EFSUMB Course Book

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**E-FAST**

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**Historical development and definition**

Morbidity and mortality of patients in haemorrhagic shock are high, and haemorrhagic shock is not only caused by trauma. Haemorrhages also occur in ectopic pregnancy, coagulation disorders, vascular pathologies, postoperatively and with significant abdominal trauma. 20 – 40% of patients with significant abdominal trauma have normal clinical findings. It is therefore obvious why trauma surgeons need reliable diagnostic aids. When searching for appropriate solutions, they discovered sonography at the end of the 1970s. This was after diagnostic peritoneal lavage (DPL) and computed tomography (CT) were introduced. Ultrasound offers great advantages over the somewhat elaborate and invasive DPL and expensive CT with its associated side effects: it is simple, is performed by the attending physician at the bedside in real time, can be repeated as often as necessary, is non-invasive, does not involve radiation, needs only a minimal amount of training, and is cost-effective. This technique rapidly developed into the standard procedure in emergency rooms. The term Focused Assessment with Sonography for Trauma (FAST) was coined by a consensus conference in 1999. FAST is concerned with the detection of fluid in the peritoneal cavity and pericardial space, without distinguishing between fluid and blood. As early as the beginning of the 1990s the ultrasound examination was extended to detecting haemothorax, and pneumothorax and incorporated in 2004, when the term Extended FAST (E-FAST) was born. In brief, E-FAST is a focused, rapid ultrasound examination that is easy to learn. It is performed at the bedside to answer 3 clinical questions transformed into 5 sonographic questions using information from 6 standard views. The main purpose is to establish whether the patient has haemodynamically relevant haemorrhages in the peritoneal cavity, or pleural or pericardial space, or pneumothorax. Together with the overall clinical assessment, this information helps in taking 5 important diagnostic and clinical decisions. This means that the objective of the E-FAST is not to establish whether there is any bleeding at all, nor is it performed to locate the exact source of bleeding, which would involve much more complex and time-consuming investigations but whether there is ongoing bleeding which demands an operation?

**Table 1** Clinical questions.

<table>
<thead>
<tr>
<th>Clinical questions:</th>
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<tbody>
<tr>
<td>Does the patient have blood in the abdomen and/or thorax?</td>
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<tr>
<td>Does the patient have a pericardial tamponade?</td>
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<tr>
<td>Does the patient have a pneumothorax?</td>
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Table 2  Sonographic questions.

<table>
<thead>
<tr>
<th>Sonographic questions:</th>
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</thead>
<tbody>
<tr>
<td>✓ Is there any fluid in the peritoneal cavity?</td>
</tr>
<tr>
<td>✓ Is there any fluid in the pericardial space?</td>
</tr>
<tr>
<td>✓ Are there signs of tamponade?</td>
</tr>
<tr>
<td>✓ Is there any fluid in the pleural space?</td>
</tr>
<tr>
<td>✓ Are lung sliding, B-lines, the lung pulse and the lung point present?</td>
</tr>
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</table>

Table 3  E-FAST, decision making.

<table>
<thead>
<tr>
<th>E-FAST = Decision making help for:</th>
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<tr>
<td>✓ Immediate laparoscopy or thoracotomy</td>
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<tr>
<td>✓ Choosing the primary site of access (thorax or abdomen)</td>
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<tr>
<td>✓ Relief from pneumothorax and haemothorax</td>
</tr>
<tr>
<td>✓ Transition to secondary survey</td>
</tr>
<tr>
<td>✓ Abdominal or thoracic CT</td>
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Figure 1  Standard views. 1: Right upper quadrant, 2: Left upper quadrant, 3: Suprapubic, sagittal and transverse axis, 4: Subcostal cardiac, long and short axis, 5 and 6: Bilateral anterior longitudinal chest.
The E-FAST has become established as an important component of the internationally recognised Advanced Trauma Life Support (ATLS) in shock room management. The ATLS consists of 2 phases. The primary survey consists of life saving measures prioritised according to the diagnostic-therapeutic ABCDE scheme (A = Airway, B = Breathing, C = Circulation, D = Disability and E = Exposure/Environmental Control). Focussed sonography forms part of the assessment done in the steps ‘Breathing’ and ‘Circulation’. Depending upon the state of the patient, the E-FAST is performed in the secondary survey (head-to-foot examination) and after discharge from the emergency room on the observation ward. It is also indispensable when examining patients with cardiovascular shock of unclear origin, acute lower abdominal pain in women of child-bearing age, and during and after resuscitation.

