Complete ultrasonography of trauma in screening blunt abdominal trauma patients is equivalent to computed tomographic scanning while reducing radiation exposure and cost

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BACKGROUND: Liberal use of computed tomography of the abdomen and pelvis (CTAP) in the screening of blunt abdominal trauma (BAT) has heightened concerns for increased radiation exposure and costs. We sought to demonstrate that in a select group of BAT patients, complete ultrasonography of trauma (CUST) is equivalent to routine CTAP but with significantly decreased radiation and costs.

METHODS: A retrospective analysis of patients screened for BAT from 2000 to 2011 in a Level 1 trauma center was performed. CUST was available from 8:00 AM to 11:00 PM daily, while CTAP was performed thereafter. Decision to perform CTAP or CUST overnight was made by the attending surgeon based on clinical examination. False negatives (FNs) were described as either a negative CUST or CTAP finding, which later required exploratory laparotomy. Medicare rates and previous data were used for the estimation of cost and radiation exposure.

RESULTS: There were 19,128 patients screened for BAT. A total of 12,577 patients (65.8%) initially underwent CUST, and 6,548 (34.2%) underwent CTAP; 11,059 patients (58% of the total BAT patients) avoided a CTAP, yielding an estimated savings of \$6.5 million and 188,003 mSv less radiation during the course of the study. Compared with the CTAP group, patients undergoing CUST had lower Injury Severity Score (ISS) (8.1 vs. 9.6), were older (44.7 years vs. 35.2 years), and experienced less traumatic brain injury (61.4% vs. 69.3%) (all with $p < 0.002$). Mortality was higher in the CUST group (1.8% vs. 1.2%, $p = 0.02$), but it was insignificant when adjusted for age older than 65 years (1.1% vs. 0.9%, $p = 0.23$) or head injury (0.6% and 0.3%, $p = 0.4$). FN CUST and FN CTAP were 0.29% and 0.1%, respectively (p = nonsignificant), with similar mortality (20% vs. 0%, $p = 0.44$).

CONCLUSION: CUST is equivalent to routine CTAP for BAT screening and leads to an average of 42% less radiation exposure and more than \$591,000 savings per year. (*J Trauma Acute Care Surg*. 2015;79: 199–205. Copyright © 2015 Wolters Kluwer Health, Inc. All rights reserved.)

LEVEL OF EVIDENCE: Diagnostic study, level IV; therapeutic/care management study, level IV.

KEY WORDS: Abdominal trauma; ultrasound; CT scan; trauma screening; fast ultrasound.

Blunt trauma to the torso is frequently evaluated with computed tomography of the abdomen and pelvis (CTAP).[1] CTAP is associated with a significant amount of ionizing radiation exposure compared with ultrasound[2,3] and is thought to be associated with increased risk of cancer, especially in younger populations.[1,4] CTAP has also been shown to incur significantly higher charges than Focused Assessment with Sonography of Trauma (FAST).[5] Rising concerns for increased radiation and cost with routine use of CTAP in the setting of blunt torso trauma has led to numerous efforts to reduce the use of CT by using physical examination algorithms and ultrasonography (US).[2,5–7] We have previously demonstrated that in a Level I trauma center, a combination of a comprehensive negative screening US result and negative clinical observation finding for 12 hours to 24 hours, in the setting of blunt abdominal trauma (BAT), virtually excludes missed abdominal injury.[8] Our hypothesis is that in a selected group of blunt trauma patients, our protocol for screening for complete US of trauma (CUST) was equivalent in the detection of clinically significant abdominal injury to CTAP while reducing cost and radiation exposure.

Submitted: September 22, 2014, Revised: March 23, 2015, Accepted: March 24, 2015.

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This study was presented as a Quick Shot at the 73rd annual meeting of the American Association for the Surgery of Trauma, September 10–13, 2014, in Philadelphia, Pennsylvania.

