. Only 30% of radiologists felt that if only Lodox/Statscan were to be obtained, similar conventional imaging would not be necessary.

There was a decrease in confidence between phase 1 and phase 2, reflected by both the trauma surgeons and the radiologists and as a total. It was not possible to analyze the data statistically, because the results were of a descriptive nature. There are no existing benchmarks in this type of acceptance testing, which is of a subjective nature. The results are also in contrast to the quantitative results (see below).

Quantitative Analysis of Lodox Image Qualities

The trauma surgeons and the radiologists were required to qualify whether the findings on conventional X-ray were the same as the Lodox images, stratified according to anatomic regions (Table 3).

In phase 1, the trauma surgeons quantified that the Lodox/Statscan images were the same as conventional X-ray in 89% of cases, and in phase 2, 92%, calculated as a weighted average. In phase 1, the radiologists qualified the Lodox/Statscan image the same as conventional X-rays in 67% of cases, and in phase 2, 61%.

If it is assumed that 85% is a reasonable level of confidence in the imaging technique, the lowest levels of confidence were shown by the radiologists, with the greatest area of concern being the cervical area, and “other areas”. The higher level of confidence among the trauma surgeons across the board may reflect their ability to cross reference the clinical examination of the patient with the images, whereas the radiologists only had the images on which to make a decision.

A further important factor is that while AP images were taken in all cases, initially, lateral images proved problematic on the Lodox/Statscan. In phase 1, 80% of all patients had AP images only, and therefore no comparison was possible with lateral images. During the period of the study the machine was upgraded to allow clear lateral images, and in phase 2, only 15% had AP images only, while 85% had lateral images as well. It must also be again noted, that all Lodox/Statscan images were taken through a spine board, cervical collar and/or head blocks. While this did not materially affect the quality of the AP scan, particularly with cervical spine investigation, it negatively impacted on the quality of the lateral scans.

Resuscitation Period

The average resuscitation times for phase 1 and phase 2 were similar (Table 4).

In phase 1, the routine ATLS X-rays plus any other X-rays as requested by the trauma surgeon took an average of 36.57 minutes to complete. However, in phase 2, there was a significant reduction in the time taken for conventional radiology to take place, where additional films (beyond the “conventional” ATLS films) were only requested if the information from the scan was in doubt (e.g. presence of bullets if shown on the Lodox meant that conventional films were no longer necessary). In phase 2, the level of confidence among trauma surgeons was higher, particularly in penetrating gunshot injury, where the initial Lodox/Statscan revealed the presence or absence of the bullet in all cases. As a result, the

### Table 2 Qualitative Results of Lodox/Statscan Images Against Conventional Images

<table>
<thead>
<tr>
<th></th>
<th>Yes n</th>
<th>No n</th>
<th>Undecided n</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Phase 1</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Trauma surgeon</td>
<td>41 (67%)</td>
<td>16 (26%)</td>
<td>4 (7%)</td>
</tr>
<tr>
<td>Radiologist</td>
<td>33 (54%)</td>
<td>26 (43%)</td>
<td>2 (3%)</td>
</tr>
<tr>
<td><strong>Phase 2</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Trauma surgeon</td>
<td>27 (50%)</td>
<td>20 (37%)</td>
<td>7 (13%)</td>
</tr>
<tr>
<td>Radiologist</td>
<td>16 (39%)</td>
<td>35 (65%)</td>
<td>3 (6%)</td>
</tr>
</tbody>
</table>

(Is there as much information available on the Lodox scan as on a conventional image?)