**Investigations**

**Standard views – normal and pathological findings**

The E-FAST investigation consists of 6 standard views. The prescribed order of investigations [Figure 1] should always be adhered to because emergency investigations are often performed under great pressure. This is the only way to ensure that no steps in the investigation are missed.

Free fluid is usually echo-free or echo-poor in an ultrasound image. A fresh haematoma, however, may on occasions be echogenic. The characteristic of free fluid is that it changes its position if the patient’s position is changed. It is therefore important to identify as such the spaces in which free fluid may collect. Exact measurement of the amount of fluid is impossible using sonography. There are formulas, however, for different regions, which make it possible to make estimates of volume [(4)]. Standard views are shown in Figure 1.
The following describes and discusses the 6 standard views with comparisons of normal and pathological findings.

**Position 1: Right upper quadrant**

The right upper quadrant view covers the hepatorenal recess between the kidney and liver, also called the Morison pouch [Figure 2]. Free fluid is visualised as an echo-poor band between the two organs [Figure 3, Video 1]. If the mean thickness of the band of free fluid in Morison’s pouch is wider than 1 cm, it can be assumed that up to 1 litre of intraperitoneal fluid is present [(5;6)]. The Morison pouch, however, is not always filled. In such cases, the intraperitoneal fluid can usually be detected along the lower anterior margin of the liver.

**Figure 2**  
Normal findings (right upper quadrant). 1: Liver, 2: Kidney, 3: Morison pouch.

![Figure 2](image)

**Figure 3**  

![Figure 3](image)

By directing the probe through the liver towards the top of the diaphragm, the presence of subphrenic fluid can be excluded or visualised [Figure 4]. Gliding the probe in a craniodorsal direction to the posterior axillary line searches for fluid in the right pleural space directly above the diaphragm. When doing so, the respiratory movements should be observed: when
filled with air, the lung should slide across the liver like a curtain in the costodiaphragmatic angle [Figure 5, Video 2]. Small amounts of fluid from 5 ml upwards can be detected here i.e. up to the physiological range [(7)]. Pleural effusions and haematomas can be very varied which means that volumetric assessments are unreliable [Figure 6]. To obtain a rough estimate of the volume in millilitres, with the patient supine, the width of the fluid in the cross-section is measured in millimetres from the interior thoracic wall to the dorsal margin of the lung and multiplied by 20 [(8)]. The best position for drainage can also be decided at the same time.

**Figure 4**       **Subphrenic organising hematoma of the liver (right upper quadrant). 1: Liver, 2: Haematoma, 3: Diaphragm, 4: Small effusion.**

![Figure 4 Image]

**Figure 5**       **Normal dorsal costodiaphragmatic angle (right upper quadrant). 1: Liver, 2: Costodiaphragmatic angle, 3: Mirror artefact, 4: Adrenal gland, 5: Kidney.**

![Figure 5 Image]

**Figure 6**       **Haemothorax (right upper quadrant). 1: Haemothorax, 2: Diaphragm, 3: Liver, 4: Spine.**

![Figure 6 Image]
Position 2: Left upper quadrant

The left upper quadrant view investigates the presence of free fluid in the perisplenic and splenorenal space, also known as the Koller pouch [Figures 7 and 8, Video 3]. To avoid missing free fluid, the splenic hilus, the spleen and kidney should be visualised in one plane. It must be borne in mind that in cases of gastric retention, the fluid may extend to the spleen, and can simulate fluid in the Koller pouch on superficial examination. If the splenic haematomas are subcapsular and are situated along the extreme outer margin, or are subphrenic, the Koller pouch may be empty [Figure 9]. Occasionally it is possible to directly visualise a ruptured spleen, although this can be quite time consuming. Whether active bleeding is present would be best evaluated using contrast enhanced ultrasound during the secondary ATLS survey.