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DOI: 10.1097/TA.0000000000000715

PATIENTS AND METHODS

The study population consisted of all BAT patients in the trauma registry database between January 2001 and December of 2011of a single Level 1 academic trauma center. All major trauma patients at our institution undergo BAT screening. CUST was available between the 8:00 AM and 11:00 PM. Major trauma admissions presenting during those hours were screened by CUST, while those arriving overnight from 11:00 PM to

8:00 AM were screened by CTAP. A total of 19,128 patients meeting the Multiple Trauma Outcome Study criteria[9] were assessed during the course of 11 years. The University of California San Diego Trauma Center is separate from the emergency department (ED), and emergency medical service–transported patients are typically admitted directly and assessed by a surgeon-led trauma team. Approximately 35 patients per year were transported by emergency medical service with significant hypotension and brought directly to a dedicated trauma operating room (OR); these patients were excluded from the analysis. After screening imaging, patients were admitted to the trauma surgery service. Choice of available imaging modalities was based on the discretion of the attending trauma surgeon. Patients were followed up clinically and received serial abdominal examinations, repeat CUST, CTAP, or other adjunct imaging based on the clinical scenario and suspicion for intra-abdominal injuries by the attending surgeon. At our center, our CUST protocol encourages surgeons to obtain CTAP if the CUST examination is of poor quality, if the patient is very obese, in cases of seat belt injury, if there is hematuria, if the patient has significant abdominal pain without operative indications, or if spinal and/or pelvic fractures are suspected. A true positive examination finding was described as an initial imaging demonstrating intra-abdominal injury, which was later confirmed by exploratory laparotomy (EL) or CT. A false positive (FP) examination finding was defined as a positive CUST or CTAP result, which was later found to be negative for intra-abdominal injury after CTAP (in the case of positive CUST result) or laparotomy (in the case of positive CTAP result) was performed. True negatives (TNs) were defined as an initial CUST or CTAP, which was read as negative, and then subsequent imaging and hospital course did not reveal any abdominal injury. TNs did not require any further intervention or imaging throughout their hospitalization, maintained a benign abdominal examination, and were followed up in the trauma clinic or in audits of county trauma centers. Those patients who expired during the initial hospitalization with a negative abdominal imaging modality and were found to have no abdominal findings in their autopsy were also considered TN. False negative (FN) was defined as a negative initial CUST or initial CTAP finding in the final radiology report, but the patient subsequently underwent EL demonstrating a significant intra-abdominal finding. The EL could have been prompted by clinical suspicion, worsening serial abdominal examination, deteriorating patient physiology, or repeat imaging. All patients who expired received an autopsy.

Patients were prospectively entered into the registry by the trauma registrars at the time of discharge from the hospital. The registry contains information about all documented injuries, both abdominal and extra-abdominal, and it is updated regularly by the trauma registrars if new injuries are discovered after discharge. To identify any missed injuries after discharge, systemic monthly audits of all trauma centers in the County of San Diego are performed.

CUST examinations were performed during the trauma resuscitation by American Registry of Diagnostic Medical Sonography (ARDMS)–registered sonographers with 1 year to 20 years of experience. Probes used were 2.25-, 3.5-, or 5.0-MHz sector transducers or 5.0-MHz curved-array transducers with full-sized US machines (ATL HDI 3000, Advanced Technologies Laboratories, Bothell, WA, or Acuson Model 128-XP, Siemens Medical Solutions USA, Inc., Malvern, PA) using our previously described protocol. CUST is a more comprehensive examination than FAST. Seven abdominal regions were examined by the sonographer for fluid, including bilateral upper quadrants, epigastrium, pelvis, both paracolic gutters, and retroperitoneum. Visceral organs including kidneys, liver, and spleen were also evaluated for parenchymal abnormalities. Cardiac views were obtained to evaluate for fluid in the pericardial sac. CUST scanning time was typically 3 minutes to 5 minutes.

