Pretransfer Imaging Decisions in Rural Trauma Cases


After completing this article, the reader should be able to:
- Define urban and rural environments.
- Understand established levels of trauma care.
- Describe basic guidelines for trauma care and how they differ between rural and urban settings.
- Recognize situations in which diagnostic testing might not benefit patients being stabilized at rural hospitals before transfer.
- Explain potential ways to reduce unnecessary imaging of patients with trauma at rural locations.

Trauma injury is a major public health issue in the United States, and trauma injuries are the No. 1 cause of mortality in people aged 1 to 44 years, leading to more years of life lost than for many common diseases. Several factors affect trauma morbidity and mortality, including the setting where trauma occurs, how quickly the patient arrives at a medical facility, and whether transfer to another facility is necessary.

Rural vs Urban Settings

There are 59 million U.S. residents living in rural settings. Rural areas are considered all territory that is not included in an urban area. The U.S. Census Bureau recognizes 2 types of urban areas: urbanized areas are those with 50,000 or more people, and urban clusters are areas with between 2,500 and 50,000 people. The Figure shows the percent population residing in urbanized areas by county in 2010.
state that has established a formal trauma system, the
ACS-COT, or both. Designated level I trauma centers must have trauma
physicians and surgeons, anesthesiologists, nurses, and
resuscitation equipment available and ready for use at all times. Level I trauma centers also must function as
a trauma care resource for area hospitals and provide
education and research as part of their comprehensive
trauma care practice. In addition, level I trauma centers
must treat a minimum number of patients, including
at least 35 patients with major trauma per designated
trauma surgeon or 240 patients with major trauma per
year. These centers serve as the place of definitive care
for the most severely injured patients.

Level II trauma centers provide comprehensive trauma care in conjunction with level I trauma cen-
ters in urban areas or basic trauma care in less popu-
lated or rural areas. Trauma care requirements for
level II centers are the same as for level I facilities, but
these hospitals do not need to meet census require-
ments or provide research and education to area
medical centers.

In most cases, level III trauma centers serve a differ-
ent purpose than level I or II facilities. These hospitals

Figure. U.S. population from 2010 Census data.
typically serve areas without immediate access to a level I or II trauma center (eg, isolated, rural, or sparsely populated communities). Level III centers are prepared to assess, resuscitate, provide emergency surgery, and stabilize patients with trauma, then provide transport to a level I or II center if necessary.

In rural locations where no higher level trauma care center is available, a hospital might be designated as a level IV trauma center. Hospitals with a level IV designation provide advanced life support and stabilize trauma patients before they are transferred to a center that can provide definitive care.6

**Timeliness and Transportation in Trauma Care**

After trauma situations in which the patient is severely injured, care must be delivered quickly and efficiently because delays in situations that require a patient transfer can be life-threatening. Patients with trauma who are transferred to major trauma centers have a better chance of survival than those who remain at a hospital not prepared to treat them, and the optimum time frame for transporting patients with trauma to definitive care is less than 60 minutes. Transport and transfer times greater than 60 minutes are associated with greater mortality in severely injured patients.12

The 60-minute time frame to reach definitive care might pose a problem for severely injured patients in rural locations. In the United States, 84.1% of people are located within 60 minutes of a level I or II trauma center whether transported by ambulance or helicopter. However, only 24% of those living in rural areas have access to a level I or II designated trauma center within 60 minutes. In 2009, the Centers for Disease Control and Prevention reported that 45 million U.S. residents do not have access to a level I or II trauma center within 60 minutes. If definitive care is farther than 60 minutes away, patients benefit from stabilization and intervention at a rural hospital before they are transported to the level I or II trauma center. Medical staff at rural hospitals must stabilize the patient quickly and communicate effectively with the trauma center and transfer team. Harrington et al reported that if the transport time from a rural hospital to a level I or II trauma center is less than 30 minutes, patients might not benefit from admission to a local hospital for stabilization prior to transfer to a trauma center.14

In almost all cases it is best for severely injured patients to be transported directly from an accident scene to a level I trauma center because the necessary staff and equipment are available to assess, resuscitate, and treat patients with severe injuries. However, in rural locations, direct transfer to a level I trauma center is not always possible. When patients are initially transported to rural hospitals, a well-defined plan that includes direct and efficient communication between both hospitals to limit potential delays in care is essential to decrease morbidity and mortality.