### Table 3 Quantitative Results of Lodox/Statscan Images Against Conventional Images

<table>
<thead>
<tr>
<th>Image Region</th>
<th>Trauma Surgeon</th>
<th>Radiologist</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>X-Ray Image Viewed</td>
<td>Lodox Same as X-Ray</td>
</tr>
<tr>
<td><strong>Phase 1</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cervical spine</td>
<td>46</td>
<td>41 (89%)</td>
</tr>
<tr>
<td>Chest</td>
<td>59</td>
<td>50 (85%)</td>
</tr>
<tr>
<td>Pelvis</td>
<td>48</td>
<td>46 (96%)</td>
</tr>
<tr>
<td>Other</td>
<td>34</td>
<td>29 (85%)</td>
</tr>
<tr>
<td></td>
<td>X-ray same as Lodox</td>
<td></td>
</tr>
<tr>
<td><strong>Phase 2</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cervical spine</td>
<td>36</td>
<td>32 (89%)</td>
</tr>
<tr>
<td>Chest</td>
<td>39</td>
<td>39 (100%)</td>
</tr>
<tr>
<td>Pelvis</td>
<td>40</td>
<td>40 (100%)</td>
</tr>
<tr>
<td>Other</td>
<td>30</td>
<td>22 (73%)</td>
</tr>
</tbody>
</table>
average X-ray time dropped to 26.17 minutes because it was possible to omit a number of X-rays.

**DISCUSSION**

Lodox/Statscan imaging represents a significance alteration in the way in which X-ray images are obtained in the trauma patient. While the technique has been previously well described, it has until now, been used “post facto”—that is after resuscitation of the patient and before additional investigations such as computed tomography (CT) scanning. In this regard, since it produces normal “X-ray like” images, while it is felt to be a satisfactory alternative to conventional X-rays, the reality is that most patients, postresuscitation will proceed to CT scan, and in many cases, the use of Lodox/Statscan imaging will contribute relatively little toward enhancing the diagnosis of the patient at that point, nor reducing the time spent in the resuscitation area.

In our situation, we placed the Lodox/Statscan unit at the entrance to the resuscitation area, adjacent to the EMS entrance, and so it was possible to perform a Lodox/Statscan on most patients before their arrival in the resuscitation room (i.e. immediately on exit from the ambulance). The delay caused by performing an antero-posterior scan was about 90 seconds, compared with direct admission to resuscitation. No patient suffered as a result of this delay, although grossly unstable patients were excluded from the study.

Initially, however, to complete a whole body lateral scan, the procedure took up to 10 minutes. Reasons for this included the time required for the rotation of the Lodox/Statscan across the patient, and it was necessary to return the scanner to its parked position before the patient could be removed. Initial difficulties with both the resolution of the lateral films, as well as the learning curve of staff contributed to this. By the end of the study, total scan time for AP and lateral views combined was less than 5 minutes, and this is now our routine. For the purpose of timing in the study, only AP views were measured.

The greatest benefit was shown in AP views and in penetrating injury. The Lodox/Statscan, by virtue of being a whole body scan, was able to show the position and nature of any foreign metal bodies such as bullets, as well as position of ET tube, presence of a pneumothorax, and all fractures. This obviated the need for any further X-rays for this purpose, and had the capacity to dramatically reduce the time needed in the resuscitation area.

Not surprisingly, probably because they have the benefit of clinical sight of the patient, the acceptance and confidence of the trauma surgeons was significantly greater than that of the radiologists, who saw the films only, and had minimal clinical data. However, in a separate study involving radiologists, in 39 stable patients where Lodox digital images were compared with conventional images using a scoring system of −3 (worse than) to +3 (better than), the digital images had a mean equivalence score of −0.429 with a SD of 0.77. This was not significant. This implies that although the radiologists may have felt less comfortable with the Lodox digital images, the diagnostic yield of both types was similar.

The trauma surgeons were comfortable with the use of the Lodox/Statscan for all imaging of the chest, pelvis, and most extremity views. However, they were not confident of clearing the neck using the Lodox/Statscan because of the absence of consistent quality lateral films. This also applied to certain distal extremity injuries, primarily because at the time of scanning, the extremities were still secured in the EMS restraining devices, and there were not always true AP or lateral images. Subsequent to this study, the hardware and software have been improved further, and the quality of the laterals is now similar to those of conventional X-ray, despite the presence of immobilization equipment. This will be the subject of a further study.

Initially the trauma surgeons who also had to learn to manipulate the digital images themselves were somewhat dubious of the effectiveness of the technique applied in the presuscitation phase. After a short training course, this posed no further problems. Once this had been completed, there was universal acceptance, despite the fact that the images also contained images of prehospital equipment! The information obtained from the AP views was the same as that from conventional X-rays throughout the study, and there were no missed injuries across the two phases.

