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Diagnostic techniques in resource-limited countries compared with developed countries

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Diagnostic techniques in resource-limited countries

compared with developed countries

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Introduction

The diagnostic techniques between resource-limited countries and developed countries like the United States vary greatly. The lack of technology and availability of resources such as imaging studies in developing countries and the possible overreliance on those imaging studies when easily accessible is one reason. This paper will address the challenge clinicians face when evaluating patients for possible acute appendicitis. It will compare differences in diagnostic approaches used in the United States versus resource-limited nations that do not have readily available imaging studies to confirm suggestive appendicitis based on history, exam, and lab findings. It will compare outcomes of techniques used looking at negative appendectomy rates as well. This paper will also discuss the pros and cons of diagnostic approaches; including costs to healthcare systems, the cost to the patient, over/under diagnoses as well as inappropriate use. Appendicitis is one of the most common indications for emergency abdominal surgery, with several ways to reach the diagnosis, which is why addressing diagnostic parameters is needed.¹

Healthcare spending in the US is among the highest in the developed world.² One suggested cause is due to overuse or inappropriate use of imaging studies.³ The definition of overuse from the Agency for Healthcare Research and Quality is “the provision of healthcare services where the likelihood of harms exceeds the likelihood of benefit.”³ For the purpose of this paper, it will also include imaging that goes against guidelines, imaging that was unnecessary according to other authors or providers, or imaging duplication. Overusing imaging studies can cause increased expenses for the patient, put more money into the healthcare system, and give the patient unnecessary radiation that can be associated with cancer risk especially for pediatric patients.³

Throughout the education of a provider, including physicians, physician assistants (PA), or nurse practitioners (NP), thorough physical exams skills are learned. These exams are meant to aid in diagnosis and in some cases, confirm. The physical exam, when suspicious for appendicitis, includes at least five different techniques that are sensitive for appendicitis.¹ According to UpToDate, this includes pain in the right lower quadrant, which is also referred to as McBurney's point, guarding, rebound tenderness, psoas sign, and Rovsing's sign. In the United States, the use of objective exam tests and scoring systems like RIPASA and Alvarado are used to guide a plan, but despite this, a radiological investigation is done in 71.2% of cases to minimize the chances of a negative appendectomy.¹ Looking at developing countries where CT scanners, MRIs, even X-ray, and ultrasound are not always available, they rely more heavily on their physical exam skills to diagnose and treat.³

One solution proposed to improve the appropriate use of imaging is to develop specific guidelines. The challenge for clinicians, however, is when conditions present atypically or when the early symptoms present subtly.¹ The decision for when imaging is needed is ultimately left to the care provider. Although a patient can decide against imaging, they often rely on the recommendations from their provider who does not want to miss a life-threatening condition or send a patient to unnecessary surgery.⁴ Without the availability of imaging devices in other countries to assist with atypical presentations, the diagnoses are based solely off history, physical exam, and scoring systems which in turn may impact correct or incorrect diagnoses leading to adverse outcomes or unnecessary surgery specifically regarding misdiagnosing appendicitis leading to negative appendectomy.

Background: Literature Review

Physical exam skills

When imaging tests are not accessible, there is a strong reliance on the physical exam. In developing countries, after obtaining a patient history, a well-performed exam is completed. Included is a head to toe exam with the patient unclothed and examined under good lighting so as not to miss essential features like jaundice, pallor, petechiae.⁵ The exam is often repeated when needed.⁵ When unsure of the diagnosis monitoring and re-examinations are common.⁵

The RIPASA score is a scoring system utilized for the sole diagnosis of acute appendicitis without the use of imaging. One study looked at the usefulness of this score comparing the results to histopathology as the gold standard.⁶ There were 15 parameters RIPASA included, each which were given a score of 0-1. These included age, gender, right iliac fossa pain, migration of pain to the right iliac fossa, nausea and vomiting, anorexia, duration of symptoms, right iliac fossa tenderness, guarding, rebound tenderness, Rovsing's sign, fever, raised white cell count, negative urinalysis, and foreign national registration identity card.⁶ A cut-off score of 7.5 and above was used to diagnose appendicitis. In this study, the RIPASA score showed that 155 cases had acute appendicitis, whereas only 152 were confirmed with histopathology.⁶ The sensitivity was 96.7%, and specificity was 93.0%.⁶ This study showed the validation and usefulness of this scoring system; however, it also showed the possibility of leading to unnecessary appendectomy. Using this scoring system, which is based upon patient's demographics and symptoms, normal appendices get removed in 15-30% of cases.⁶

Imaging overuse

Emergency Departments have seen an increase in the use of imaging to diagnose patients with appendicitis from 6.3% to 69% from 1996-2006.⁷ From 1996 to 2007 CT scanning overall in the ED has increased 300%, unrelated to the number of visits that only increased 30%.⁴ The use of ultrasound has also doubled between 2001 and 2010.⁴ One reason for the increase is due to

imaging duplication.⁴ This study alluded to several reasons why this was being done. Reasons included the scan not being received, poor image quality, or physician preference explaining a belief that repeating imaging is routine care when a patient is in a trauma center or being transferred.⁴ A study of 7713 adults showed that patients with Medicare received more duplicate CT scans when compared to patients that did not hold insurance.⁴ This alludes to that fact that insurance status may also impact imaging overuse, although not called out in this study.