**Transfer Delays in Rural Trauma Cases**

Because time associated with transport alone is unavoidable for patients in remote and rural locations, other delays must be limited. Once patients with trauma arrive at rural hospitals, therapeutic interventions, diagnostic testing, and inefficient protocols can delay their transfer to a facility for definitive care. Therapeutic procedures for severely injured patients with trauma include intubation, chest tube insertion, blood transfusion, fracture stabilization, and fluid administration. These procedures often are necessary to stabilize patients, and they typically account for delays only when staffing is inadequate or staff are unqualified. Delays also can occur if medical personnel in the rural facility do not realize they lack the proper resources to treat a patient or if they fail to realize that the patient requires transfer to a trauma center.17

Nontherapeutic testing, including radiographic examinations, can cause major delays that could lead to increased mortality or other negative outcomes for patients with trauma who arrive in rural hospitals. In many cases these nontherapeutic tests go against Advanced Trauma Life Support (ATLS) guidelines and could provide no benefit to the patient. In some circumstances, however, pretransfer imaging is clinically warranted to provide the highest level of patient care. Imaging is appropriate if it is based on sound clinical information. For example, it might be necessary to assess and stabilize some patients before they are transferred to a trauma center or even to determine whether a transfer is necessary.
Nonclinical Reasons for Imaging

In some cases the decision to perform radiographic imaging procedures might not be based on clinical criteria. Some studies suggest emergency department physicians order radiographs of patients with trauma based on fear of malpractice litigation rather than clinical indication.19,20

A cross-sectional survey completed by Lee et al suggested that referring physicians often consider nonclinical factors when ordering pretransfer radiographic imaging.7 This study indicated that almost half of those surveyed ordered pretransfer imaging for nonclinical reasons, including a misunderstanding of the law, liability concerns, and misperceptions of the receiving facility’s expectations. Physicians also might order diagnostic radiographic imaging because they think the examinations are expected by the trauma center to which the patient is being transferred.7 Concurring with many other studies, these authors concluded that nonclinical reasons for pretransfer imaging cause delays in transfer and do not alter pretransfer care.8

Potential Harms Associated With Pretransfer Imaging

Many peer-reviewed studies suggest pretransfer imaging in rural trauma cases provides little or no benefit to the patient. In addition, some studies provide evidence that pretransfer imaging could actually harm patients with trauma and reduce the likelihood of a positive outcome.

Longer Stays at Referring Hospitals and Delayed Treatment

Kearney et al reviewed outcomes of patients transferred via helicopter after serious traumatic injury.21 This retrospective cohort study compared transfer times for patients receiving pretransfer diagnostic procedures with transfer times of those who did not. Patients who received pretransfer diagnostic testing had a mean transfer time of 502 minutes compared with 223 minutes for those without pretransfer diagnostic testing. Although the delay in transfer was a significant amount of time, this study identified only a slight increase in mortality in the patients who were transferred after diagnostic testing compared with those who did not receive pretransfer imaging.21

Chatoorgoon et al reviewed cases occurring from 2002 to 2006 in which patients with trauma were transferred to a level I pediatric trauma center.22 Patients were divided into 2 groups: early transfer (< 2 hours) and late transfer (> 2 hours). The authors collected data on demographics, mode of transport, and referring hospital information, including pretransfer imaging. They determined that 82% of the patients arrived at the level I trauma center more than 2 hours after they were injured, and patients in the late transfer group arrived an average of 6 hours later than the early transfer group, making their arrival at the trauma center up to 8 hours after the injury occurred.22

The authors found that the referring hospital, the type of injury, the method of transport, and travel distance were not associated with an increased rate of late transfer.22 Pretransfer imaging was the factor that significantly increased the rate of late transfer. Forty-nine percent of patients in the late transfer group received more pretransfer imaging than the early transport group, and only 23% of those transferred in 2 hours or less had pretransfer imaging.22

In addition, Lee et al found that pretransfer radiographs did not always influence patient care at the referring hospital and that up to 45% of physician imaging requests might not meet clinical criteria.8 If diagnoses provided by radiographic imaging do not alter care at the referring hospital, the delay is most likely not beneficial to the patient. In fact, it becomes detrimental.

