Impact and Appropriateness of the Emergency Ultrasonography in a Tertiary Care Hospital

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Objective: *To quantify the notion of the impact of ultrasonography (US) on and the appropriateness of its use in, the diagnosis and treatment of emergency conditions.*
Material and Method: *A prospective study was conducted between September 2006 and April 2007 at a tertiary care hospital. US was performed or supervised by experienced staff radiologists during the working hours and by final year radiology residents during the off-hours. Data collection forms were filled by radiology residents. The final discharge diagnoses were obtained from medical charts and computerized records. Data collected included age, gender, provisional diagnosis, ultrasound findings, the discharge diagnosis, time of ultrasound examination, other radiologic investigations and therapeutic interventions. Outcomes included the impact, appropriateness, and diagnostic accuracy of US.*
Results: *Six hundred eighteen patients underwent 702 emergency ultrasound examinations. The median age was 51 years. Approximately 50% were male. The anatomical region most commonly examined was the abdomen (80%). US had an impact on clinical management in 85% of all examinations. Appropriate use of US was seen in 64% of all examinations. The overall accuracy of US was 90%. Factors associated with higher impact included suspected urological, vascular and musculoskeletal conditions, while vague abdominal conditions were associated with less impact.*
Conclusion: *The impact of US on the management of emergency conditions was high and most requests for US were appropriate. However, a more efficient use of emergency US is still possible, especially for abdominal conditions.*

Keywords: *Impact, Appropriate use, Emergency, Ultrasound*

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The ease, accuracy and safety of ultrasonography (US) have led to an increase in the number of requests for its use in the emergency setting[1-7]. There was a concern that the increase was partly due to inappropriate requests and that US was used without any clinical impact. The aims of the present study were to assess and measure the appropriateness of emergency US requests as well as the impact of US on clinical practice.

Material and Method

The present prospective study was performed during the period between September 2006 and April 2007. The Hospital's Research Ethics Committee approved the present study. Data on all patients referred to the Department of Radiology for emergency US during the present study period were collected. Emergency US was defined as an US requested on an emergency basis by the referring or primary physician. US for biopsy purposes or for emergency interventions, such as US-guided abscess drainage, were excluded.

US was performed or supervised by experienced staff radiologists during the working hours (8.30 to 16.00 o'clock) and usually by third year (final year) radiology residents during the off-hours (16.00 to 8.30 o'clock). Data collection forms were filled by radiology residents or research nurses. The final discharge diagnoses were obtained from medical charts and computerized records.

Data collected for the present study included age, gender, admitting or provisional diagnosis,

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ultrasonographic findings and diagnosis, the final (discharge) diagnosis, time of US, other radiologic investigations, and therapeutic interventions. No attempt was made to elicit the opinion of referring physicians or residents on whether the results of US "influenced" or "had an impact on" clinical decision making.

All diagnoses were categorized according to organ-systems. A positive US result was defined as a clear abnormality detected by US. A negative US was defined as unclear findings or a finding of no obvious abnormality. A negative final diagnosis was one that was vague, non-specific and not of clear clinical significance (for example, "dyspepsia", "abdominal pain", "muscle pain", "testicular pain", "cramps", and "rule-out neck mass"). If the patient was transferred to another hospital or died unexpectedly, the final diagnosis was unknown. The final diagnosis was assumed to represent the true status of the patient at discharge.

The concordance or agreement between provisional diagnosis and US for a particular patient was defined as the same or practically the same diagnoses for both (for example, "acute appendicitis", "appendicitis", and "consistent with appendicitis" were considered practically the same diagnoses). US can "disagree" with or "exclude" the provisional diagnosis if its findings were clearly incompatible or inconsistent with the provisional diagnosis or were unclear. US could reveal an "alternative diagnosis" if it disagreed with the provisional diagnosis as well as demonstrated other, anatomically or pathologically unrelated but clinically important and acute, abnormalities.