When looking at inappropriate imaging as another cause, a study shows that patients with complicated gallstone disease that were of older age received abdominal CTs when the correct diagnostic imaging was an ultrasound.⁴ Also, CT use was more often in the evening in contrast to daytime. Another discretion was between English speaking patients and non-English speaking where the non-English speaking patients were subject to abdominal CT scans for abdominal pain more often.⁴

When the providers were asked about their inappropriate use, their main reasons were fear of misdiagnosing and to avoid any malpractice issues.⁴ Trauma surgeons were asked about their current practice regarding imaging use and stated that their actions were primarily based on the litigious environment.⁴ Other responses were expectations of the patient or their families, time-saving, pressure to increase reimbursement, and that imaging has become a standard of practice.⁴

Developing countries

Through interviews of numerous patients, as well as Dr. Jose Alejandro Madrigal Lobo from the Costa Rican Doctors' Association, it was learned that although imaging studies can be found in their hospitals in San Jose, in the more rural area they are often not available. Many

patients must travel very far in order to get to a clinic/hospital where there is access, and even there, imaging studies are not as numerous as more developed countries. The clinics that are in the communities have limited access and rely on history and exam mainly, with some having a lab available for blood work.

Without imaging often available, many countries and even rural areas of developed countries, make numerous diagnoses based on physical exam and patient history. A study was conducted in Mahajanga, Madagascar looking at appendectomies and confirmed acute appendicitis.⁸ During the study, 173 appendices were removed, and 130 had histopathology performed. Of the 130, 112 showed no sign of acute inflammation, meaning that 85% of the time a normal appendix was removed.⁸ When comparing the USA, Sweden, France, and Mahajanga, Mahajanga has by far the highest rate of unnecessary appendectomies as seen in Table 1 with a rate of 43.0/10,000 population per year.⁸ The study looked at why Mahajanga had significantly higher rates. It was found that after only one exam, the decision to go to surgery and remove the appendix was made and that even if uncertain, monitoring the patient or re-examining them was not done.⁸ Further reasons include that of workload, lack of time, or patients not returning if discharged.⁸ Negative appendectomies can lead to wound infection, hernia development, and adhesions.⁹ There is also the cost of surgery, recovery time for the patient, and general burden to the patient of going through a surgery that was not needed.

A similar study was done at Medical College, Kolkata in India analyzed 912 appendectomies that had been performed over six years and compared their rate of negative appendectomy to the histopathology.¹⁰ The rate was 36.40% of negative appendectomy, which again was higher than other studies.¹⁰ This is showing an inconsistency between countries regarding their ability to correctly diagnose acute appendicitis. The study also commented on the

fact that 409 appendixes seemed normal when looking intra-operatively, but of those, 77 did have acute appendicitis according to the histopathology.¹⁰ They suggest that when needed, imaging should be done to aid in diagnosis and diagnostic laparoscopy.¹⁰

Another international study was conducted to address the clinic outcomes of acute appendicitis in Sri Lanka and the United Kingdom using different diagnostic modalities.¹¹ Ultrasound and/or physical exam were included in the preoperative workup in Sri Lanka, whereas CT and/or ultrasound were utilized in the UK. Ultrasound sensitivity was 80.2% and specificity was 81.8% in the Sri Lanka group, whereas the UK demonstrated poor statistics for their ultrasound use.¹¹ CT in the UK had a sensitivity of 83.9% and specificity of 90.9%.¹¹ The CT scan in the UK found other pathology for the patients' symptoms in 4 cases in which they avoided unnecessary surgery. However, the positive predictive value was very similar, with 94.9% in the UK and 97.3% in Sri Lanka.¹¹ Post-operative complications were similar between the two groups, but re-admission only occurred in the UK group. Histology positive for a perforated appendicitis was seen more often in the UK group.¹¹ Some attribute that higher perforation rate to a longer time to diagnosis when incorporating more imaging such as CT. Other research suggests that these imaging studies can be beneficial when the diagnosis is unclear.¹¹ The study concluded by suggesting a higher number of patients underwent unneeded surgery in the UK group than in Sri Lanka for a supposed appendicitis.¹¹ They allude this to the surgical trainees in Sri Lanka having more confidence and experience without relying on imaging to diagnose an acute appendicitis.¹¹

Ultrasound has also been used more frequently recently in the Republic of Djibouti, Africa.¹² A study was conducted here to look at the use of ultrasound with acute appendicitis and the person performing it. The results showed the sensitivity of ultrasound to be 88% and

specificity of 96%.¹² Although CT scanner still maintains a higher accuracy, this study validates ultrasound to be a valuable diagnostic tool for appendicitis.

