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PILLCAM: THE IMPROVED COLON IMAGING DEVICE ALTERNATIVE TO A COLONOSCOPY

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Abstract—Approximately 1.6 million Americans suffer from Crohn's Disease, an inflammatory disease that affects the digestive tract. All patients are required to undergo a colonoscopy as part of the initial diagnosis, a test which allows doctors to look at the inner linings of the large intestine through a small camera to check for ulcers, polyps, tumors and other abnormalities. However, this invasive procedure is incredibly painful and uncomfortable for the patients, often requiring sedation. Furthermore, a traditional colonoscopy cannot reach the small intestine because the scope is bound to a tube, but doctors need direct visualization of the small bowel to accurately diagnose disease and monitor its progression. To solve this problem, researchers have developed the PillCam, a vitamin-sized capsule with a built-in miniature camera that patients swallow. This device is sustainable because it improves quality of life by providing a timely, less invasive means of colon imaging while maintaining affordability. The PillCam is a more flexible and thorough tool than the traditional colonoscopy that is used to monitor the deeper parts of the colon. Doctors analyze the precise images from the capsule to look for early warning signs of disease, such as bleeding, or to determine the severity of tumors, polyps, and other irregularities in the colon. Diagnosing diseases of the small bowel, specifically Crohn's disease, is a lengthy and troublesome process, but the innovation of the PillCam can reduce diagnosis time and allow for a speedier recovery process.

Key Words—Behçet’s Disease, Colonoscopy, Colorectal Cancer, Crohn’s Disease, Diagnostic Tool, PillCam, Small Intestine, Sustainability

WHY WE NEED A NEW INTESTINAL SCREENING DEVICE

Medical technologies have undoubtedly come a long way in the past century. From prosthetic limbs to 3-D printed organs, health disciplines such as transplantation and bioprinting have been the focus of scientists. While these are vital to improving the quality of human life, endoscopic and intestinal screening disciplines have only had a few technical advances. Most innovation in this field has come from adapting the scope design of a colonoscopy, the most widely used form of intestinal screening. However, these changes do not address making the screening process more accurate and less painful for the patient. Therefore, an improved colon imaging device alternative to a colonoscopy is necessary to improve the diagnostic yield of gastrointestinal diseases and patient comfort. The PillCam sustains the quality of life for the patient because of its non-invasive nature and its highly specific detection ability for various diseases of the bowels.

DRAWBACKS OF A TRADITIONAL COLONOSCOPY

A colonoscopy is a readily used medical procedure in which a doctor uses a long, flexible, narrow tube equipped with a light source and miniature camera to view the inner linings of the rectum and colon [1]. The purpose of this procedure is to check for ulcers, polyps, tumors and other abnormalities located in the intestines in patients experiencing abnormal symptoms, such as abdominal pain or rectal bleeding [1]. Additionally, patients with an increased risk for abnormalities of the bowel due to a family history of disease or adverse lifestyle choices, such as cigarette smoking, often receive a colonoscopy screening [1]. However, those individuals over the age of 50 are highly recommended to have a colonoscopy performed even if they do not experience unusual symptoms due to their high chance of developing serious neoplasia, the growth of abnormal tissue, in the intestines [2]. If a patient is known to suffer from a severe disease of the bowel, such as colorectal cancer or Crohn’s Disease, a colonoscopy is required to verify the initial diagnosis and to monitor the progression of the disease.