Figure 7  Normal findings for Koller pouch (left upper quadrant). 1: Spleen, 2: Fat in the Koller pouch, 3: Kidney, 4: Costodiaphragmatic angle.

Figure 8  Small amount of free fluid in the Koller pouch (left upper quadrant). 1: Spleen, 2: Fluid, 3: Kidney.
Figure 9  Free fluid at the lower pole of the spleen, subphrenic (left upper quadrant). 1: Spleen, 2: Fluid, 3: Diaphragm.

Similar to the view described in Position 1, the probe is also pointed cranially to examine the left pleural space for free fluid. The same criteria apply as for the right side. Because the spleen is considerably smaller than the liver, it is not always possible to achieve a good sonic window to the costodiaphragmatic angle. In such cases, to exclude the presence of fluid in the pleural space, the lower margin of the lung should be visualised in the posterior axillary line for respiratory-synchronous movement (‘curtain phenomenon’).

Position 3: Suprapubic pelvis

Directly above the symphysis, attempts should be made to visualise the urinary bladder in the sagittal and transverse axis. In women, the examination starts with the sagittal axis and the uterus is visualised behind the bladder. The Douglas pouch is situated dorsal to this [Figures 10a/b, Video 4]. In men, the examination starts with the transverse axis and the operator orients themselves on the prostate behind the bladder [Figures 11a/b, Video 5]. Any free fluid in the Douglas pouch [Figures 12a/b, Video 6] or rectovesical pouch [Figures 13a/b, Video 7] can be visualised directly in this way using the urinary bladder as a sonic window. Large amounts of fluid, when present, are found in front of, beside and behind the uterus. Difficulties occur if the bladder has been emptied or perforated. In such cases, the free fluid can sometimes be visualised in the pelvis minor with no lateral edge. The patient must have a full – or even only partially full – bladder if fluid in the lower abdomen is to be excluded.
This is because if the bladder is empty, intestinal gas often impairs the imaging of the relevant structures. The status of bladder filling must therefore be documented in the patient’s records. The ellipsoid rotation equation can be used to estimate the volume of fluid in the lower abdomen, especially if the edges and shape of the body of fluid are roughly this shape. The equation is length x breadth x depth x 0.5 and, with an appropriately shaped collection of fluid, the result is an acceptable estimate.

**Figure 10**  Normal lower abdominal findings in women (suprapubic sagittal and transversal) (a) sagittal axis 1: Uterus, 2: Bladder (b) transverse axis 1: Bladder, 2: Uterus, 3: Rectum.

![Figure 10](image)

**Figure 11**  Lower abdominal view in men (suprapubic sagittal and transversal). (a) Sagittal axis. 1: Bladder, 2: Prostate, 3: Seminal vesicle. (b) Transversal axis. 1: Bladder, 2: Prostate, 3: Rectum.

![Figure 11](image)
Figure 12  Fluid in the Douglas pouch (suprapubic sagittal and transverse). (a) Sagittal axis. 1: Bladder, 2: Uterus, 3: Free fluid in the Douglas pouch. (b) Transverse axis. 1: Bladder, 2, Uterus, 3: Free fluid in the Douglas pouch.
Figure 13  Rectovesical free fluid in men (suprapubic sagittal and transverse). (a) Sagittal axis. 1: Free fluid in the rectovesical excavation, 2: Balloon of indwelling catheter, 3: Bladder, 4: Clot in the rectovesical excavation, 5: Intestine. (b) Transverse axis. 1: Free fluid in the rectovesical excavation, 2: Clot in the rectovesical excavation.