Computed Tomography

The study by Chatoorgoon et al specifically found that patients receiving head computed tomography (CT) or abdominal CT imaging had an increased rate of late transfer and were more likely to be in the late transfer group because of the increased length of time required in the radiology department to perform these examinations.22

According to a study by Onzuka et al, trauma patients who received CT scans at the referring facility had an added 90-minute delay before they were transferred, compared with patients who did not receive a CT scan prior to transfer.9 Furthermore, the authors inferred that the 90-minute delay associated with diagnostic testing did not alter the care for these patients.9
Another study found that patients spent a median time of 60 minutes outside the emergency department for noncontrast CT examinations.23

Although diagnosis can be important for patient assessment and stabilization, a study by Harrington et al found that patients with trauma who were transported to rural hospitals had diagnostic radiographs, including CT scans of the head (35%), CT scans of the abdomen (5%), and aortic arch arteriography (3%), at hospitals where neurosurgeons, cardiothoracic surgeons, and general surgeons were not available.44 The mean length of stay at the referring hospital was 162 minutes. The authors concluded that delays often are associated with nontherapeutic testing, including diagnostic imaging.19 In some cases, if medical staff is not available to provide intervention based on the diagnosis a radiographic study yields, there is little reason to perform the examination.

Haley et al studied 410 patients referred to trauma centers and quantified the effects of pretransfer radiographic imaging and repeat imaging.24 The authors found that patients who received a complete diagnostic workup, including a CT scan, at the referring hospital had a mean transfer delay of approximately 1 hour. They also found that repeat imaging at the level I trauma center was more likely for patients who had an increased length of stay at the referring hospital. The authors concluded that as a patient’s length of stay at the referring hospital increased, the more likely he or she was to receive a CT scan. Therefore, associated transfer delays were more likely.24

Onzuka et al also identified CT scanning as a factor leading to increased delay in transfer to a trauma center.9 This study measured the length of stay at the referring hospital for all trauma patients transferred to a regional trauma center during a 2-year period. Of the 249 patients in this study, 31.7% received pretransfer CT imaging. The patients who received a pretransfer CT scan had an average length of stay of 213 minutes at the referring hospital, compared with 118 minutes for patients who did not receive pretransfer imaging. The demographics and transfer characteristics of the 2 groups were not significantly different. The authors concluded that pretransfer CT imaging led to potential harmful effects for the patient and that the pretransfer CT scans did not appear to alter patient care at the referring hospital. Thus, pretransfer imaging contradicts the consensus that rapid transfer of significantly injured trauma patients is key to survival.9

A study by Mohan et al also suggested that pretransfer CT scanning leads to increased delays in transfer.25 In this retrospective cohort study, patients who had at least one pretransfer CT scan waited an average of 73 minutes before being transferred to a trauma center compared with patients who had no pretransfer CT imaging. Therefore, the length of stay for patients who received CT scans was 237 minutes vs a length of stay of 160 minutes for patients who did not. The authors also indicated that patients who had pretransfer CT imaging had an increased crude mortality rate, meaning they were more likely to die from any cause, when compared with those not receiving pretransfer CT imaging. The authors concluded that pretransfer CT scanning did not alter pretransfer care and could compromise patient health.25

Likely as a result of studies such as those discussed above, the ATLS guidelines for patients with trauma specify that CT examinations should not be a part of pretransfer diagnostic testing and that CT imaging should not be used to determine whether transferring a patient to a facility for definitive care is necessary.23

Teleradiology

Diagnostic imaging of patients with trauma for stabilization purposes prior to their transfer to a trauma center results in delays, and if a teleradiology interpretation is necessary, the length of the delay increases. Teleradiology is the transmission of digital images to another location so a radiologist can provide an interpretation for a physician in another facility.26 A study performed at the University of North Carolina Hospital found the mean turnaround time for teleradiography interpretations was 1.3 hours.20 For patients with trauma, this turnaround time might be too long.

Higher Radiation Doses and Increased Cancer Risks

Beyond the delay in transfer to a trauma center, pretransfer radiographic imaging can be harmful to patients because imaging might be repeated by the receiving facility. Thus, increased radiation dose and its potential stochastic effects are risks for patients who undergo...
pretransfer radiologic procedures, especially CT scans. Patients with severe injuries often receive multiple CT scans for screening and assessment. 10 Repeat imaging is especially concerning because patients with trauma often are young, and stochastic effects such as cancer, which takes years to develop, are more of a concern in younger people. 27 In some cases repeat imaging can be useful for staging or determining progression of an injury, so repeating the examination could be clinically necessary. However, if imaging is repeated for nonclinical reasons, the pretransfer imaging did not benefit the patient and unnecessarily increased his or her cancer risk.