The concordance or agreement between US and final diagnoses was also called "diagnostic accuracy". If US and final diagnoses were both the same, this was considered a true positive finding for the US. If both US and the final diagnoses were "negative" then this was considered a true negative finding. Otherwise, the disagreement between US and final diagnoses was either a false positive or a false negative finding for the US.

US had an "impact" if the US diagnosis agreed with the final diagnosis. However, if, following US, further radiologic investigations were performed for the same provisional diagnosis (that is, the US results seemed to have been ignored), then US had no impact. US had a "therapeutic impact" if, following US, a therapeutic maneuver consistent with the US findings was immediately instituted. In this situation, no further radiologic investigations to confirm or exclude the US diagnosis should have been done. Other situations apart from those described above, defined "no impact" of US.

US use was "inappropriate" if the US findings were "negative" and the final diagnosis was "negative", regardless of the provisional diagnosis. Otherwise, US use was "appropriate". This definition was based on the idea that a patient with no abnormality (negative final diagnosis) should not have undergone a useless US (negative US findings).

As a check on the accuracy of US, the sensitivity and specificity of the US in the diagnosis of two common conditions were measured. The accuracy of US in diagnosing acute appendicitis and acute cholecystitis was obtained from the present data using a combination of operative findings, clinical follow-up, and other radiologic investigations as the comparative gold standard.

US was performed using the Aloka SSD-5000 (Aloka Co. Ltd., BJC Trading Company Ltd., Japan) and the HDI 5000 (Philips Medical Systems, USA) US systems. Transducers were 2.0-5.0 MHz convex type for abdominal examinations and 5.0-12 MHz linear array transducers were used for examining the vascular systems or small organs such as the thyroid gland.

Each US study was the unit of analysis. As a first approximation, different studies performed on a single patient were assumed to be uncorrelated. Continuous-type variables in the data were summarized as mean and standard deviation (SD) or median and range as appropriate. Categorical variables were summarized as counts and percentages. Chi-square test or Fisher's exact test was used for comparing categorical variables between independent groups. All statistical analyses were performed using the software Stata version 9 (Stata Corp, College Drive, TX, USA). Statistical significance was defined as a two-sided p-value of 0.05 or less.

Results

Six hundred eighteen patients underwent 702 emergency US examinations at the Department of Radiology between September 2006 and April 2007. Missing data for some important variables occurred due to the transfer of patients to other hospitals. Some outcomes of interest ("impact", "agreement" and diagnostic accuracy) could not be determined because of insufficient data to make the judgment. However, "appropriateness" was assigned to all US studies.

The vast majority of patients in the present study were adults (91%). The median age was 51 years (range, 4 days to 93 years). Male and female patients were equally represented (51% and 49%, respectively). The most common anatomical region examined was abdominal (80%). Most of the examinations took place out of hours (65%).

Table 1 to 3 present data on characteristics of patients, anatomical regions suspected of harboring disease, and provisional, ultrasound, and final disease categories. Table 4 and 5 present the main outcomes of the present study: agreement, impact, accuracy, and appropriateness of US. Factors associated with the impact of US on clinical diagnosis and treatment are given in Table 6.

According to Table 5, higher percentages of inappropriate US were seen in patients with vague abdominal complaints and those with suspected liver diseases. Patients with more precise diagnoses (*e.g.* biliary tract obstruction or pancreatitis) and those with vascular and musculoskeletal complaints had a lower percentage of inappropriate US examinations.

According to the present study, age, gender, and timing of US had no relationship with the impact of US. There was a significant association between the anatomical region of US examination and impact: there was a greater chance of impact if the region examined was the KUB (kidney, ureter, and bladder) system or if Doppler US was performed, and a greater chance of no impact if the region examined was abdominal (upper, lower, and whole) (Table 6). US had a greater chance of having an impact if the provisional diagnosis was related to vascular or KUB conditions, and less chance of impact for suspected appendicitis or intraabdominal infection and collection. There was also less chance of impact if the US diagnosis was intraabdominal infection or mass.