All US imaging was archived digitally with a picture archiving and communication system network (Healthcare IMPAX, Agfa, Ridgefield Park, NJ) and reviewed with a 19-in 1,024-pixel-resolution color monitor (MWD 421, Barco Display Systems, Kortrijk, Belgium). All US imaging were interpreted prospectively by the resident and staff radiologist on the US service at the time the scans were obtained. CUST scans were considered positive if they depicted free fluid or a parenchymal abnormality suspected of being an injury as read by a radiologist; otherwise, CUST findings were considered negative. On the basis of the findings in our previous study, small quantities of anechoic fluid less than 3 cm in the maximum anteroposterior dimension and isolated to the cul-de-sac or paraovarian recesses in women of reproductive age were considered physiologic and nontraumatic in the absence of other suspect findings.[10]

Statistical analysis was performed using SPSS version 19.0 (IBM Corp., 2010). Comparisons between the CUST and CT groups were performed using χ^2 for categorical variables, and Student's *t* test for continuous variables. Variables that did not meet parametric assumptions were analyzed using Mann-Whitney U-test for continuous variables and Fisher's exact test for categorical variables. Sensitivity (Sn), specificity (Sp), positive predictive value (PPV), and negative predictive value (NPV) were calculated to evaluate the performance of CUST to detect the need for EL.

RESULTS

A total of 19,128 BAT major trauma admissions were evaluated in our Level 1 trauma center from 2001 through 2011. Their mean (SD) Injury Severity Score (ISS) was 8.9 (8.6); 16.8% had an ISS greater than 15. A Glasgow Coma Scale (GCS) score of 13 or lower was present in 12.7%. From 8:00 AM to 11:00 PM, CUST was performed in 12,577 (65.8%) upon the discretion of the attending trauma surgeon as part of their BAT screening (Fig. 1). From 11:00 PM to 8:00 AM, CTAP alone without a CUST was used to screen the other 6,548 BAT patients (34.2%). Within the 12,577 CUST patients, 493 were read as positive (4%) and underwent either further imaging with a CTAP or proceeded to the OR because of associated findings or hemodynamic instability. CTAP was performed for 385 patients with a positive CUST finding, 199 (51%) were read positive, and 186 (49%) were read as negative. For the 12,070 CUST-negative patients, 10,951 (90.7%) did not require any further imaging throughout their hospitalization and were considered a TN finding. These patients did not

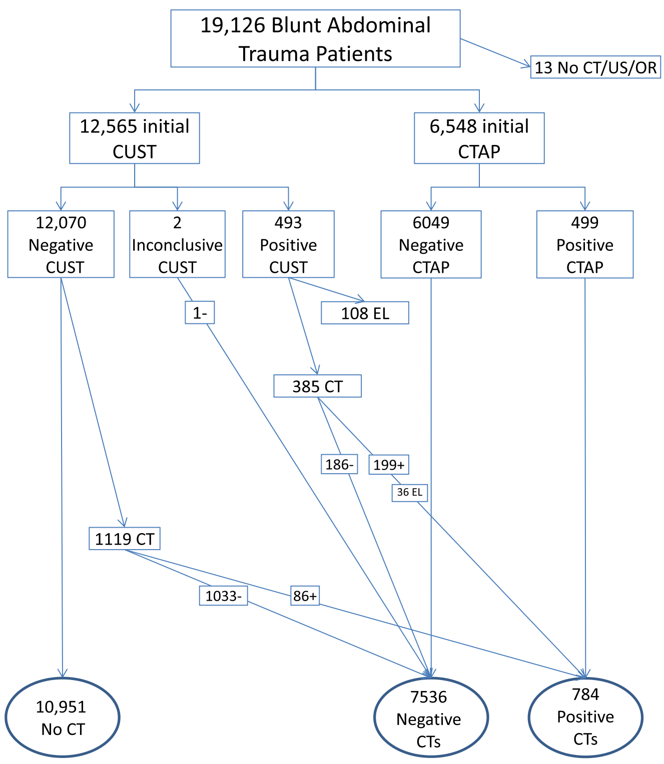

Figure 1. Distribution of patients for initial BAT imaging. The 6,548 initial CTAP patients include all CTAP during day or night shifts. EL, exploratory laparotomy.

require any further BAT interventions. Of the 1,919 patients with an originally negative CUST finding in whom the surgeon ordered a subsequent CTAP, 1,033 (92.3%) were negative for intra-abdominal injury. Only 86 patients from the originally CUST-negative group of 12,070 patients were found to have a positive CTAP finding (0.7%).