Many patients with trauma who are stabilized at rural hospitals before transfer to a level I trauma center receive CT scans, and these patients’ CT scans often are repeated when they arrive at the trauma center. 8-10,25,26,30 CT scanning is associated with a high radiation dose, and a prospective cohort study of patients with trauma identified an average of 22.7 mSv dose per patient. 27 Using a linear no-threshold model extrapolation, the authors suggested that this dose level would result in nearly 190 additional cancer deaths in a population of 100,000. 27 In addition to this estimated whole-body dose, patients in this study experienced a mean dose of 156.3 mSv to the thyroid gland. 27 This dose level extrapolates to an estimated 11.7 fatal thyroid cancers per 100,000 individuals exposed at that level. 27

Emergency department physicians might not consider the risk of increased radiation dose while treating trauma patients. However, if pretransfer images do not provide clinical benefits, delay a patient’s transfer to definitive care, and are inadequate for diagnosis, the cancer risk and resource waste should be considered.

Another potential risk of pretransfer imaging is the additional intravenous contrast media a patient receives for a CT scan performed at the referring hospital. In 2011 Liepert et al reported that repeat CT imaging performed after transfer to a trauma center could lead to increased radiation dose, increased iodinated contrast material dose, a delay in definitive care, and increased financial costs to the patient. 11

**Repeat Imaging**

The evidence demonstrates that when trauma patients are imaged at a rural hospital prior to transfer, imaging studies likely will be repeated at the trauma center, and in some cases serial examinations are necessary. However, repeat imaging often provides no clinical benefit to the patient, wastes resources, delays definitive care, and increases the patient’s radiation dose.

In addition, repeat examinations often are conducted because images are not transferred with patients, a radiologist has not interpreted the pretransfer images, or pretransfer imaging was inadequate. Sometimes examinations are repeated because of medicolegal concerns. Repeat examinations conducted for these reasons indicate that the pretransfer imaging was unnecessary, wasted valuable resources, and added to costs.

Haley et al reported in 2009 that 53% of transferred trauma patients received repeat imaging at the trauma center to which they were referred. 24 A 2010 study identified the following reasons for repeat imaging at trauma centers: 27

- Inadequate technique.
- Lack of reconstructions.
- Inappropriate use of intravenous contrast material.
- Incompatible software.
- Images not accompanying the patient.

In the cohort studied by Mohan et al, approximately 57% of patients transferred to a level I trauma center had pretransfer CT scanning at the referral hospital. 24 Of the group who received pretransfer CT scans, 75% had a CT scan of the head, 55% had a CT scan of the spine, 55% had a CT scan of the abdomen and pelvis, and 35% had a CT scan of the chest. In addition, 75% of the patients in the study who received pretransfer imaging had duplicate scans upon arrival at the trauma center.

Mohan et al found that patients transferred from hospitals affiliated with the level I trauma center that was the setting for the study had decreased rates of repeat imaging compared with patients who were transferred from unaffiliated hospitals. 25 The authors presumed that the hospital network’s online radiologic database was the reason patients from the affiliated hospitals did not typically undergo repeat CT scans when they arrived at the trauma center. 24 The total cost of repeat CT acquisition for the study’s cohort of 7713 patients was estimated to be $3,761,389, or $488 per patient transferred. 24 In addition to increasing patients’ exposure to radiation, repeating CT scans for reasons...
not clinically indicated places a financial burden on patients and the U.S. health care system.

Gupta et al found many of the same reasons for repeat imaging when they evaluated trauma registry data for a cohort of patients transferred to a level I trauma center. The researchers gathered data that included the rate of CT scans at referral hospitals, the rate of scans repeated, and the reason each scan was repeated. They found a repeat scan rate of 40% in the retrospective data, and a repeat scan rate of 45% in the prospective data. Overall, 75% of the patients received pretransfer CT imaging, and 58% of these had repeated imaging upon arrival at the level I trauma center.

The authors identified inadequate techniques involving a lack of image reconstructions or a lack of intravenous contrast as the largest factor contributing to repeat imaging. Other factors that caused repeat CT scans were images not being transferred along with the patient (7%) and incompatible software (13%). The authors suggested that level I trauma centers and rural hospitals work together to standardize procedures and protocols for CT imaging in trauma situations to reduce the rate of repeat CT scans. By working together, the trauma centers and rural hospitals can limit repeat imaging, saving resources, improving patient safety, and limiting unnecessary radiation dose to the patient.