The impact of US was greater when the final diagnosis was related to KUB problems, skin and soft tissue infections, or sepsis of unknown origin. US was least likely to impact on the final diagnoses of intraabdominal diseases, with the exception of gall stone disease.

Agreement between provisional and US diagnoses had no association with the impact of US. It was to be expected, according to the present definition of impact, that further investigations were associated with less impact. Similarly, it was expected

Table 1. Provisional disease categories at presentation (n = 702)

Characteristics & diagnoses	Summary: number (%) (unless otherwise stated)
Anatomical area examined using US	
Upper abdomen	224 (32)
Whole abdomen	157 (22)
KUB system	110 (16)
Lower abdomen	71 (10)
Vascular (Doppler US)	64 (9)
Musculoskeletal system	45 (6)
Testes	6 (1)
Others	25 (4)
Disease categories according to provisional diagnoses	
KUB disease and condition	117 (17)
Cholecystitis	108 (15)
Intraabdominal infection or fluid collection	98 (14)
Appendicitis and related conditions	73 (11)
Vascular problems (aneurysms, DVT, occlusion)	68 (10)
Liver disease and condition (tumors and infection)	59 (8)
Biliary tract obstruction and/or infection	48 (7)
Skin & musculoskeletal system	41 (6)
Abdominal pain and/or mass	32 (5)
Pancreatic disease (pancreatitis, pseudocyst, tumor)	14 (2)
Others	44 (6)

US = ultrasonography; KUB = kidney, ureter, bladder; DVT = deep vein thrombosis

Table 2. Disease categories according to ultrasound diagnosis (n = 702)

Diagnoses	Summary: number (%)
Disease categories from ultrasound examination	
KUB disease and condition (obstruction, tumor, infection)	44 (6)
Gall stones and/or cholecystitis	62 (9)
Intraabdominal infection or fluid collection or mass	65 (9)
Appendicitis and related conditions	23 (3)
Vascular problems (aneurysms, DVT, occlusion)	29 (4)
Liver disease and condition (tumors and infection)	30 (4)
Biliary tract obstruction and/or infection	14 (2)
Skin & musculoskeletal system	43 (6)
Pancreatic disease (pancreatitis, pseudocyst, tumor)	6 (1)
Negative findings (none or incidental findings)	352 (50)
Others	34 (5)

KUB = kidney, ureter, bladder; DVT = deep vein thrombosis

Table 3. Disease categories according to final diagnosis (n = 702)

Diagnoses	Summary: number (%)
Disease categories according to final diagnoses	
KUB disease and condition (obstruction, tumor, infection)	32 (5)
Gall stones and/or cholecystitis	48 (7)
Intraabdominal infection or fluid collection or cancer	32 (5)
GI tract or splenic or other abdominal conditions	18 (3)
Appendicitis and related conditions	31 (4)
Vascular problems (aneurysms, DVT, occlusion)	27 (4)
Liver disease and condition (tumors and infection)	22 (3)
Biliary tract obstruction and/or infection	23 (3)
Skin & musculoskeletal system	28 (4)
Pancreatic disease (pancreatitis, pseudocyst, tumor)	12 (2)
Sepsis-unidentified cause	30 (4)
Unknown (no information available)	63 (9)
Negative findings (none or incidental findings)	265 (38)
Others	71 (10)

KUB = kidney, ureter, bladder; DVT = deep vein thrombosis

that the more accurate the US examination, the more it would have an impact.

The results of the check on the accuracy of US in diagnosing acute appendicitis and acute cholecystitis were as follows. For acute appendicitis, in 73 patients with available data, the sensitivity was 65.5% (95% CI: 45.6% to 82.1%) and the specificity was 95.5% (95% CI: 84.5% to 99.4%). For acute cholecystitis, in 108 patients with available data, the sensitivity was 86.8% (95% CI: 71.9% to 95.6%) and the specificity was 88.6% (95% CI: 78.7% to 94.9%).