The average time taken for all requested X-rays was 37 minutes. This significantly contributed to the total time spent in the resuscitation area, since the secondary survey was generally complete (including “conventional” for X-rays) within 30 minutes of the patient’s arrival. The resuscitations rely on simultaneous resuscitation and radiography. This inevitably leads to a degree of mutual interference, and some radiology consequently takes longer. By omitting certain views, it was possible to improve the flow of the resuscitation dramatically. When additional X-rays for injury were omitted, this time dropped to 27 minutes. These figures compare to figures from two other centers where patients are scanned.

### Table 4 Average Resuscitation Times

<table>
<thead>
<tr>
<th>Time Phase 1</th>
<th>Phase 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>From entrance to resuscitation (direct) ≤30 sec</td>
<td>n/a</td>
</tr>
<tr>
<td>From entrance to resuscitation From AP only 2.16 min</td>
<td>(1.5–2.5 min)</td>
</tr>
<tr>
<td>(via Lodox) From lateral 6–18 min</td>
<td>70.73 min</td>
</tr>
<tr>
<td>From entrance to From first X-ray image to last X-ray image exit last X-ray image to last X-ray image 36.57 min</td>
<td>26.17 min</td>
</tr>
</tbody>
</table>
after resuscitation. (The average Lodox/Statscan scan time (AP and Lateral) (range) was 12.85 (10–15) minutes and 7.4 (3–21) minutes, and time for conventional X-rays was 21 (15–25) minutes and 33.4 (20–60) minutes, respectively) (Personal communication; unpublished abstract data10).

CONCLUSIONS

The Lodox/Statscan is a significant advance in the imaging repertoire used in the trauma patient. We have shown that the confidence of use increased with time. Lodox/Statscan can replace conventional X-rays in the AP plane, particularly with regard to chest and pelvic examination, and the location of metallic foreign bodies. It proved equal to conventional X-ray in the coarse diagnosis of most long bone fractures. However, it is not a CT scanner, and should not be compared with one.

It was not as effective in our situation (compounded by the fact that the patients were still immobilized by EMS) in the lateral plane, and in clearing the cervical spine. Since the trial has been completed, the Lodox/Statscan equipment and its resolution of images has been significantly enhanced. Greater confidence has also allowed a wider range of patients to be examined. Many centers will routinely CT scan the cervical spine in preference to X-ray. The Lodox/Statscan has the potential, therefore, to replace all existing radiology in the Emergency Room.

With regard to resuscitation times, it has been shown that because of the effectiveness and remarkable speed of the Lodox/Statscan imaging process, it is possible to abandon a significant number of plain conventional X-rays in the resuscitation process. This means that it is possible to shorten the total time taken to resuscitate a patient with major injury, and to effect a dramatic reduction in the time spent in the resuscitation area.

Radiation emission and exposure is significantly lower than for conventional X-rays, averaging only 6% of conventional radiologic exposure. The speed of imaging, and the low dose of radiation may make the Unit particularly useful for pediatric assessment in trauma.

It is expected that there will be particularly enhanced indications for the use of the scan in a military and mass casualty context, since the Unit is transportable, and capable of imaging a large number of patients in a very short time with complete accuracy in showing metal fragments.

The Lodox/Statscan has a significant role to play in the initial management of the trauma patient, and the potential to replace conventional radiology as the immediate investigation of choice.

REFERENCES


DISCUSSION

Dr. Mark L. Gestring (Rochester, New York): Despite the evolving role of CT in trauma, it remains clear that standard radiographs play an important role in the early management and assessment of injured patients.

The information displayed on a chest X-ray or a pelvic X-ray in this patient population supplements the physical exam, is quickly available and allows decisions to be made regarding management and additional imaging.

The practical limitations of X-ray, however, require that each area of interest be imaged separately, and that patient manipulation is sometimes required to complete the diagnostic goal.