Sung et al also found that repeat scans were performed because of inadequate technique and software issues. This group studied the characteristics and quantity of pretransfer CT scans submitted for reinterpretation with patients transferred to a level I trauma center. Of the 425 CT scans identified in the study, 29% were repeated. Along with inadequate technique and software issues, the authors listed incomplete examinations, clinical decision, or a combination of these as reasons for repeat scans. In total, 35% of the repeated CT examinations were performed because of inadequate imaging or software issues, which the authors suggested might have been avoided. Sung et al concluded that pretransfer CT examinations put an unnecessary burden on radiologists, who must reinterpret the images, and that the trauma system they studied had significant communication failures between the referral hospital and the level I trauma center.

Part of the communication process between facilities is making sure pretransfer images are transferred with the patient to the trauma center. A retrospective chart review by Cook et al analyzed 382 cases, of which 199 patients (52%) received CT scans at the referring facility. In this group of patients, 18% had repeat CT diagnostic testing at the trauma center. Of those repeated CT scans, 53% were performed because images were not transferred with the patient, 17% were clinically warranted, and 30% were repeated even though the pretransfer CT scan was acceptable and there was no change in the patient’s condition. Using previously established radiation dose estimates for each scan, the authors estimated that repeat scans in their study cohort totaled 180 mSv. The authors suggested that rural physicians’ limited trauma training might lead to their use of CT scans to triage trauma patients and account for their decision to scan patients who would subsequently be transferred to a trauma center. In addition, medicolegal issues with radiologists’ reports and inadequate or nonexistent trauma protocols were listed as possible reasons for high rates of repeated CT examinations.

Chwals et al analyzed pediatric patients transferred to a trauma center after receiving a pretransfer CT scan of the abdomen or head. They found that 91% of the patients who received a pretransfer CT scan received a repeat CT examination after transfer to the trauma center. This group was compared with a group of patients who received initial diagnostic CT imaging at the trauma center after being transferred from a referral hospital. The patients without pretransfer scans did not require a repeated CT examination. After reviewing the trauma database and patients’ charts, the authors concluded that no repeat scans were acquired because of a patient’s worsening clinical condition or specific radiologists’ notations of additional clinical concerns. The authors concluded that the repeat CT examinations were acquired because of nonclinical factors including inadequate pretransfer scans, images not accompanying the patient, and incompatible imaging systems. For this study, unnecessary radiation dose was an even greater risk to the patients because of their young age. Another factor they identified was a potential delay in care for patients because of radiologists’
difficulty with accessing or evaluating the outside CT images. Delays in care and increased exposure to radiation are substantial concerns for patients, but the cost of repeat imaging also is of interest.

Haley et al quantified and examined the costs of repeat imaging in patients transferred to trauma centers. The authors studied 410 patient transfers and found that 53% of the transferred patients received repeat CT imaging. The calculated cost of the repeat imaging was $609 895, or $2985 per patient. The authors noted that although patient care is the primary concern, the cost of repeat imaging might indicate a need for improved trauma transfer protocol.

Thomas et al also reported on costs associated with radiograph repetition in patients with trauma who were transferred from a referring hospital to a trauma center. In this cohort, 43.3% of patients who underwent pretransfer CT imaging had the examination repeated at the trauma center. This study quantified only the frequency of repeat examinations and did not establish reasons for the repeat imaging. The authors estimated a cost of $49 843 for the repeated radiologic studies.

Repeat imaging is appropriate when it is acquired based on clinical indications or for follow-up care of a specific diagnosis. However, the literature suggests that a majority of the repeat CT scans are performed for nonclinical reasons. The most common nonclinical reasons for repeated medical imaging are:

- Images or radiologist’s report not being transferred with the patient.
- Reluctance of trauma center radiologists to rely on outside images.
- Information technology issues.
- Misperceptions of trauma center expectations.
- Medicolegal concerns.

Once a patient arrives at the trauma center, pretransfer CT images could place an unnecessary burden on the trauma center physicians and radiologists. Difficulties include having to navigate unfamiliar imaging systems and scanning protocols, which creates an increase in workload and might delay care. In addition, physicians must determine whether the pretransfer images are adequate, which also can lead to a delay in care.