Once a colonoscopy is scheduled to occur, several lengthy steps of preparation are required before the procedure can be performed. A change in diet, specifically a clear liquid diet for one to three days before the exam, is a prerequisite for clearing the presence of any stool that would inhibit the doctor’s ability to visualize the intestines [1]. Not only does this bowel preparation cause diarrhea in the patient, but colonoscopies are often incomplete because of insufficient bowel preparation due to the patient’s inability to follow the strict guidelines, requiring the procedure to be completed all over again. The
uncomfortable and troublesome nature of a colonoscopy does not end with bowel preparation, as the procedure itself requires an IV needle to be placed in the patient’s vein to provide anesthesia. Undergoing the procedure without a sedative is nearly impossible because of the inherently painful and invasive method of screening the intestines, in which the endoscope is directed through the patient’s rectum. Although the entire procedure typically only lasts 30 to 60 minutes, patients are required to stay in the hospital for several hours after the procedure to recover and monitor side effects [1]. This is not a sustainable practice because of the inconvenience placed on the patient. These side effects are common and often include bleeding from the anus and abdominal pain [1].

The risks of serious adverse events following a colonoscopy screening are low, but nonetheless, complications such as death, perforations of the colon, hemorrhage, and hospitalizations have occurred. In one retrospective cohort comprised of 43,456 individuals who underwent outpatient colonoscopies between 1994 and 2009, the integrated healthcare organization in Washington State calculated the rate of serious adverse events in the 30 days following a colonoscopy [3]. The results revealed that of those thousands of individuals, 15 died, 21 experienced serious perforations, 122 suffered from hemorrhages, 508 had to be hospitalized, and 1,019 required an emergency care visit [3]. While the likelihood of these adverse events remains relatively low, the risk of serious complications is three times higher among 75 to 84 year-olds compared to that of younger individuals [3]. This is a significant complication considering that most people receive decennial colonoscopies beginning at the age of 50, so more frequent recipients of the procedure run the higher risk of experiencing adverse events.

In addition to the invasive, troublesome procedure and the risks associated with a colonoscopy, the procedure is restricted by factors such as intubation limitations and the technical skill of the endoscopist. In a standard colonoscopy, the scope is slowly withdrawn from the patient once it reaches the opening of the small intestine, and as a result, the visualization of the small intestine is limited, if not completely forgone. This leads to the misdiagnosis of disease, especially Crohn’s Disease, because the small bowel is the most commonly affected site, with approximately 30% of Crohn’s Disease cases reported in the region [4]. Without a clear image of the affected area, diagnosis becomes extremely difficult. Additionally, the innate manual dexterity of the endoscopist affects the accuracy of screening during the procedure because the scope must be guided through the patient by a human. The angulation and bends of the colon are difficult to navigate by even the most trained doctors, with 10% to 20% of doctors citing considerable difficulty in completing intubation [5]. An incomplete intubation caused by either human error or limited viewing of the small intestine makes it difficult to adequately assess the status of disease. Doctors need a clear and deep view of the intestines to check for early warning signs of disease such as polyps and ulcers in order to provide an accurate diagnosis. Therefore, a colonoscopy limits the accuracy of diagnosis, and the necessity of an alternative, sustainable, more precise procedure is evident.

The ALTERNATIVE: WHAT IS THE PILLCAM?

To correct the limitations presented by a colonoscopy procedure, researchers have developed the PillCam, a vitamin-sized capsule that patients swallow; it is intended to provide less invasive and painful means of colon imaging. The pill encloses two miniature video cameras and a light source that allows for viewing of the inner linings of the digestive tract, specifically the small intestine, which is beyond the reach of a traditional colonoscopy. It also contains a transmitter that sends precise images of the large and small intestines between the rate of 4 and 35 photos per second to a recorder that the patients comfortably wear around their waist [5]. Doctors then analyze the precise images to look for early warning signs of disease, such as bleeding, or to determine the severity of tumors and other irregularities in the colon. Thus, the diagnoses of diseases that are difficult to locate and diagnose by a traditional colonoscopy is improved by a more sensitive and clear means of imaging. This will reduce diagnosis time
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and allow for a speedier recovery process, a sustainable practice that improves the quality of life for the patient.