Ovarian cysts, infiltration of bleeding into cystic ovaries and endometrial cysts can lead to misleading results.
Position 4: Subcostal cardiac

The subcostal cardiac view visualises the 4 chambers of the heart including the pericardium [Figure 14, Video 8] by pointing the probe cranially in the direction of the left shoulder. This enables visualisation of a pericardial effusion. The pericardium appears as a light echo-rich line surrounding the heart. An effusion is echo-free or echo-poor [Figure 15, Video 9]. Blood and pus can be moderately echogenic, especially in cases of organised haemopericardium. In the subcostal cardiac view, the extent of the pericardial effusion is likely to be overestimated because of the angle of the view. The haemodynamic relevance of a pericardial effusion cannot be estimated based on its size. Even a small acute pericardial effusion may be very dangerous, whilst large, slowly-developing chronic effusions can be well tolerated. B-mode signs for tamponade should be used to assess haemodynamic relevance. These are inversion of the right atrium (late diastolic) and right ventricle (early diastolic). It is also worth turning the probe anticlockwise to assess the filling status and collapsibility of the vena cava inferior (this is not part of standard E-FAST).

Figure 14  Normal 4 chamber view of the heart (subcostal, long-axis). 1: Liver, 2: Right ventricle, 3: Left ventricle.

Figure 15  Haemopericardium with no signs of tamponade (subcostal, long-axis). 1: Liver, 2: Pericardial effusion, 3: Right ventricle, 4: Left ventricle.
The subcostal approach to imaging the heart is difficult in obese and flatulent patients. Recourse can be taken to the parasternal approach in the long and short axes, or sometimes apical imaging of the four chambers is possible. In some cases, the operator has to be satisfied with the best possible view. In order not to miss focal pericardial effusions, the best image possible should be obtained, preferably with a 4 chamber image and two dimensional visualisations with M-mode documentation.

Epicardial fat may make diagnosis difficult (see 2.2. Pitfalls). In cases of tamponade, targeted drainage can be performed immediately under sonographic control so that complications such as injuries during puncture and even myocardial puncture are avoided.

**Positions 5 and 6: Bilateral anterior chest**

The examination is conducted with the patient supine. The starting point is the 3rd or 4th intercostal space between the parasternal and the mid-clavicular line. With the patient supine, this is usually the highest point. Air rises up to this point if it is not trapped elsewhere. First the longitudinal axis is investigated to locate the rib shadows and the respiration-dependent pleural reflex in the intercostal space. This approach also enables the less experienced operator to be sure that they have located two rib shadows, the intercostal musculature and the deeper seated pleural line. The focus is placed on the pleural line, and the respiration-synchronous sliding sign is observed [Video 10]. If lung sliding can be demonstrated, then pneumothorax is not present. In case of no sliding, the probe is fanned anticlockwise onto the intercostal space to enable further signs to be better assessed. The image shows B-lines and the lung pulse [Figure 16]. Absence of these indicates the presence of pneumothorax. The lung pulse and lung sliding can be documented with M-mode or colour-Doppler. The most definite evidence of pneumothorax is the lung point. This is the transition point between the inflated lung and the pneumothorax. The lung point is respiration-synchronous [Figure 17, Video 11]. If the criteria for a pneumothorax are present with the probe in the starting position, it is slid laterocaudally to look for the lung point, which permits a careful estimate of the extent of the pneumothorax.

Lung sliding may be absent if pleural adhesions are present. Respiratory excursions are limited in the presence of severe chronic pulmonary obstructive disease, and lung sliding may not always be demonstrable. To exclude pneumothorax, therefore, all four criteria must be fully investigated and the two sides of the chest must always be compared.

**Figure 16** Normal findings for the pleura and lung (anterior interpleural). 1: Pleurareflex, 2: B-line.
Figure 17  Lung point with pneumothorax (anterior interpleural). 1: Normal lung, 2: Lung point, 3: Pneumothorax.

**Pitfalls**

Although the investigation is easy to perform and is simple in terms of diagnostic sonography, ambiguous findings and wrong interpretation of findings can lead to incorrect diagnoses. This section describes the most important pitfalls that lead to false-positive and false-negative findings.

**False-negative findings**

**Peritoneal cavity**

Small amounts of free fluid in the peritoneal cavity can be missed at ultrasound. Depending on the site and body position, estimates range between 30 ml and >600 ml. If all standard views are properly investigated, however, the threshold lies at about 200 ml [(9)]. If it is an
initially small amount of blood and bleeding persists, the deep detection rate can be increased by repeating the investigation.
In the early stages of development, haematomas can be echogenic, especially when they are in the process of organisation.