Discussion

A study of the impact of a radiologic test on the clinician's decision to perform further diagnostic procedures or to treat patients is best done by directly eliciting the clinician's opinion at the appropriate time. Therefore, any indirect measure of impact will necessarily be limited by the unknown validity of that measure. Nonetheless, a recent study which directly assessed the impact of US by means of a questionnaire filled in by clinicians before and after abdominal US[8] found similar results to another study which indirectly measured the impact of abdominal US by using the

Table 4. Agreement, impact and accuracy of US, and further investigations

Outcomes and investigations	Summary: number (%)
Outcomes of US	
Agreement between provisional diagnosis and US (n = 677)*	
Confirmation	216 (32)
Exclusion	404 (60)
Exclusion with alternative diagnosis	57 (8)
Impact of US (n = 588)*	
Impact on either diagnosis or treatment	501 (85)
No impact	87 (15)
Diagnostic accuracy of US (n = 387)*	
True positive and true negative diagnosis	349 (90)
False positive and false negative diagnosis	38 (10)
Further investigations (n = 67)	
CT scan	57 (85)
MRI scan	3 (5)
Others (Doppler US, repeat US, BE, IVP)	7 (10)

* Include only cases with sufficient information
US = ultrasonography; CT = computerized tomography; MRI = magnetic resonance imaging; BE = barium enema; IVP = intravenous pyelography

Table 5. Inappropriate use of US for each provisional diagnostic category (n = 702)

Provisional diagnosis	Inappropriate	Appropriate	Total
Liver disease	33 (56%)	26 (44%)	59 (100%)
Abdominal pain & mass	16 (50%)	16 (50%)	32 (100%)
KUB disease	53 (45%)	64 (55%)	117 (100%)
Appendicitis	31 (42%)	42 (58%)	73 (100%)
Cholecystitis	42 (39%)	66 (61%)	108 (100%)
Vascular problems	25 (37%)	43 (63%)	68 (100%)
Biliary tract obstruction & infection	13 (27%)	35 (73%)	48 (100%)
Intraabd infection & collection	22 (22%)	76 (78%)	98 (100%)
Pancreatic disease	3 (21%)	11 (79%)	14 (100%)
Skin & MSK system	6 (15%)	35 (85%)	41 (100%)
Others	6 (14%)	38 (86%)	44 (100%)
Total	250 (36%)	452 (64%)	702 (100%)

US = ultrasonography; KUB = kidney, ureter, bladder; MSK = musculoskeletal; intraabd = intraabdominal

criteria of high concordance between postimaging and the discharge diagnoses[9]. By comparison, a measure of the appropriateness of a request for a diagnostic test is more difficult to define. Such a measure should not involve the clinician directly since he or she is prone to stating that his or her decision is appropriate a biased assessment in many situations.

Inappropriate US use was intuitively defined as the application of US on cases where very little benefit is expected from US. Such cases should include patients with diseases not easily diagnosed with the ultrasound, as well as those unlikely to have abnormal findings. Hence, "inappropriate US use" was operationally defined as occurring when both the US findings and the final diagnosis were "negative" in the sense defined earlier. Since this definition has never been used previously, its validity was unclear.