The PillCam is comparable in size to a normal pill, with dimensions of 32 mm by 11.6 mm and a weight of merely 3.4 grams [5]. Within the capsule lies a CMOS (Complementary Metal Oxide Semiconductor) image sensor that provides images at a resolution of 320 x 240 pixels, a lens that allows for wide-field 170-degree viewing, 4 to 7 LEDs that illuminate the imaging area, a battery consisting of two 1.5 V cells, and eight transmitters that permit wireless communication with the receiver placed on the patient [5]. The capsule travels through the body for approximately 10 hours, and is excreted by the patients after 24 hours [5].

Once the data from the PillCam is transmitted to the receiver, the memory card within the receiver is transferred manually to a computer for a medical professional to analyze with dedicated software. This software presents the images in the form of a video, allowing the doctor to mark important areas of the video and create reports. Doctors will be able to see any signs of ailment in the intestines, thus helping professionals solidify a diagnosis of various gastrointestinal diseases. Subsequent sections will review the results of the PillCam’s ability to diagnose Crohn’s Disease, Bechet’s Disease, and Colorectal cancer, three common disorders of the intestines.

![FIGURE 2][6]
Labeled diagram of the components of the PillCam

The diagram above highlights the main technological components of the capsule. These features all contribute to the PillCam’s ability to take precise images of the intestine and transmit them to the receiver.

**EVOLUTION OF THE PILLCAM**

For a device to become approved by the Food and Drug Administration (FDA) and be put on the market, it must pass guidelines and regulations to ensure that it is safe enough for the general public. In 1998, Given Imaging founded in the city of Yokneam Illit, Israel, began developing the technology of a capsule imaging device due to the drawbacks of a colonoscopy. Three years later, the capsule, called M2A, was the first video capsule endoscopy to be approved by the FDA [7]. Innovations of capsule imaging devices have occurred over the years; most notably, they have become smaller, allowing for easier intake for the patients. The size of the transmitter, which is worn on the waist of each patient, has also become considerably smaller. This sustainable improvement gives patients the freedom to partake in everyday tasks without feeling constricted by a large device attached to them. Previously, the capsule would remain oriented in the same direction as it was ingested, but to improve the angle range of the device, another camera was added, allowing both ends of the capsule to transmit images. This guarantees that the entire surface of the colon is screened no matter how many times the capsule rotates around its own axis. Since the capsule must travel through the entire stomach and small bowel to reach the colon, and the capsule’s travelling process is time-consuming, early models of the capsule would lose battery power before reaching the desired location. Given Imaging solved this problem by adding a third battery, and they developed a mechanism that allowed the transmissions of images to cease for the initial hour and a half after ingestion to allow the capsule to travel to the target area.

Other aspects of the PillCam that have been changed are the picture quality, transmission speed, and the ability to find the exact location of the capsule in the body, as well as the duration in which the capsule is in a certain location. This monitoring of duration is useful because, if the capsule is in the same location of the stomach after a long time, the capsule will notify the patient. After recognizing no movement, the PillCam will send vibrations to the receiver, causing a beeping signal and message to be displayed on the device informing the patient to ingest a prokinetic agent. The prokinetic agent is a drug that enhances gastrointestinal motility by increasing the frequency of contractions in the intestines, causing the capsule to move at a faster speed [7]. Typically, once any improvement is made to the design and function of a device, follow up testing is required to ensure the safety of any new features.

**Food and Drug Administration Testing of the PillCam**

After any improvements are added to a device, various trials are conducted to confirm the successful effects of those improvements. Additionally, these trials ensure that all aspects of the device are safe, including its electrical wiring, stability, and biocompatibility. For example, one test that was required for its approval the FDA was a non-clinical test to demonstrate the mechanical and functional integrity of the device while under stressed conditions, such as bites. Another trial tested the capsule's battery life in order to prove that the battery capacity does not constrain the capsule’s operating time. Additional tests that were performed to determine the safety of the device include checking the imaging ability in locations in the body.
with bad light exposure, shelf lifespan, color performance, among others [8].