Guidelines and criteria

The American Board of Internal Medicine Foundation and the American College of Emergency Physicians have noticed the trend of imaging overuse and put together guidelines to lessen the amount of low-yield imaging.¹ Since 1980, more than ten scoring systems have been created in hopes of creating a better tool for diagnosing acute appendicitis.⁶ RIPASA is the most recently developed in 2010. This study compared RIPASA and Alvarado, which utilizes 15 and 8 parameters. The study found that RIPASA has a very high sensitivity but lower specificity than Alvarado.⁶ A limited amount of data from this study came from western health systems because of the use of imaging.⁶ Therefore, more studies would need to be conducted to see if sensitivity and specificity are just as high in western societies.

CT scanning has decreased the rate of negative appendectomies from 16% to 4% in developed countries.¹³ The sensitivity and specificity of a CT scan to diagnosis an acute appendicitis are both 97%.¹³ Because of this, imaging is often used in developed countries, and scoring systems are not often utilized independently.¹³

Methods

When searching for articles Pub Med and ScienceDirect databases were used through Augsburg Lindell Library. Keywords used were “diagnostic techniques,” “imaging use,” “developing countries,” “physical exam skills,” “diagnosing appendicitis.” 25 articles were initially reviewed and narrowed down if they did not contain pertinent information to diagnostic approaches in developing or developed countries. 11 articles were included in this review, and an

additional two references were included for supplemental information. The articles referenced throughout this review were peer-reviewed and only included if they were human studies that were in English. Interviews conducted in Costa Rica from patients as well as one physician were included as well.

Discussion

Acute appendicitis is a medical condition that can present with right lower quadrant pain, guarding, fever, elevated white blood cell count, anorexia, and rebound tenderness. However, there are many conditions that can cause pain in this area and similar symptoms. Appendicitis is a prevalent condition that requires immediate surgery to remove the appendix. This poses a need for accurate and early diagnostic techniques. The current techniques differ from using a scoring system that incorporates patient demographics, signs/symptoms, and lab values in resource-limited countries, to using imaging studies in developed countries such as CT scan most commonly.

Many different scoring systems have been developed to lessen the number of negative appendectomies that are performed. Although this is very beneficial, especially in developing countries, there is still too high of a rate of incorrectly diagnosed appendicitis, which can increase morbidity. Utilizing more than one scoring system, for example, both the RIPASA and Alvarado together could possibly improve accuracy. One having high sensitivity and the other having a higher specificity is superior to choosing one and possibly missing appendicitis or diagnosing incorrectly. Neither are perfect scoring systems, and more research needs to be conducted on what features of each scoring system account for the higher sensitivity and specificity, and a new system needs to be developed that incorporates all essential features.

There were also significant discrepancies between countries when comparing statistics of misdiagnosed appendicitis and negative appendectomies. Although the scoring systems are validated, more thorough guidelines should be put in place when there is any uncertainty. Referring to Appendix A, Table 1, there was a much higher rate of negative appendectomies in Mahajanga compared to the United States and Sweden. Diving into the reasons why, the study claimed patients were not re-examined or monitored when the diagnosis was unclear, but instead, they were sent to surgery. This is showing the importance of a better protocol with guidelines, so when patients present atypically, the provider knows what steps to take. These being of admittance and observation with constant monitoring and re-examinations so as not to miss any new signs or symptoms.

Imaging studies take some of the questions out of diagnosing appendicitis and make relying on a good physical exam less critical. Throughout this paper, both positive and negative attributes of using imaging studies were addressed. The high sensitivity and specificity create fewer negative appendectomies, and therefore, fewer complications from surgery. However, there is still the risk of radiation exposure and cost to the patient, as well as possibly increasing the risk of perforation by taking more time to conduct the imaging. Further examining imaging overuse, the issue does not appear to be with using imaging for diagnostic purposes, but with using it to cut down on time, for ease, to avoid litigation, ordering the wrong study, or not receiving images from a study already completed. The study examining inappropriate image use shows a need for a more consistent guideline on when imaging should be used to try and limit the discrepancies such as language a patient speaks, time of day, or type of insurance held. If we could eliminate the overuse and focus on the diagnostic needs, we could lessen the average

radiation risk to the patient and overall cost keeping technology a positive contribution to the healthcare field.