The above definition of "inappropriate US use" negative US findings and negative final diagnosis encompassed the situation where applying imperfect

Table 6. Factors associated with the impact of US (n = 588)

Factors	Impact (n = 501) Number (%) Unless otherwise stated	No impact (n = 87) Number (%) Unless otherwise stated	p-value*
Anatomical region			
Doppler US	53 (11)	2 (2)	0.001
KUB system	81 (16)	5 (6)	
Upper abdomen	165 (33)	31 (36)	
Lower abdomen	53 (11)	13 (15)	
Whole abdomen	98 (20)	32 (37)	
MSK system	37 (7)	2 (2)	
Testes	5 (1)	1 (1)	
Others	9 (2)	1 (1)	
Provisional diagnosis			
Appendicitis	50 (10)	19 (22)	<0.001
Cholecystitis	79 (16)	12 (14)	
KUB diseases	92 (18)	8 (9)	
Vascular problems	53 (11)	3 (3)	
Liver & pancreatic diseases	52 (10)	11 (13)	
Intraabdominal infection & collection	57 (11)	18 (21)	
Biliary tract obtstruction & infection	36 (7)	7 (8)	
Abdominal pain & mass	24 (5)	5 (6)	
Skin & MSK infection & problems	35 (7)	1 (1)	
Others	23 (5)	3 (3)	
Ultrasound diagnosis			
Negative findings	265 (53)	46 (53)	0.030
Gall stones or cholecystitis	44 (9)	10 (11)	
Appendicitis	21 (4)	2 (2)	
Intraabdominal infection or mass	39 (8)	13 (15)	
Liver & pancreatic problems	23 (5)	5 (6)	
Biliary tract obstruction & infection	10 (2)	1 (1)	
KUB disease	30 (6)	3 (3)	
Vascular problems	21 (4)	0	
Skin & MSK infection & problems	36 (7)	1 (1)	
Others	12 (2)	6 (7)	
Final diagnosis			
Negative	221 (44)	27 (31)	<0.001
Gall stone or cholecystitis	37 (7)	8 (9)	
Appendicitis	20 (4)	11 (13)	
Intraabdominal infection or cancer	17 (3)	10 (11)	
GI, splenic & abdominal problems	12 (2)	1 (1)	
Liver & pancreatic problems	22 (4)	11 (13)	
Bilary tract obstruction & infection	12 (2)	6 (7)	
KUB disease	26 (5)	4 (5)	
Vascular problems	23 (5)	1 (1)	
Skin & MSK problems	27 (5)	0	
Sepsis unknown source	26 (5)	0	
Others	45 (9)	3 (3)	
Unknown final diagnosis	13 (3)	5 (6)	
Further investigations			
Yes	18 (4)	48 (55)	<0.001
Accuracy of US			
Accurate	313 (99)	35 (49)	<0.001

US = ultrasonography; KUB = kidney, ureter, bladder; MSK = musculoskeletal; GI = gastrointestinal
* Chi-square test p-values

clinical skills led to a highly uncertain diagnosis (*e.g.*, "rule-out acute appendicitis"). If the US could not find any significant abnormality and the final diagnosis confirmed no significant abnormality, many radiologists would consider an US request unjustified. This definition did not necessarily relate to the idea of "impact", since inappropriate use could have an impact on diagnosis and treatment (for example, when ruling out disease), while appropriate use might not have an impact (such as when an US diagnosis of acute cholecystitis was followed by a CT scan).

Nonetheless, according to Table 5, the definition of inappropriate US seemed reasonably valid since a higher percentage of inappropriate use was seen in patients with vague abdominal complaints, as would be expected. Although the percentage of "inappropriate US" in the range of 30% to 60% might seem rather high, this might be an artifact of the present definition. That is, this definition might have led to an overestimation of inappropriate use. Further studies might be needed to confirm this impression.

Although the appropriateness of US should be judged prior to and regardless of US examination and results, it was not possible to do so in the present study. A better term for the present definition might be "potentially inappropriate use" because it was possible for an inappropriate US as defined above to have actually been appropriate. Other scenarios compatible with the idea of inappropriate use were assumed to have occurred rarely. For example, US might have incidentally found a significant abnormality seemingly unrelated to the provisional diagnosis and the referring physician was not competent to diagnose that condition. This was assumed to occur rarely because, according to the present data, a significant finding on US (*e.g.* acute cholecystitis) can usually be related in some manner to the provisional diagnosis (*e.g.* acute appendicitis).