If a scan acquired at the rural hospital is inadequate, a repeat examination is required because proper diagnosis and treatment decisions might not be possible otherwise. In these cases, complete repeat imaging using the trauma center’s protocols and standards is appropriate. Improper training or unclear trauma protocols at the referring hospital can result in inadequate pretransfer images, which increase the radiation dose to the patient, overuse resources, and delay the patient’s transfer to definitive care. Gupta et al suggested that trauma center staff provide education to staff at referring hospitals if advanced pretransfer imaging will be performed at the rural facilities. This can help standardize processes across the trauma system and potentially reduce the need for repeat CT acquisition.

Information technology issues and system incompatibility should not be the cause of repeat CT scans for patients arriving at a trauma center. In most cases, rural hospitals are linked to referral trauma centers within their geographic region. This can be a formal agreement as either an independent or satellite facility, which includes the ability to share or transfer medical records electronically. In other cases, there is no formal agreement, and the relationship is solely because of proximity. A transfer protocol and plan should include tested and reliable means for transferring information such as diagnostic images and reports.

In 2012 Robinson et al conducted a study on the medical imaging of transfer patients using a survey of the American Society of Emergency Radiology. This study categorized the reasons for repeat imaging and found that the reason most widely given for repeat imaging at the trauma center had to do with image quality. They also found that 2.4% of repeat imaging might have been caused by delays in receiving the pretransfer images. In addition, 2.4% of respondents said that repeat imaging allowed the trauma center to bill for the examinations. However, using repeat imaging solely as a method of generating revenue is not in the best interest of the patient.

Misperceived trauma center expectations and misunderstandings of the law were listed by Lee et al as main reasons pretransfer CT scans are ordered at the referring hospital and then repeated at the trauma center. In this study, many physicians stated that they ordered pretransfer CT scans because they believed the trauma center expected them to do so. The authors...
stated that miscommunication and inadequate trauma protocols are the cause of these misperceptions and that they indicate a disorganized or poorly defined trauma system.\(^4\)

In addition, Lee et al identified confusion of legal issues, including a misinterpretation of the Emergency Medical Treatment and Active Labor Act, as a cause of high rates of pretransfer imaging.\(^4\) The Emergency Medical Treatment and Active Labor Act states that when an individual presents at the emergency department of a hospital, “the hospital must provide appropriate medical screening examination within the capability of the hospital’s emergency department, including ancillary services routinely available to the emergency department, to determine whether or not an emergency medical condition exists.”\(^35\) This statement can be misinterpreted by emergency department physicians and often leads to unnecessary imaging when physicians think they should order any available test for diagnosis, whether it follows ATLS guidelines or not.\(^15\)

**Strategies to Reduce Unnecessary Pretransfer Imaging**

Improved protocols, clinical decision-making tools, and policies concerning rural trauma transfers could help determine when, how, and why patients should be transferred to trauma centers, as well as when radiographic imaging is clinically warranted. In fact, one study in rural Oregon showed that mortality among trauma patients decreased after a state-wide trauma system was implemented.\(^56\)

Proper training and improved communication also can help reduce pretransfer imaging and its negative effects on patients. For example, physicians who are not trained in trauma procedures sometimes use a CT scan for diagnosis and as a means of triage to identify whether a patient should be transferred to a trauma center.\(^50\)

Physicians at rural hospitals would benefit from ATLS certification because this knowledge is associated with a decreased rate of unnecessary pretransfer imaging.\(^3,11,22,24\) In a study by Lee et al, physicians who were not certified in ATLS were more likely to make imaging decisions based on nonclinical reasons and also more likely to order pretransfer CT scans.\(^3\)

Haley et al also suggested that requesting or requiring physicians treating trauma patients to be ATLS certified might limit the high rate of repeat CT imaging.\(^72\) In addition, the authors recommended improved image transfer protocols and the use of teleradiology to help facilitate proper image transfer and reduce repeat imaging.\(^29\)

Thomas et al noted that pretransfer imaging can aid in reaching a diagnosis that indicates a need to transfer the patient to a trauma center.\(^33\) Sufficient training in transfer protocols would help physicians avoid ordering pretransfer imaging for nonclinical reasons.