**Pericardium**

Despite injury to the heart due to penetrating trauma, no pericardial effusion may be present, because the blood has escaped from the ruptured pericardium into the pleural space [(10)]. If the patient’s condition is unstable and the blood drains from the pericardium into the pleural space, emergency thoracotomy is still indicated.

**False-positive findings**

**Peritoneal cavity**

**Ascites, urine and intestinal contents**

Urine and leaked intestinal contents are difficult to distinguish from blood. With ascites, however, usually additional sonographic signs of cirrhosis of the liver, liver metastases, right heart failure or pathologies of the gall bladder are found. If there is the slightest doubt, this can only be clarified by needle aspiration under ultrasound control.

**Double-line sign**

Echo-poor fat in the Morison pouch can simulate fluid. The ‘double-line sign’ is used to distinguish between the two [(11)] [Figure 18]). Fat has two echo-rich lines on either side, one along the liver and the other along the kidney. This echo-rich line directly along the liver is generally not present with free fluid in the hepatorenal recess [Figure 3].

**Figure 18** Double line sign in Morison’s pouch (right upper quadrant). 1: Liver, 2: Margin of liver, 3: Margin of kidney, 4: Kidney.
**Gastric fluid sign**

When examining the left upper quadrant of the abdomen, the operator needs to know how to differentiate between fluid in the stomach and free intraperitoneal fluid. Usually, free fluid collects either subphrenically or between the spleen and the kidney, resulting in an echo-poor band. Gastric content is generally oval surrounded by an echo-rich edge (stomach wall) and often contains food residues (light, floating internal echoes) [(12)] [Figure 19].

**Figure 19**  Gastric fluid sign (left upper quadrant). 1: Lower pole of spleen, 2: Stomach contents, 3: Stomach wall.

**Kissing liver**

When examining the left upper quadrant of the abdomen, if the left lobe of the liver is touching the spleen, it can be somewhat echo-poorer than the spleen because of anisotropy, and can be mistaken for free peritoneal fluid. To avoid this pitfall, the operator should turn up the gain so that liver tissue is easier to identify, position the probe anteriorly, or turn on the colour Doppler to visualise liver vessels [Figure 20].

**Figure 20**  Kissing liver (left upper quadrant). 1: Liver, 2: Spleen, 3: Pleural reflex.
Seminal vesicle

In men, a large seminal vesicle can simulate fluid. Free intraperitoneal fluid, however, is never found beside or directly above the prostate, but more cranially and beside or above the bladder [Figures 21a,b].

Figure 21  (a) Seminal vesicle (suprapubic sagittal). 1: Bladder, 2: Prostate; 3: Seminal vesicle. (b) Seminal vesicle (suprapubic transverse). 1: Bladder, 2: Prostate, 3: Seminal vesicle.

Physiological fluid in women of childbearing age [(13)] [Figure 22].

Figure 22  Physiological fluid in the Douglas pouch (suprapubic sagittal). 1: Bladder, 2: Ovary, 3: Uterus, 4: Intestine. □ = Antero-posterior diameter 2.1 cm.
Independent of the menstrual cycle, free fluid in the Douglas pouch is normal in 30–40% of women of childbearing age. If the antero-posterior volume has a diameter of more than >3 cm, or there are internal echoes, and/or the collection of fluid spreads above or beside the bladder, then this finding is pathological.

**Pericardial space**

**Epicardial fat**

Echo-poor epicardial fat can be mistaken for a pericardial effusion. M-mode is used to distinguish between the two. Fat produces wave-like movement in the whole width of the band, whilst with fluid, there is a decrease in the diastole and an increase in the systole. In addition, fat has a granular echotexture and occurs only above the right ventricle, i.e. it does not surround the whole heart [Figure 23a,b].

**Figure 23** (a) Epicardial fat (subcostal long-axis). 1: Parietal pericardium with parallel movement (to the right), 2: Visceral pericardium. (b) Pericardial effusion with collapsed right ventricle/signs of tamponade (subcostal short-axis). The systolic (yellow arrow) diastolic interval (red arrow) are also indicated.
Pneumothorax

Lung sliding, B-lines and the lung pulse (transmission of cardiac pulsation via the pulmonary tissue to the pleura, visualised in M-mode) [Figure 24] or colour Doppler are sure signs that pneumothorax is not present. If they are lacking, it is highly likely that pneumothorax is present. The patient may, however, have a large bulla or thickened adherent pleura. The lung point is the only firm evidence of pneumothorax.