In cases of penetrating injury, radiographs are commonly used to plot trajectory and search for foreign bodies or retained projectiles. Frequently, however, this requires flexibility on the part of the radiology technician, since not all wounds or patients are the same, and imagination is sometimes required to obtain the desired information in a timely fashion.

For these reasons, the ability to perform a total body X-ray in a rapid fashion, using minimal radiation would certainly be appealing in the trauma patient population.

The technology involved in this process has been available to the mining industry for some time, and it is now being applied in the medical arena. The authors of this paper are to be congratulated for applying this methodology to the complexities of trauma care.

The study was well designed and provides considerable insight into the future of medical imaging. In general, I
believe it is safe to say that imaging technology will continue to improve, and that more sophisticated, more portable and more versatile imaging modalities will continue to evolve in the evaluation of these patients.

I think, however, it is important to maintain a conceptual framework with regard to the application of these advancements. While the authors of this work utilize a study design, in which a physician meets the patient on arrival and rapidly decides which patient is appropriate for the stetscan and which one is not, it is not unreasonable to assume that the next step in this process will involve direct transport of the patient to the rapid imager without benefit of physician involvement.

As a group, I believe that trauma surgeons need to be aware of this potential and resist the temptation to follow such a path. The initial primary survey, performed by a trained physician, should remain the gold standard with imaging applied only as an adjunct as described in the ATLS approach.

I believe we have taken a step backwards if we work to improve the speed at which we X-ray a tension pneumothorax instead of keeping the focus on clinical recognition of these types of problems.

Despite these overall concerns, I must confess to being extremely impressed with this new technology and would like to ask the authors the following general questions:

You alluded to not replacing CT scan with this new device, but did you see in your approach to these patients any change in use of CT in this patient population?

The machine at your institution is used exclusively for trauma, or did it find uses for other emergency department related problems? If so, what type of problems was it helpful with?

From reading the manuscript, this device sounds like it would be a very useful adjunct during triage. Do you have any experience with this technology in either a mass casualty or a disaster situation? I think we’d like to learn some more about that.

Lastly, since the devil is truly in the details with these types of technological advances, can you comment on the practical difficulties involved with putting this device into your institution, the learning curve, the problems that you noticed trying to implement this?

I appreciate the opportunity to discuss this interesting paper and look forward to hearing further applications as they unfold.

Dr. Kenneth D. Boffard (Johannesburg, South Africa): Thank you very much indeed, Mark. The learning curve that we have is, I guess, the same as everyone else’s learning curve. But what I presented here was an attempt to be prospective about certain aspects of this.

I can advise you that we have probably halved the number of CT scans that we are doing of cervical spines because of the ability now with the latest technology on this particular machine.

The quality is so good that we have significantly reduced the number of patients that we are uncertain of on the cervical spine and send for CT.

Obviously, those patients with brain or belly or some other spinal stuff will still go on to CT, so it’s not a replacement for CT, but we have reduced the number of patients that we send to CT.

No, we do not just use it for trauma. We found it particularly useful because of its speed within the realms of the normal emergency department. It’s so close to the front entrance; our nurses can use it just as much as our radiographers.

So what we’re finding is that where you’ve got somebody with a wrist injury that you don’t want to send to the conventional X-ray department, you can run this thing over a wrist and get accurate X-ray data in just the same time.

We found great acceptance with kids, because since it’s open, it’s not in a closed room, people aren’t all gowned up and so on, you can bring a child with its mom and sit it down without stress, do the film with far less exposure than a conventional X-ray which is good for the child, and it’s far faster.

So we’ve had a lot of acceptance across the board outside of trauma. There are some areas of South Africa where you can argue that a Saturday night is a normal mass disaster, and I suspect that there are areas in the United States that are exactly the same.

Because of the fast scanning, it does allow us to process multiple patients in the time allowed. Frankly, that’s why it was designed in the first place.

The learning curve, the biggest learning curve comes from the trauma surgeons, who have to learn to manipulate a computer wheel and a computer mouse and digitally play with the image.

It has one additional advantage. You can produce standard films on a piece of 8x4 paper which goes into the clinical notes as well as tie it down to a PACS system or anything else.