According to ATLS guidelines and trauma protocols established by the American College of Surgeons Committee on Trauma (ACS-COT), pretransfer CT scanning should not be a part of rural hospital trauma procedures.\(^14,24,28\) Increasing compliance with ACS-COT trauma treatment algorithms and creating a designated trauma team could reduce pretransfer diagnostic CT imaging and improve outcomes for patients initially treated at trauma centers level III and below.\(^37\)

**ACS-COT Compliance**

As a means to achieve fast and efficient treatment for patients with severe injuries, the ACS-COT developed treatment algorithms to help emergency department physicians successfully identify and treat these patients and transfer them to a better-equipped trauma center when necessary. Hospitals that participate in the ACS-COT verification program and trauma level designation have significant improvement in outcomes for trauma patients.\(^38\) In addition, institutions that prepare for ACS-COT verification are more likely to establish efficient trauma treatment and transfer protocols that improve patient care.\(^38\)

In January 1980, the ACS-COT created the ATLS course to better prepare health care institutions to treat severely injured patients.\(^39\) The program operates in more than 60 countries and is conducted for U.S. military medical personnel worldwide.\(^39\) The program was designed to give emergency department physicians a safe, reliable methodology to determine immediate treatment of trauma patients with multiple injuries. The program teaches participants to:\(^39\):

- Quickly and accurately diagnose a patient’s condition.

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Resuscitate and stabilize patients according to priority.
Determine whether the patient’s needs exceed the facility’s capabilities.
Arrange the patient’s transfer to another facility.
Ensure the level of care remains constant throughout evaluation, resuscitation, and transfer.

The ATLS course states that definitive diagnosis is not essential before transfer to a trauma center and could lead to unnecessary delay. Lee et al found that physicians who were not ATLS certified were more likely to order pretransfer imaging regardless of delay; incorrectly assume that the Emergency Medical Treatment and Active Labor Act indicates they must use all available resources before transfer, including advanced imaging; and were more likely to obtain a head CT scan of unstable patients. ATLS-certified physicians have increased compliance with ACS-COT treatment guidelines, which improves patient outcomes when transfer to a trauma center is necessary. Requiring emergency department physicians in rural locations to be ATLS certified might help reduce the negative factors associated with pretransfer CT imaging.

Designated Trauma Teams

A designated team of staff trained for triage, diagnosis, and treatment of trauma patients in rural hospitals could reduce delays in patient transfer and achieve compliance with ACS-COT guidelines. A before and after study that researched the effectiveness of a full-time trauma service at a level III trauma center in a rural setting found that the trauma team led to improved patient outcomes, including a 33% reduction in mortality. A staff trained specifically to treat severely injured patients can quickly and efficiently diagnose and prepare a patient for transfer to an advanced trauma center when needed. The ACS-COT has developed a specific program to help medical facilities in rural areas develop their own trauma teams and trauma programs to facilitate effective treatment of patients with trauma.

The Rural Trauma Team Development Course was designed to create a team capable of timely, organized, and rational response to care for trauma patients in a rural setting. Objectives of this one-day course include research into current regional, state, and local trauma systems. Based on this information, participants then identify components of an effective trauma team at their facility and what would be necessary to develop their own rural trauma team. This information is used to create the rural hospital’s trauma plan, and understanding of these concepts is assessed using simulated injured patient scenarios. After completing the course, participants should be able to develop and implement a rural trauma team.

A priority of the Rural Trauma Team Development Course is creating a 3-person trauma team consisting of the following members:

- Team leader – an emergency department physician or trauma surgeon.
- Team member 1 – a nurse.
- Team member 2 – a nurse, aide, emergency department technician, emergency medical technician, or clerk.

Each member of this team attends the Rural Trauma Team Development Course for special trauma care training along with other hospital personnel who might be involved in supportive roles for the trauma team, including respiratory technicians, laboratory technicians, radiologic technologists, and nurses.

Peer-reviewed research provides evidence that these strategies improve patient outcomes in trauma situations, reduce unnecessary pretransfer imaging and repeat imaging, and reduce delays at the referring rural hospital.

Advanced training and education in ATLS concepts and ACS-COT guidelines can ensure that even the smallest rural hospital provides timely and efficient trauma care to stabilize patients for transfer with fewer delays and less pretransfer imaging.