The average age of the CUST and CT groups was 44.7 years and 35.2 years ($p < 0.001$), respectively. The percentage of male sex in CUST versus CT group was 66.9% and 76.2% ($p < 0.001$), respectively (Table 1). Length of stay (LOS) was 3.9 days for the CUST group and 4.3 days for the CT group ($p = 0.07$). The CT group seemed to be more severely injured compared with the CUST group, as indicated by the higher ISSs (9.6 vs. 8.1, $p < 0.001$), more days on mechanical ventilation (0.9 days vs. 0.7 days, $p < 0.001$), lower GCS score on admission (13.8 vs. 14.1 $p < 0.001$), higher incidence of head injury (69.3% vs. 61.4%, $p < 0.001$), and higher intensive care unit (ICU) LOS (1.5 days vs. 1.4 days, $p < 0.001$), respectively. However, unadjusted mortality was higher in the CUST group compared with the CT group (1.8% vs. 1.2%, $p = 0.03$). Given the higher incidence of head injury in the CUST group, these data were reevaluated after controlling for head injury. When adjusted for the presence of head injury, there was no significant difference in mortality comparing the CUST group with the CT group (0.6% vs. 0.3%, $p = 0.38$). Multinominal logistic regression modeling was also used to control for head injury, as well as for age older than 65 years. Evaluation by CUST did not predict mortality in this group ($p = 0.362$), while age older than 65 years and presence of head injury was associated with increased mortality ($p < 0.0001$). Although the ISS for CUST versus CT group remained significantly lower (5.2 vs. 6.8, $p < 0.001$), the LOS (3.7 days vs. 4.2 days, $p = 0.13$) and mechanical ventilation days (0.4 vs. 0.5, $p = 0.58$) were not significantly different.

A total of 12,070 patients were found to have negative CUST finding during the 11-year period. Of the 12,070 patients, 35 subsequently required a laparotomy, constituting a 0.29% FN rate for CUST. The remaining 12,035 patients with negative CUST finding (99.7%) did not require any further intervention during their hospital stay and satisfied our definition of TN. Thirty-five patients underwent laparotomy following a negative initial CUST finding: 13 of them had a CTAP first and

TABLE 1. Univariate Analysis of Patients Screened by CUST or CT-PM, Including Patients With or Without Head Injury (All) and Without (No Head Injury) Head Injury

	All			No Head Injury			Age < 65 y		
	CUST	CT-PM	*p*	CUST	CT-PM	*p*	CUST	CT-PM	*p*
n	12,498	3,791		4,825	1,165		8,933	5,881	
Age, mean, y	44.7	35.2	<0.001	42.3	35.4	<0.001	36.5	33.5	<0.001
Male, %	66.9	76.2	<0.001	61.7	69.4	<0.001	70.6	78.0	<0.001
LOS, d	3.9	4.3	0.07	3.7	4.2	0.13	3.5	4.7	0.004
ISS, mean	8.1	9.6	<0.001	5.2	6.8	<0.001	7.2	9.8	<0.001
Ventilation days	0.7	0.9	<0.001	0.4	0.5	0.58	0.6	1.0	<0.001
GCS score on admission	14.1	13.8	<0.001	14.7	14.6	0.14	14.2	13.8	<0.001
Head injury, %	61.4	69.3	<0.001	N/A	N/A	N/A	59.8	69.4	<0.001
SBP, mean	139.3	136.4	<0.001	139.7	136.5	<0.001	137.2	135.8	0.76
ICU LOS, d	1.4	1.5	<0.001	0.87	0.97	<0.001	1.0	1.6	0.01
OIS liver > 0, %	1.3	2.4	0.002	1.1	2.2	0.004	1.4	2.3	0.02
OIS spleen >0, %	1.3	2.4	<0.001	1.3	3.5	<0.001	1.4	2.4	0.004
HVI, %	0.4	0.8	0.002	0.5	0.5	0.87	0.4	0.9	0.001
EL, %	1.1	1.5	0.07	1.1	1.8	0.30	1.2	1.6	0.08
Mortality, %	1.8	1.2	0.03	0.6	0.3	0.38	1.1	1.4	0.03

HVI, hollow viscus injury; NA, Not Applicable; OIS, American Association for the Surgery of Trauma Organ Injury Scale; SBP, systolic blood pressure.