Another idea of inappropriate US use related to the accuracy of the US for a particular condition. For example, an US examination to confirm the presence of intraabdominal abscess in a postoperative febrile patient might not be appropriate because US might not be sensitive enough to detect certain types of abscesses. However, it was difficult to judge the appropriateness of US in this respect, because the need to use US, as opposed to other, more accurate radiologic investigation, could be context specific. US might have been used, instead of the computerized tomography (CT) scan, to detect intraabdominal abscesses because the patient had kidney impairment or other contraindications to the CT scan. Therefore, it was assumed that US was sufficiently useful or accurate for all provisional diagnosis and thus the use of US was always appropriate in this sense.

The accuracy of US in the diagnosis of certain common conditions, such as acute appendicitis and acute cholecystitis, was consistent with that of previous studies. For example, the sensitivity of the US in acute appendicitis ranged from 80 to 88.5% and specificity from 95 to 98%[10-12]. The sensitivity and specificity in the diagnosis of acute cholecystitis were 81 to 100% and 60 to100%, respectively[13]. The overall accuracy of US in the present study was also reasonable (90%; Table 4). This was encouraging because it could be claimed that the impact or appropriateness of US was determined in the setting of competent US use.

The measures of impact on clinical management and the appropriateness of US in the present study were consistent with the criteria of "construct" validity[14]. That is, both measures were able to differentiate between certain characteristics known or expected a priori to be different. For example, it seemed reasonable to expect that US should have a larger impact for problems specifically related to vascular or urinary tract systems, compared to suspected abdominal abscess. Similarly, the appropriateness of US for diagnosing vague abdominal problems should be less than that for biliary tract systems. Although the absolute measures of "impact" (85% impact) or "appropriateness" (64% appropriate) would very likely depend on the definitions used, qualitatively the findings in the present study seemed reasonable. For example, the apparently large impact of US on clinical practice was consistent with the ever-increasing use of US (otherwise, the use should decrease). Similarly, the relatively low appropriateness was consistent with expectations, as these assessments were made by researchers who were not part of the clinical team requesting US.

The use of emergency US in the present institution seemed to have a large impact (85%) on clinical practice, comparable to the impact of US on 80.9% of the discharge diagnoses as reported by Siegel et al[9] although many of the requests might have been inappropriate (36%). Suspected abdominal abscess (as a provisional diagnosis) was related to lower US impact (Table 6) possibly because some of these cases would proceed to CT scans. Similarly, the

US findings of abdominal masses had less impact because a CT scan would be performed subsequently. Management of suspected acute appendicitis was influenced more by clinical rather than radiologic findings, also leading to a lower US impact. Conversely, KUB (kidney-ureter-bladder), vascular, musculoskeletal problems and regions were associated with higher impact, because US was a sufficiently accurate diagnostic procedure for these systems, especially for ruling out diseases. The fact that the final diagnosis of negative findings was also associated with higher US impact, because the clinicians felt that US could confidently rule out certain diseases, seemed to confirm this.

Clearly, then, the use of US could be refined. In conditions where US cannot rule out diseases with confidence, such as when a post-operative intraabdominal abscess is suspected, or where US is not sufficiently accurate, such as abdominal masses requiring knowledge of their nature and extent, more appropriate imaging studies should be used from the beginning, if possible. Hence, clinicians need to be aware of the limitations of US.

The most important limitation of the present study concerned the definitions of impact and appropriateness. These definitions were complicated and required subjective judgments in certain situations. Therefore, some observer variation and error in assigning impact or appropriateness to certain observations must have occurred.

The use of US in the emergency setting is still necessary and will continue to have an impact on clinical practice. Further study is needed to show whether more training to improve clinical skills and clinical reasoning can reduce the rate of inappropriate US use. Similarly, to confirm the high prevalence of US impact, a study directly eliciting the impressions of emergency department physicians concerning the clinical impact of emergency US should be performed in the future.