Conclusion

When patients with trauma are transported to a rural facility, many decisions must be made, including whether to perform medical imaging before transferring the patient to a trauma center. When medical imaging is not performed according to trauma guidelines, patients might suffer acute, life-threatening consequences and potential health issues in the future because of increased radiation doses. In addition, resources are wasted and health care costs rise dramatically.
Radiologic technologists in rural settings can partner with emergency department physicians to create and use trauma protocols. This partnership can help improve the care patients with trauma receive at the rural hospital and ensure they reach the trauma center as soon as possible.

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References


1. According to the article, which of the following terms refers to areas with between 2500 and 50,000 people?
   a. metropolitan  
   b. municipalities  
   c. urban clusters  
   d. urbanized areas

2. Which of the following statements is true of level I trauma centers but not true of level II trauma centers?
   a. Anesthesiologists must be available 24 hours a day.  
   b. Trauma physicians and surgeons must be available 24 hours a day.  
   c. Resuscitation equipment must be available at all times and ready for use.  
   d. The facility must meet trauma census requirements.

3. Hospitals designated as level III are prepared to assess, resuscitate, provide emergency surgery, and stabilize patients with trauma and then provide transport to a level I or level II trauma center when necessary.
   a. true  
   b. false

4. Time-sensitive care is vital to the survival of severely injured patients, and the optimum time frame to transport patients to a trauma center is less than _______ minutes.
   a. 30  
   b. 60  
   c. 90  
   d. 120

Read the preceding Directed Reading and choose the answer that is most correct based on the article.
10. Haley et al concluded that as a patient's length of stay at the referring hospital increased, the more likely he or she was to receive a(n):
   a. CT scan.
   b. blood transfusion.
   c. interventional radiologic procedure.
   d. PET scan.

11. Which of the following are Advanced Trauma Life Support (ATLS) guidelines regarding CT examination of patients with trauma?
   1. CT imaging should be part of pretransfer diagnostic testing when the emergency room physician thinks it is appropriate.
   2. CT imaging and diagnosis should not be used to determine whether transferring a patient to a facility of definitive care is necessary.
   3. CT imaging should not be part of pretransfer diagnostic testing.
   a. 1 and 2
   b. 1 and 3
   c. 2 and 3
   d. 1, 2, and 3

12. ______ effects such as cancer are more of a concern in younger people.
   a. Deterministic
   b. Stochastic
   c. Hormetic
   d. Homeostatic

13. According to Mohan et al, what is the estimated cost for repeat CT acquisition per patient transferred to a trauma center?
   a. $12
   b. $78
   c. $488
   d. $1293
14. In their study, Gupta et al identified which of the following reasons for repeated CT scans?
   1. inadequate techniques
   2. incompatible software
   3. images not being transferred with the patient
   a. 1 and 2
   b. 1 and 3
   c. 2 and 3
   d. 1, 2, and 3

15. In their retrospective study, Chwals et al found that ______% of patients who underwent pretransfer CT scanning had a repeat CT scan at the trauma center.
   a. 18
   b. 30
   c. 53
   d. 91

16. Which of the following is often misinterpreted by emergency department physicians, leading to high rates of pretransfer imaging?
   a. The U.S. Policy and Access to Care Act
   b. The Health Coverage Rights and Protections Provision
   c. The Emergency Medical Treatment and Active Labor Act
   d. The Affordable Health Care for America Act

17. Haley et al suggested which of the following to help facilitate proper image transfer and reduce repeat imaging?
   1. teleradiology
   2. improved image transfer protocols
   3. a standard software application across the trauma system
   a. 1 and 2
   b. 1 and 3
   c. 2 and 3
   d. 1, 2, and 3

18. According to the article, which of the following are strategies to reduce pretransfer imaging and improve outcomes for patients treated at trauma centers level III and below?
   1. passage of legislation prohibiting pretransfer imaging
   2. increased compliance with the American College of Surgeons Committee on Trauma (ACS-COT) treatment algorithms
   3. creating a designated trauma team
   a. 1 and 2
   b. 1 and 3
   c. 2 and 3
   d. 1, 2, and 3

19. A before and after study that researched the effectiveness of a full-time trauma service at a level III trauma center in a rural setting found that mortality was reduced by ______%.
   a. 24
   b. 33
   c. 55
   d. 75

20. Which of the following was/were designed to create a team capable of providing timely, organized, and rational care to trauma patients in rural environments?
   a. ACS-COT guidelines
   b. The Emergency Medical Treatment and Active Labor Act
   c. ATLS courses
   d. The Rural Trauma Team Development Course
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