Figure 24  Lung pulse in M-mode (anterior longitudinal chest). 1: Lung pulse (referred activity of the heart).

Pearls and tips

Avoidance of false-negative findings

Serial investigations in the presence of persistent bleeding

There is no international standard for this at present. We recommend a repeat investigation if the cardiopulmonary state of the patient deteriorates, or findings are unclear or uncertain, and in all cases before discharge from the emergency room [(14)].
Patient positioning
The Trendelenburg position and the right lateral decubitus position significantly increase the detection rate of fluid in the Morison pouch.

Subphrenic and paracolic sonic windows
Although not part of the standard investigations, the left and right subphrenic views are the most sensitive way of detecting fluid in non-intubated patients. Further information is also gained by scanning along the length of the left and right paracolic recesses. Perisplenic fluid cannot always be demonstrated in the Koller pouch, but sometimes occurs in the subcapsular or subphrenic regions, or at the caudal pole.

Avoidance of false-positive findings
If positive findings are present, all standard views should be completely investigated. The operator should observe for pulsation and peristalsis in all investigations. Colour Doppler can be of assistance, which shows whether there is fluid in the stomach, intestine, gall bladder or great vessels. Care must be taken with cysts, for example, with cortical cysts of the kidney [Figure 25]. The cysts should be completely visualised and in two planes. Differentiation between a pericardial effusion and a left-sided pleural effusion [Figure 26a,b] The ideal position is the parasternal long-axis. Fluid between the atrium and the transversely imaged descending aorta is pathognomic for a pericardial effusion. If it spreads dorsally from the descending aorta, a pleural effusion is present.

Figure 25  Cortical cyst of the kidney in the Morison pouch (right upper quadrant). 1: Liver, 2: Cyst, 3: Kidney, 4: Spine.

![Cortical cyst of the kidney in the Morison pouch](image)

Figure 26  (a) Differential diagnosis – pleural or pericardial effusion (parasternal long-axis view). Pleural effusion. 1: Right ventricle, 2: Ascending aorta, 3: Left ventricle, 4: Transverse descending aorta, 5: Pleural effusion dorsal to the aorta. (b) Pericardial effusion. 1: Anterior pericardial effusion, 2: Right ventricle, 3: Ascending aorta, 4: Left ventricle, 5: Posterior pericardial effusion ventral to the descending aorta, 6: Transverse descending aorta.
Differentiation between haemoperitoneum and haemothorax

If the diaphragm is visualised (echo-poor band edged with an upper and lower echo-rich border), the patient has haemothorax. If all that can be visualised is an echo-rich reflex, the fluid is intraperitoneal.

Pneumothorax

The operator should not feel restricted to visualisation of lung sliding to confirm or reject the presence of pneumothorax. The further criteria of the lung pulse and lung point considerably increase reliability.

Technique

The spleen and splenorenal recess often lie very dorsal and cannot be accessed ventrally. An alternative for the subcostal view for visualisation of the heart is the parasternal long-axis view.
Parts of the investigation may be difficult in obese and flatulent patients. In such cases, attempts should be made to expel the intestinal gas or use non-standard views for visualisation.

An empty bladder impairs investigation of the lower abdomen. Gas in the intestine may impair visualisation of the target structures.

**Clinical applications**

**Objectives and indications**

Clinical investigations do not provide reliable results for the diagnosis of intraperitoneal and intrathoracic injuries. We are therefore reliant on diagnostic aids. Because the attending physician in such cases is ‘blind’, it would help him to have a look inside the torso. Ultrasound enables us to look inside, although it does have its limitations. Unlike CT, the aim of E-FAST is not to identify specific lesions and sources of bleeding, but rather indicate signs of injuries to internal organs, i.e. blood (fluid) in the peritoneal cavity, and pleural and pericardial spaces. Because it is not possible to distinguish between blood and other fluids with ultrasound, the following principle applies: fluid is blood until it is proved not to be.