Conclusion

The use of emergency US at a tertiary care medical center seemed to have a high impact and reasonable appropriateness. The accuracy of US in the emergency setting was good. Impact on clinical management was most likely when US was performed for suspected vascular, KUB and musculoskeletal problems. Further refinement in the use of emergency US to improve efficiency is still possible, especially for patients with abdominal conditions.

Potential conflicts of interest

None.

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การศึกษาการตรวจคลื่นเสียงความถี่สูงในผู้ป่วยภาวะฉุกเฉินในด้านประโยชน์ในการวางแผนการรักษาและความเหมาะสมในการส่งตรวจ

บุษณี วิบุลผลประเสริฐ, ชลทิพย์ วิรัตกพันธ์, จันทร์จิรา ชัชวาลา, นิษฐกานต์ สุระศรีพัฒน์, ภาณุวัฒน์ เลิศสิทธิชัย

วัตถุประสงค์: *เพื่อศึกษาว่าผลการตรวจคลื่นเสียงความถี่สูงในผู้ป่วยฉุกเฉินนำไปสู่การวางแผนการรักษาได้มากน้อยเพียงใด และศึกษาความเหมาะสมในการส่งตรวจ*

วัสดุและวิธีการ: *เป็นการศึกษาแบบไปข้างหน้า ระหว่างเดือน กันยายน พ.ศ. 2549 ถึง เมษายน พ.ศ. 2550 ในโรงพยาบาลระดับตติยภูมิ ได้บันทึกข้อมูลผู้ป่วยภาวะฉุกเฉินที่ส่งตรวจคลื่นเสียงความถี่สูงทั้งด้านคลินิก สิ่งตรวจพบจากคลื่นเสียงความถี่สูง การรักษาที่ได้รับ ตลอดจนการวินิจฉัยสุดท้าย*

ผลการศึกษา: *จำนวนผู้ป่วยฉุกเฉิน 618 ราย ที่ได้รับการตรวจคลื่นเสียงความถี่สูงทั้งสิ้น 702 ครั้ง อายุเฉลี่ยของผู้ป่วย คือ 51 ปี ประมาณครึ่งหนึ่งของผู้ป่วยเป็นเพศชาย ชนิดการตรวจคลื่นเสียงความถี่สูงร้อยละ 80 เป็นการตรวจช่องท้อง ผลการตรวจคลื่นเสียงความถี่สูงส่งผลต่อการวางแผนการรักษา ร้อยละ 85 จากการวิเคราะห์พบความเหมาะสมในการส่งตรวจร้อยละ 64 ความถูกต้องในการวินิจฉัยด้วยคลื่นเสียงความถี่สูงในผู้ป่วย ภาวะฉุกเฉินพบร้อยละ 90 เมื่อเทียบกับการวินิจฉัยสุดท้าย จากการศึกษาพบว่าปัจจัยที่ผลการตรวจคลื่นเสียงความถี่สูงมีผลต่อการวางแผนการรักษามากที่สุดคือ ผู้ป่วยภาวะฉุกเฉินที่สงสัยสาเหตุมาจากระบบทางเดินปัสสาวะ ระบบหลอดเลือด และระบบกระดูกและกล้ามเนื้อ ในขณะที่ผู้ป่วยฉุกเฉินที่มีอาการทางช่องท้องที่ไม่ชัดเจน พบว่าคลื่นเสียงความถี่สูงไม่มีผลต่อการพิจารณาวางแผนการรักษา*

สรุป: *การส่งตรวจคลื่นเสียงความถี่สูงมีผลมากในการวางแผนการรักษาผู้ป่วยภาวะฉุกเฉิน โดยส่วนใหญ่การส่งตรวจมีข้อบ่งชี้ที่เหมาะสม*