One study done at Nationwide Children's Hospital introduced a standardized ultrasound template in pediatric patients for suspected appendicitis.¹⁴ This decreased CT use by 78.3% and ultrasound increased by 22.6%.¹⁴ This in turn, led to cost savings of over \$100,000 for the time period of the study.¹⁴ Implementing this new template in other institutions may help to lower the overall cost the healthcare system and to the patient, while lowering radiation exposure. More research should be done on this template in the adult population.

Further, more specific research needs to be conducted on precise statistics of outcomes comparing physical exams to CT scans when diagnosing appendicitis. Information needs to be presented about all signs and symptoms of the patient and how closely it depicts the typical appendicitis. When using the scoring systems, there needs to be exact numbers presented. For example, when the scoring systems show maximum scores indicative of appendicitis, could the diagnosis be made and be correct majority of the time and therefore comparable to the CT scan? If so, the CT scan and other imaging could be used only in unsure cases, or if a patient does not present with all the criteria.

Limiting, not eliminating, the use of imaging could benefit our healthcare system and lessen the cancer risk to many patients. Basing the diagnosis of appendicitis off physical exam and history and using imaging only to aid when needed could also lessen the rate of perforations because of the time spent obtaining the images.

Analyzing the study comparing ultrasound use in Sri Lanka to CT use in the United Kingdom brought forth an exciting finding. The sensitivity and specificity of the use of

ultrasound between the two countries differed significantly. They attributed this to a lack of experience with ultrasound in the UK because of the availability of CT scanners. The study also showed that a higher number of patients underwent unnecessary surgery in the UK group compared to the Sri Lanka group. It can be presumed that if more time and teaching was spent on ultrasound, this could be used in place of CT scans to eliminate the radiation risk and lessen the cost. This is a point that is also pertinent to more rural areas, even in developed countries that may have ultrasound available, but not a CT scan. Bedside ultrasounds are very quick, and if the operator is skilled, should not considerably lengthen the time to diagnosis. Although the accuracy of an ultrasound machine is not as high as CT, in some cases, particularly with children, the risk of radiation and cancer may outweigh the benefit. This is not to say in all cases with all conditions, but when focusing on appendicitis, a condition that for decades used to be diagnosed based off clinical assessment, ultrasound may be useful when trying to avoid radiation or lessen the cost. At that point, if nothing was seen on ultrasound, but there is a high suspicion, a CT could then be obtained.

This study also implied that Sri Lanka did better in predicting the need for surgery. This is despite the high use of CT imaging in the UK.³ They hypothesized that because providers in Sri Lanka do not have imaging to rely on, they have superior experience and confidence when making diagnoses such as acute appendicitis.³ Possibly, more emphasis should be placed on developing the skills to make correct diagnoses without the reliance on imaging studies.

Conclusion

Overall, more studies are needed to accurately compare the use of clinical assessment such as history and physical exam to CT scans to make a correct diagnosis of acute appendicitis. Further research should also investigate the use of ultrasound in specific populations instead of

CT scans to limit the amount of radiation and cost. Also, in rural settings where ultrasound is all that may be available, providers in the United States and other developed countries still need this skill and should be comfortable utilizing ultrasound for suspected appendicitis.

Further directions should be aimed at research to develop higher accuracy scoring systems to use in resource-limited countries which do not have access to imaging studies and other technology. Studies should look at cases in which the scoring systems did not predict the diagnosis correctly and ways to improve it. Presumably combining RIPASA and Alvarado when practicing is superior to utilizing only one system with one having higher sensitivity and the other higher specificity. The use of these scoring systems should also be common place in developed countries with less reliance on CT scans.

In developed countries, the use of CT scan for the diagnosis of acute appendicitis has very high accuracy and dramatically reduces the number of negative appendectomies. Although imaging overuse is an issue specifically regarding the cost to the healthcare system, the cost to the patient and radiation exposure leading to cancer risk, proper use of imaging studies has significantly improved the diagnostic ability for appendicitis and in turn the care of patients. Further training of providers on proper imaging utilization versus overuse could be addressed as well as education on different modalities of imaging such as ultrasound instead of CT.

More specific research needs to be conducted to strengthen scoring systems when imaging studies are not available, such as in resource limited countries or in rural areas. Research regarding the use of ultrasound to diagnosis acute appendicitis should also be done, as should more teachings on the proper use of these devices at the bedside. Imaging with CT scans is superior in diagnosing conditions such as appendicitis compared to clinical assessment, but risks

need to be weighed compared to the benefits. Imaging protocol should be put in place to lessen the amount of those risks.

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Appendix A

Table I. Incidence/10000 population/year of appendicectomy, appendicitis, negative appendicectomy, and perforation in Mahajanga compared with the USA, Sweden, and France⁵

	USA	Sweden	France	Mahajanga
Appendicectomy	13.9	16.7	52.6	51.1
Appendicitis	11.1	11.6	26.3	7.7
Negative appendicectomy	2.04	5.09	26.3	43.0
Perforation	2.06	1.8	2.9	2.8

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