After initial tests were completed, the PillCam went through a series of clinical trials. A total of 700 subjects between the ages of 50 and 75, classified as average risk per the American Gastroenterological Association Guidelines for colorectal cancer, were gathered for an FDA study. The primary objective of the study was to compare the efficacy of polyp detection by a traditional colonoscopy to that of an optical colonoscopy. The test data was split into different sections, which were based on the sizes of the tumor and polyp found by the traditional colonoscopy and a capsule imaging device [8]. The test results of the colonoscopy and the PillCam were almost identical, which reveals that the detection levels of the two different devices are quite comparable. Since results were similar, they provided further justification for the FDA to approve the PillCam and allow it to be put on the market.

Although traditional colonoscopies remain the standard for intestinal screening, the PillCam is becoming more commonly utilized in doctors’ offices. Since becoming FDA-approved, roughly 3,000 gastroenterologists use the PillCam, and it is available to more than 220 million Americans by various health insurance providers. This is a sustainable feature because many individuals can only afford to purchase medical devices covered by their health insurance companies. Overall, the PillCam has been used in more than 2 million procedures worldwide, as well as in more than 1,900 clinical studies [9]. As the use of the PillCam gains popularity in the medical field, more case studies are being conducted to support the device’s diagnostic advantages over the traditional colonoscopy for different gastrointestinal diseases.

**CROHN’S DISEASE: A GROWING EPIDEMIC**

Crohn’s Disease is one of the most common intestinal diseases that the PillCam is utilized to diagnose. Crohn’s Disease is a chronic inflammatory condition that affects the gastrointestinal tract, specifically the end of the small bowel. While as many as 1 million Americans are suspected to be affected by Crohn’s, only about 700,000 of those individuals have been diagnosed [10]. Crohn’s is more prevalent among young adolescents between the ages of 15 and 35, and factors such as heredity and genetics tend to contribute to the development of the disease [10]. Common symptoms of the disease include persistent diarrhea, rectal bleeding, abdominal cramps, loss of appetite and fatigue, and, in extreme cases, tears in the lining of the anus [10]. As such, those afflicted by the disease often suffer and have a difficult time managing their symptoms on a day-to-day basis.

Diagnosing the disease is often a long and troublesome process because of Crohn’s specific localization in the small bowel and the lack of a singular diagnostic test; and unsustainable feature. The most frequent diagnosis method involves a colonoscopy, in which patients with suspected Crohn’s Disease are required to undergo the procedure as part of the initial diagnosis. However, for 75% of Crohn’s patients, lesions and warning signs are found in the small bowel, and in 30% of patients, those same lesions are found exclusively in the small bowel [11]. Since a colonoscopy is limited to viewing of the large intestine only, doctors would completely miss these lesions and warning signs. Therefore, a new diagnostic tool that detects abnormalities in the small intestine to a higher degree is essential to the diagnosis Crohn’s Disease during its earliest stages. This sustainable diagnostic tool is the PillCam.

**Case Study for Crohn’s Disease Patients**

Many case studies that seek to find the feasibility and benefits of using the PillCam over the traditional colonoscopy to assess cases of Crohn’s Disease have been conducted over the past two decades. One clinical study was conducted from August 2000 until December 2001 in the department of gastroenterology of two Israeli medical centers to evaluate the application of the PillCam in patients with suspected but undiagnosed Crohn’s Disease. The final study group consisted of 17 patients, whose mean age was 40 and included eight males and nine females [12]. All patients noted symptoms consistent with Crohn’s, including abdominal pain, diarrhea, and weight loss. Additionally, 15 of the 17 patients underwent a total colonoscopy within six months prior to the study, and the colonoscopy produced normal results with no indication of disease [12]. The patients ingested the PillCam, and were free to go about their usual daily activities until the capsule passed with a natural bowel movement. The results from the PillCam were wirelessly sent to the transmitter worn by each patient, and the transmitter data was reviewed independently by two experts who were blind to the clinical data.