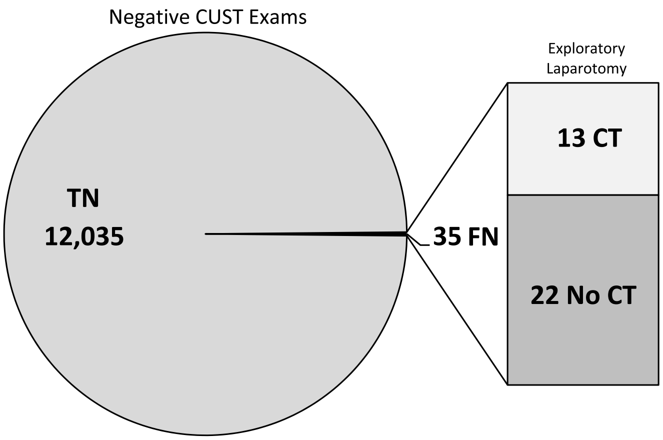

Figure 2. Incidence of FN as defined by a negative CUST finding and need for EL. Only 35 (0.29%) of 12,070 patients with a negative CUST finding required an EL.

22 went directly to the OR (Fig. 2). Seventy-three patients with initial negative CUST finding subsequently received CTAP, which resulted in a positive abdominal finding but did not require an EL. This constitutes an FN rate of 0.60% as defined by negative CUST finding but positive CTAP finding, compared with 0.3% FN as defined by negative CUST finding and positive EL finding, and remains consistent with our previous report.[8]

We defined true positive as an initially positive CUST finding in a patient confirmed at CT or EL. The Sn, Sp, PPV, and NPV of CUST were 76%, 97%, 22%, and 99%, respectively (Table 2). Alternatively, the Sn, Sp, PPV, and NPV of CTAP were 94%, 95%, 25%, and 99.9%, respectively. The FN rate for the CUST and CTAP groups were 0.29% and 0.1%, respectively ($p = 0.5$).

Positive results were noted in only 3.9% (493 of the 12,577) of our patients screened by CUST. Immediate laparotomy was performed in 108 (21.9%) positive CUST examination results, while 385 patients (78.1%) underwent further evaluation using CTAP. Of the latter group, 199 (51.6%) of 385 were found to have a positive CTAP result, 36 (18.1%) of 199 subsequently underwent laparotomy. Of the 385, 186 (48.3%) had a negative CTAP result, despite an initial positive CUST finding—these are FPs.

There were 35 FN CUST patients who underwent EL. A comparison of FN CUST to FN initial screening CTAP performed between 11:00 PM and 8:00 AM (CT-PM) is shown at Table 3. The CT-PM group does not include any patients that were surgeon selected to skip CUST in favor of CTAP. Four patients who were evaluated with CT-PM with an FN result underwent an EL. Even though the mean ISS (28 vs. 15.5, $p = 0.03$), presence of a liver injury (10 of 35, 27% vs. 0, $p = 0.04$), and presence of a spleen injury (10 of 35, 27% vs. 0, $p = 0.04$), were significantly higher in the CUST-FN group compared with the CT-PM FN group; all other characteristics including mortality were not statistically different. Hollow viscus injuries rates, which had been expected to have a higher missed rate in the CUST group compared with CTAP, were also not statistically different between CUST FN and CT-PM FN groups (31.4% vs. 25%, p = nonsignificant). Twenty-two patients (63%) of the CUST-FN group proceeded directly to the OR for EL without any further imaging, suggesting that the negative CUST result was disregarded by the surgeon because of the clinical scenario.