Dr. Dennis Wang (Potomac, Maryland): Let me have a disclaimer first. Our hospital actually had one of these Lodox Scanners. Our hospital, Washington Hospital Center, actually purchased one of these units about nine months ago and had it up and going, and we did have a specific contract so I was actually in the promotional material. This is a disclaimer prior to my comments.

We have a different configuration than yours in terms of how it is used in the initial trauma workup, and it’s very similar to shock traumas. One of the things I don’t see specific data on is just how accurate for different regions of bodies, cervical spine, chest, pelvis, extremities.

Are you correlating anything in terms of signs and symptoms? What we have learned specifically is that the cervical and thoracic junction is a very difficult area to see.

The time of 13 seconds is only true for a small person, an AP view. Additional time for thoracic spine and t-spine will
take significantly more time, although it’s still less than probably plain film.

One of our difficulties, which I would like your comment on, is how does your orthopedic surgeon view this? Is it adequate to look at the extremity films from Lodox and have them satisfied that this is what they’re going to operate on and use it for complete diagnosis or screening tests?

How accurate is it because of different angles of projection from the digital point for thoracic? How comfortable are you with using it for the thoracic to rule out the aortic tear in blunt trauma patients?

Dr. Kenneth D. Boffard: Our orthopedic surgeons are very comfortable with it. We did analyze the different body regions in detail, and they will be in the manuscript. I didn’t, in the interest of time, put them in here.

The comfort in the accuracy in chest and pelvis is 100 percent. We’re now running at about 89% for the cervical spine and about 76% for the C-spine/T-spine junction.

We’re running again at about the mid-80 percent confidence for long bones. We have broken it down by body region. Bearing in mind that these patients that we presented today were very specifically not positioned for the Lodox, they were positioned as the EMTs positioned them on the backboard.

We feel the advantage of putting them through as a screening test out of the ambulance exceeds the disadvantages of not positioning them.

Dr. Khaleel A. Shaikh (Scranton, Pennsylvania): In 1978, we had used a preliminary X-ray machine which was less sophisticated as this one. All patients who came to shock trauma got a single AP view of the whole body. It helped to identify and concentrate on fractures.

This was given to us by the Army Research Lab, who wanted to use it in the field. We found it quite helpful, especially when you’ve got a large volume of patients, and there are patients waiting in line for X-rays to get later on.

You could exactly say, I want these X-rays. I see a lot of future for this machine.

Dr. Kenneth D. Boffard: The advance of this as compared previously is firstly you didn’t have multiple films. This is a continuous film.

Secondly, we’re talking about a whole body X-ray with something like 1/6 of the exposure of a standard chest X-ray. The third is the speed.

One of the other spin-offs that we’ve had of this is angiograms now take 5ccs of contrast in the emergency room, because you can give the contrast and use the machine to follow that bolus of contrast down a leg or the arm, so 5ccs of contrast again enhances what we can do.

Dr. David W. Scaff (Allentown, Pennsylvania): Just a couple questions, before we make a broad statement of applying this as potentially a standard of care or for all institutions. At the University of Pennsylvania, we actually did a very similar study, using tomograms of the CT scan and compared that to the chest X-ray, and we presented that here at this meeting.

What we found is similar to what you’re finding, that the chest X-ray and the tomogram was very similar. However, their sensitivities compared to a chest CT scan was very poor. You know sensitivities of 30–40%.

Actually, we’re finding a number of injuries on the CT scan that required an intervention after they had a normal chest X-ray or normal tomogram. So I wonder, have you had to do any interventions after your rapid scan or statscan based on the results that are found on that?

Did people then go on to have missed injuries based on your statscan that were picked up on a CT scan that required an intervention?

Dr. Kenneth D. Boffard: We’ve had very few patients who have gone on to tomograms. Again, the issue is both time and the geography of access to the patient.

Where we find some benefit is that we can pick up very easily a pulmonary contusion on the statscan. In a number of patients with decreased air entry, maybe the tube is down too far, we can pick that up on statscan. Patients may get a chest tube because the decreased air entry is due to a pneumothorax and is differentiated from a pulmonary contusion.