When diagnosing pneumothorax, the absence of normal findings (no lung sliding, no B-lines and no lung pulse) is only an indirect sign and also not a 100% certain sign for the presence of pneumothorax. The lung point provides decisive evidence.

In summary, E-FAST makes no claim to be able to detect all internal injuries, however small, in the region of the torso. The point of the investigation is, in the context of the accompanying clinical findings, to identify immediately life-threatening intraperitoneal and/or intrathoracic bleeding and pneumothoraces that require surgical treatment. The ultrasound investigation is performed to support the physician in their decision as to whether to perform emergency laparotomy or thoracotomy or not. What makes it all the more important to have this supporting information is that at present, patients with intraabdominal and intrathoracic injuries rarely undergo surgery and are generally treated conservatively. If the right time for surgical haemostasis is missed, however, the outcome may well be fatal. The E-FAST also assists with the decision as to whether to perform pleural or pericardial drainage, whether to pass from the primary to the secondary survey, and whether abdominal or thoracic CT is indicated [Table 2].

The E-FAST investigations are, however, only indicated if it is expected to have a significant effect on further management. This means that the E-FAST should not be performed in patients obviously urgently requiring surgery unless it is expected to provide essential additional information. Table 4 summarises the indications in detail.

**Table 4   Indications.**

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<td>➢ Trauma patients with:</td>
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<td>▪ Shock</td>
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<td>▪ Dyspnoea/hypoxia</td>
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<td>▪ Pain or clinical findings in or of the chest or abdomen</td>
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<td>▪ Clouding of consciousness/intubation</td>
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<td>▪ High respiratory pressure</td>
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<td>▪ Suspected internal injuries</td>
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<tr>
<td>➢ Postoperative</td>
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<tr>
<td>➢ Shock of unclear origin</td>
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**Interpretation**

**Positive E-FAST**

The E-FAST is used to visualise small amounts of free intraperitoneal, intrapleural and intrapericardial fluid. It is not intended to detect the type of fluid (in cases of doubt, puncture under ultrasound control must always be performed) or the source of bleeding. The interpretation of and the ultimate practical conclusions drawn from the E-FAST findings are only possible in the context of all accompanying clinical findings. The aim is to answer 5 definite questions:

1. Is the fluid blood and, if so, is it indirect evidence of organ injury?
2. Is immediate surgical haemostasis necessary, can the patient wait, or is a CT scan also needed?
3. If surgery is necessary, what should be opened first, the abdomen or the chest?
4. In cases of haemopericardium, would temporary drainage be sensible (i.e. win some time) or would this ultimately only delay pericardiomy which is indicated anyway?
5. Is a chest X-ray or CT needed to be able to decide whether to intervene because of pneumothorax or haemothorax?

In the absence of lung sliding, B-lines, the lung pulse, and the lung point, the E-FAST is unable to give 100% evidence that pneumothorax is present, and it also cannot determine the extent of pneumothorax.

**Negative E-FAST**

A negative E-FAST does not preclude the presence of intraabdominal or intrathoracic injuries.
A negative E-FAST also does not rule out the presence of retroperitoneal or mediastinal lesions.

**Pathophysiology of the peritoneal cavity**

To be able to interpret the presence of fluid in the peritoneal cavity, an awareness of the anatomy and pathophysiology of this region is necessary [Figure 27] [(9)]. The mesenteric folds divide the peritoneal cavity into the supramesocolic and inframesocolic spaces. The inframesocolic space is divided into a right and left inframesocolic and paracolic space plus the Douglas pouch in women and the rectovesical excavation in men. The supramesocolic space, above the transverse colon, is connected to the inframesocolic space via the right
paracolic recess. On the left side, this connection is usually prevented by the phrenicocolic ligament. The falciform ligament separates the supramesocolic space into two chambers. Fluid can only circulate along the caudal margin of the falciform ligament.