With the use of this protocol of screening surgeon-selected BAT patients with CUST, 11,059 patients avoided CTAP during their hospitalization. This constitutes 57.8% of the entire group of BAT patients screened during 11 years. Based on 2012 Medicare Physician Fee Schedule Payment Rates, we used the CPT for 74177, CT abdomen and pelvis with contrast reimbursement rate was $270.60 and $87.14 for technical and professional components, respectively. This is a conservative estimate as for almost all our BAT patients, our protocols require CPT 74170 and 72194, a CT abdomen and pelvis study with contrast, followed by a repeat, delayed non-contrast study, which has a Medicare charge of $597.[11] The average national US reimbursement rates for CPT 76700, "ultrasound, abdominal, real-time with image documentation, complete" was $126.90 in 2010.[12] With the use of the

TABLE 2. Two-by-Two Tables for CUST and CT Performed Between 11:00 PM and 8:00 AM (CT-PM)

		EL				
		Positive	Negative	Total		
					Sn	76%
					Sp	97%
CUST	Positive	109	384	493	NPV	99%
	Negative	35	12,035	12,070	PPV	22%
	Total	144	12,419	12,563	FN	0.3%
		EL				
		Positive	**Negative**	**Total**		
					Sn	94%
					Sp	95%
CT-PM	Positive	61	180	241	NPV	99.9%
	Negative	4	3,546	3,550	PPV	25%
	Total	65	3,726	3,791	FN CT	0.1%

TABLE 3. Comparison of Demographics for FN Groups as Determined by EL for Those Screened With CUST or CT-PM

	FN Group		
	CUST	CT-PM	*p*
n	35	4	
Age, mean	43.6	31.8	0.16
Sex	Male, 26; female, 11	Male, 3; female, 1	1.00
LOS, d	31.3	21.2	0.82
ISS, mean	28.0	15.5	0.03
Ventilation days	12.3	4.8	0.22
GCS score on admission	11.3	15	0.08
Head injury	26 (74%)	2 (50%)	0.56
SBP, mean	122.9	140.0	0.34
ICU LOS, d	19.7	9.8	0.47
OIS liver > 0	10 (27%)	0	0.04
OIS spleen > 0	10 (27%)	0	0.04
HVI	11 (31%)	3 (25%)	1.00
Mortality	7/35	0/4	0.44

HVI, hollow viscus injury; OIS, American Association for the Surgery of Trauma Organ Injury Scale; SBP, systolic blood pressure.

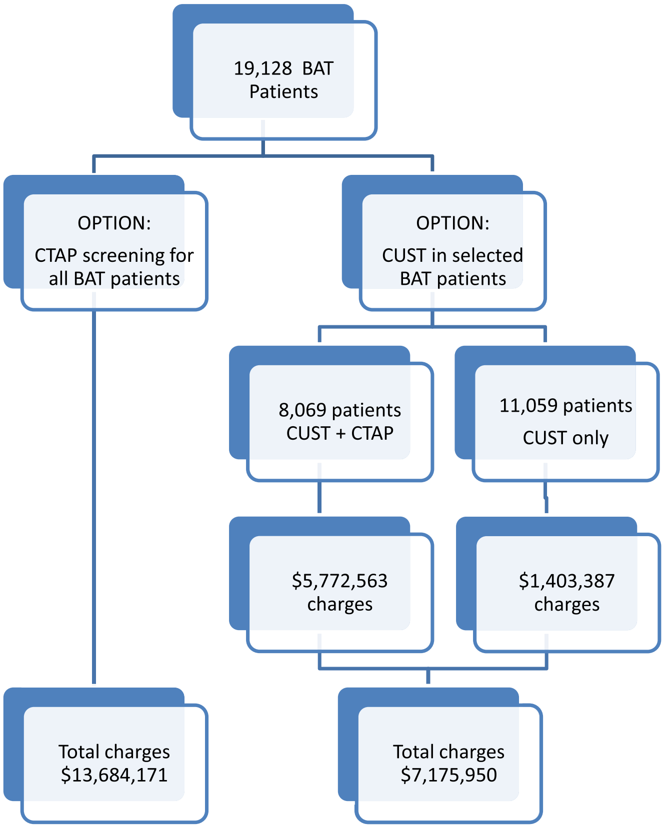

Figure 3. Charges of universal CTAP screening for BAT versus CUST. Using CUST reduced charges from $13,684,171 to $7,175,950 during the 11-year study period.