Each examiner diagnosed Crohn’s Disease in 12 of the 17 patients based on findings of mucosal erosions, ulcers and other lesions in the distant small bowel [12]. With a diagnostic yield of 71%, the PillCam can detect abnormalities of the small bowel to a considerably higher degree than the conventional diagnostic method of a colonoscopy, in which Crohn’s Disease was left undetected [12]. This alternative method for visualizing the distant areas of the bowel is not only more effective in detecting abnormalities and signs of disease, but it is also far more comfortable for the patient. Since the PillCam is non-invasive, patients are given the freedom to carry on normal activities as opposed to being tested in the confinements of clinical care as required by a colonoscopy. With at least 1 million Americans suffering from Crohn’s Disease alone, the need for a proper diagnostic method not only for Crohn’s, but also for other gastrointestinal diseases, cannot be overlooked.

**BEHCET’S DISEASE: TOO DISTANT FOR A COLONOSCOPY**
Behcet’s Disease, like Crohn’s, is another disease that directly affects the small intestine. The intestinal manifestation of Behcet’s Disease is a chronic multisystem immune disorder characterized by ulcerative lesions in the small intestine, bowel perforations, and extensive hemorrhaging [13]. Those afflicted experience symptoms such as abdominal discomfort, diarrhea, vomiting, and weight loss [13]. Because Behcet’s Disease ulcers are usually confined to the small intestine and are deeply rooted, diagnosing the disease has previously been difficult. Typically, a colonoscopy procedure would be performed on those suspected to suffer from the disease, but the intestinal ulcers essentially resemble vasculitis, or inflammation of blood vessels, which is rarely observed in a colonoscopy. Therefore, colonoscopies have not been consistently able to precisely diagnose Behcet’s Disease, and many cases remain undiagnosed, leaving sufferers with little to no treatment options.

**Case Study for Behcet’s Disease**

To explore the manifestation of this disease in the small bowel, an increasing number of case studies have focused on Behcet’s Disease. One particular clinical study was conducted by the Rheumatology and Gastrointestinal Unit at the University of Sao Paulo and aimed to assess small bowel Behcet’s Disease using the PillCam. Ten patients consisting of nine women and one man with an average age of 38 participated in the study, all presenting gastrointestinal complaints with mild symptoms [14]. Five subjects had only abdominal complaints and were classified as having “inactive” Behcet’s Disease, while the remaining five had manifestations associated with Behcet’s Disease, including oral ulcerations and arthritis, classifying their condition as “active” Behcet’s Disease [14]. Each patient was given a PillCam to ingest, and for 8-10 hours of transmission as allowed by the battery life, images were sent to the recording device worn by each patient. Once the PillCam was excreted by each patient, images from the recording device were downloaded for analysis by an endoscopist.

Results revealed that small bowel erosions and ulcerations were found in 80% of patients from both the “inactive” and “active” groups [14]. Additionally, all patients had abnormal findings from the PillCam images even though they reported experiencing only mild gastrointestinal symptoms [14]. This reveals that the sensitivity of the PillCam is high because it can detect signs of disease even when patient symptoms remain mild, which indicates that the disease had a recent onset in the patient. The ability to identify premature signs of disease is a sustainable feature because less screening time is required to reach a diagnosis. The colonoscopy was not able to match the results of the PillCam due to its limited reach in only the large intestine, where localization of disease is less common. Therefore, the PillCam proves to be superior to the colonoscopy as a diagnostic tool for Behcet’s Disease.