Figure 27  Anatomy of the peritoneal cavity. Intraperitoneal anatomy and flow. 1: Phrenicocolic ligament, 2: Transverse mesocolon, 3: Ascending mesocolon, 4: Descending mesocolon, 5: Root of mesentery, 6: Sigmoid mesocolon, 7: Falciform ligament, 8: Left paracolic space, 9: Right paracolic space, 10: Right infracolic space, 11: Left infracolic space, 12: Right supracolic space, 13: Left supracolic space. (Strunk H. Klinikleitfaden Sonographie Common Trunk. Urban & Fischer. With kind permission of the Publisher.

The lowest points of the peritoneal cavity are the Morison pouch and the Douglas pouch in women and the rectovesical excavation in men. The distribution of intraperitoneal fluid depends, however, not only on anatomy, gravity and site of a lesion, but also on respiration, which has a major influence on the intraperitoneal pressure gradient and the distribution of fluid. For example, spontaneous breathing creates a pressure gradient in the direction of the subphrenic space as a result of inspiratory expansion of the thorax. These physiological conditions mean that fluid is most often found subphrenically and there even in very small quantities. The pressure gradient runs in the opposite direction in the intubated patient, i.e. in the direction of the Morison pouch and the pelvis minor.

A knowledge of the peritoneal anatomy and pathophysiology helps when searching for very small amounts of blood. The most likely sites are the right anterior subphrenic region and the pelvic region (15). Also, the site where the blood collects may provide some indication of the source of bleeding.

**Diagnostic-therapeutic algorithm**

The procedure is divided into three algorithms [Figures 28–30] based on the questions sonography is performed to answer.
Figure 28  FAST Algorithm – blunt Trauma (modified after Jehle D. ACEP 2001).

![FAST Algorithm Diagram](image-url)
Figure 29  FAST Algorithm – penetrating Trauma (modified after Jehle D. ACEP 2001).
Figure 30  E-FAST Component. Ptx = Pneumothorax.

Evidence

The evidence is summarized in the next 3 paragraph [(16)].

Abdominal FAST

The sensitivity for detecting the presence of intraabdominal lesions is between 63 and 99% in the literature, and the specificity is between 88 and 93% [(9)]. This wide variability is due to differences in study design, objectives (fluid, injuries to organs), gold standard (surgery, CT, clinical course etc.), training and experience of the operator, quality and whether the E-FAST was repeated. Only a few studies have had as their objective the actual sense and purpose of performing abdominal E-FAST. The main sense and purpose are that the E-FAST should help the physician with two decisions: 1. Immediate surgery to rescue life – yes or no? and 2. Continue investigations with CT or serial ultrasound investigations? This focus is the reason why a much quoted meta-analysis [(17)] and Cochrane review [(18)] led to conclusions that are of no benefit in everyday clinical practice. The objectives of these investigations are of little relevance to the practising physician. For example, the meta-analysis claims that abdominal FAST is unable to rule out intraabdominal injuries with adequate certainty. The Cochrane review claims that there is no evidence for the use of ultrasound based clinical investigations in patients with suspected blunt abdominal trauma. Both papers, by the same
group of authors by the way, miss the point: in an age when abdominal injuries are generally treated conservatively, the primary survey in an emergency is not the time to be looking for tiny amounts of fluid or small and even trivial injuries. What the practical physician wishes to know is whether emergency surgery is necessary because even the slightest delays increase mortality with each passing minute [(19)]. Two papers published by Melniker show that this objective can be achieved with abdominal FAST [(20;21)].

**Thoracic FAST**

It is generally agreed that sonographic diagnosis of haemothorax is certain. With a sensitivity of 96–98% and a specificity of 99.7–100%, FAST is far superior to chest X-ray [(22;23)]. Only a few papers have been published on FAST and haemopericardium. They report sensitivities of 56–100% and specificities of 87–100% [(24)]. The low sensitivity of 56% is due to the fact that, with additional pericardial lesions, blood from myocardial injuries leaks into the pleural space.

**E-FAST**

With a sensitivity of 90.9% vs 50.2%, the detection rate of pneumothorax by ultrasound is greatly superior to that of chest X-ray in the supine patient [(25)]. Thanks to this highly sensitive method, occult pneumothoraces can be discovered, the clinical significance and consequences of which are often unclear.

**References**

Reference List