previously mentioned reimbursement rates as estimates for charges, the use of CUST in a selected group of BAT patients in our institution led to a cost saving of $6,508,221 over 11 years or $591,656 savings, on average, per year (Fig. 3). If our entire major trauma patient population had been screened for BAT with CTAP, as is routine in many centers worldwide, estimated charges of $18,989,000 would have incurred.

With the use of a conservative estimate of approximately 17-mSv radiation exposure per CTAP based on previous publications, approximately 188,003 mSv of radiation exposure was avoided using CUST.[2,13]

DISCUSSION

This large retrospective single-center study demonstrates that CUST, an enhanced ultrasound abdominal trauma screening protocol, when combined with real-time surgeon judgment is associated with similar outcomes as CTAP-screened patients. CUST offers reduced radiation exposure, with significant cost savings in BAT screening.

Our institution has used a protocol with preferential use of CUST in the evaluation of BAT since 1994. The nonavailability of CUST from 11:00 PM to 8:00 AM provided an opportunity for the evaluation of these two methods of screening BAT patients. The low PPV, a moderately low Sn (typically 60–85%), and an Sp ranging from 92% to 97% for FAST screening of BAT, as compared with CTAP, have been previously described by multiple authors.[14–16] The higher rate of FP and relative lower Sn of CUST compared with the original FAST studies may be because our radiologists regard any potential CUST abnormality, such as solid organ abnormalities, as an indication for further diagnostic evaluation using CTAP or EL. This may be a reasonable strategy to minimize the rate of FN cases at the expense of an acceptable increase in FP rate for CUST.

TNs are the most common result in studies of FAST. Similarly in our 12,070 patients who had an initially negative CUST finding, 10,951 patients (91%) were TN. TN patients did not require any further imaging or intervention and were eventually discharged from the hospital without any further abdominal intervention. The countywide medical audit system did not detect any readmissions to any trauma center in the county in the TN group. Review of autopsy data demonstrated that those TN patients who died from nonabdominal injuries did not have any contributory abdominal injuries. There were 1,033 patients who had an initially negative CUST finding but were subsequently further evaluated with a CTAP for clinical suspicion of BAT and found to have no findings on CTAP. Although our retrospective database did not include details of the clinical circumstances leading to the surgeon's decision to obtain further imaging in the CUST-negative group, most likely reasons for added imaging were those findings previously described that may have lowered confidence in CUST.

The liberal use of CTAP in the setting of BAT has been advocated and practiced in some trauma centers.[17–19] A patient screened for BAT using CUST with a positive result can be sent for surgical intervention or further imaging, depending on patient hemodynamics. Since imaging patients with a positive CUST finding with CTAP is within a common standard of care and since TN patients do not require any further intervention, emphasis in studying the quality of BAT screening should be placed on the FN group. An imaging modality with historically low Sn, the FN group of FAST or CUST has the potential for delayed or missed diagnosis with poor outcomes. Therefore, the FN group is of interest in the evaluation of CUST as a potential source of increased mortality.

Our results indicate that the mortality rate for BAT patients screened with CUST was similar to those screened with CTAP when controlled for head injury and slightly higher in CTAP group compared with the CUST group when controlled for age older than 65 years (Table 1). The CT-PM group was younger and more severely injured by higher LOS, ISS, mechanical ventilation days, percent head injury, need for EL, as well as lower GCS score and systolic blood pressure on admission. The raw mortality rate was higher for the CUST group compared with the CT-PM group. Mean age, however, was significantly higher in the CUST group compared with the CT-PM group, suggesting that age was a major contributor. Interestingly, the increased mortality noted in CUST-screened BAT became insignificant once controlled for head injury and was actually higher in the CTAP group compared with the CUST group once controlled for age older than 65 years, confirming the contribution of older age and its known higher risk for morbidity and mortality in the setting of trauma.[20] Furthermore, despite the observation of no difference in mortality in the head injury–controlled group, the incidence of liver, spleen, and hollow viscus injuries remained higher in the CT-PM group as compared with the CUST group. This observation also suggests that the increased incidence of abdominal injuries found in the CT-PM group did not contribute to the increased mortality but instead that head injury was the major contributor to death.

Since the incidence of BAT in the injured patients in most centers ranges from 2% to 6%[6,21,22] and since the FN rate for CUST is similar to that of CTAP, we believe it is reasonable to use a less invasive screening technology with decreased potential for radiation exposure and cost. If CTAP were to be used for all BAT screening at our center, 11,059 more patients during the course of 11 years would have received additional radiation. Given the large number of young trauma patients and the estimation that up to 2% of all cancers in the United States might be caused by medical imaging,[4] it is preferable not to subject this population to ionizing radiation as long as patient safety is not compromised. There are recent reports of centers attempting to minimize radiation exposure for screening for BAT using various decision guidelines and predictive models with resultant significant radiation savings.[2,4,6] Even though the risk of trauma death far outweighs the long-term risk of death from a future malignancy in major trauma patients, the younger patients with low suspicion for BAT are probably most likely to benefit from a radiation-sparing approach.[23,24] By applying our protocol of selected CUST in BAT, we avoided ionizing radiation in 58% of our BAT-screened patient population. This statistics from a single trauma center, if generalized to the entire country, would translate into a significant reduction in the rate of ionizing radiation to a relatively young patient population, and theoretically, a decrease in iatrogenic radiation exposure-related malignancy rates.

This study has significant limitations. The retrospective nature of this review highlights the distinct set of biases and restrictions inherent in any such review. Nonetheless, this review is the largest of its kind, reviewing 19,128 patients, with a negative screening CUST finding in 12,035 of those patients. The FN rate is 0.29%, consistent with our previous reports. The generalizability of these data to other institutions without the continuous presence of ARDMS-credentialed sonographers, radiographers, and surgeons willing to perform CUST may limit applicability. Our protocol is well embedded since 1994 without any observed increase in missed injuries, complications, or mortality as demonstrated by our previous publications by our institution in this regard.[8,10,14,15] The CUST process is a more detailed examination than FAST, and broader adoption will have implications for training, performance, interpretation, and quality assurance of abdominal ultrasound in trauma. However, we think it may be achieved by well-trained physician-sonographers using Quality Assurance processes with the involvement of interested surgeons. Supporters of routine ED “pan scanning” including CTAP argue that they can discharge patients from the ED more rapidly. However, we feel that ED patients with suspicion of BAT but otherwise responsive may be well served by an assessment with CUST and observation, thus avoiding the unnecessary radiation and higher charges of routine CTAP.

As result of our study, we have reached agreement within our health system to have ARDMS-registered sonographers available 24 hours a day and have stopped the use of CTAP for routine BAT screening at night.

In conclusion, surgeon-selected BAT screening with CUST seems to have similar outcomes as CTAP yet demonstrates significant reduction in charges as well as a large reduction in radiation exposure in trauma patients. Even though further investigation of CUST in a prospective, randomized fashion is needed, the current data do strongly suggest consideration for implementation of such a protocol in trauma centers.

AUTHORSHIP

Z.A.D. contributed in the literature search, data analysis, study design, and writing. Q.M. contributed in the study design and data analysis. A.S. contributed in the data collection and data analysis. G.C. contributed in the study design, data interpretation, study design, and critical revision. R.C. contributed in the study design and critical revision. J.D. contributed in the literature search, study design, data analysis, data interpretation, writing, and critical revision.

DISCLOSURE

The authors declare no conflicts of interest.

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