**COLORECTAL CANCER: EARLIER DETECTION IS NECESSARY**

Compared with Behcet’s Disease and Crohn’s, colorectal cancer, also known as colon cancer, is an especially troublesome gastrointestinal disease. It is the third most common cancer diagnosed in both men and women in the United States and represents a major cause of mortality in Western countries [15]. The American Cancer Society estimates 95,520 new cases of colon cancer in the year 2017, and the disease is expected to cause about 50,260 deaths [15]. This aggressive cancer is caused by malignant cells that form in the tissues of the colon and often begin as polyps that grow to become cancerous [15]. A number of factors lead to increased risk of developing the disease, including having a family history of colon or rectal cancer. Other factors include having a personal history of Crohn’s Disease or other bowel disease, having three or more alcoholic drinks per day, and smoking cigarettes [15]. The effects of these risks increase with older age. Common symptoms of the cancer are similar to those of other gastrointestinal diseases and include bright red or dark blood in the stool, diarrhea, weight loss, bloating and vomiting [15]. Traditionally, a colonoscopy was one of the most common procedures done to check for polyps and other signs of cancerous growths. However, recent medical case studies have indicated that a conventional colonoscopy is not the most accurate method of detecting polyps associated with colorectal cancer, as discussed in the next section.

**Case Study for Colorectal Cancer**

In one multicenter prospective trial conducted throughout multiple Gastroenterology Units at hospitals across Western Europe, researchers investigated the sensitivity and specificity of the PillCam versus a colonoscopy for detecting polyps in patients with known or suspected colonic diseases. From August of 2009 to July of 2010, 109 patients between the ages of 18 and 80 were recruited to participate in this trial based on indications of colorectal cancer, including the results of past screening tests and the indication of clinical symptoms that correlated with the disease [16]. After capsule ingestion and eventual excretion, data was interpreted by medical professionals who were specifically trained for analyzing PillCam images and who were blind to the nature of the study to eliminate any bias. Once the PillCam procedure was completed, a standard colonoscopy was performed on each patient by a physician blind to the previous procedure [16]. The study primarily compared polyps greater than 6mm and 10mm in size [16].

Results led to the conclusion that the PillCam revealed a sensitivity of 84% and a specificity of 64% for detecting polyps >6mm in size [16]. Similarly, a sensitivity of 88% and a specificity of 95% was determined for polyps >10mm in size [16]. Overall, the PillCam accuracy, calculated via the mean between sensitivity and specificity, for >6mm and >10mm
polyps was 76% and 92%, respectively [16]. Additionally, it was found that no polyps were detected with a colonoscopy in 5 cases in which the PillCam detected at least one >6mm polyp [16]. It can be concluded that a colonoscopy has a suboptimal sensitivity, especially for 6 mm polyps. As such, a colonoscopy is not a sustainable procedure to use for detecting polyps that could be linked to disease because the procedure could overlook significant, yet prematurely formed polyps. Thus, a device with a high sensitivity is necessary for the visualization and detection of polyps in their earliest stages of development in order to maximize the chances of its spread. Since these statistical results reveal high PillCam sensitivity for clinically relevant polyps, the PillCam is a better alternative for detecting potentially dangerous polyps. With such a high sensitivity, the PillCam could impact the future of colorectal cancer management by detecting warning signs of cancer in the colon more quickly than a colonoscopy.

**DRAWBACKS OF THE PILLCAM**

With all the noted benefits of the PillCam, including its high sensitivity for detecting small polyps and premature abnormalities and the non-invasive nature of its procedure, some potential complications can arise from the usage of the capsule. Such complications include capsule retention, swallowing disorders in patients, and technical failures, with capsule retention being the most common difficulty [17]. This problem involves the PillCam remaining in the digestive tract for more than 2 weeks, and the capsule cannot be excreted without medical intervention [17]. Capsule retention occurs in only about 1-2% of PillCam users, and two-thirds of those cases occur in patients with Crohn’s disease [17]. In the end, this represents only a miniscule fraction of all individuals ingesting the PillCam. Medical experts believe that they must obtain a thorough gastrointestinal history of patients with a high risk of retaining the capsule in order to prevent capsule retention [17].

Another potential complication is a patient’s inability to swallow the capsule, but this has only been reported by 1.5% of PillCam users [17]. The problem can be easily overcome by introducing the capsule into the body via oral esophageal tube, or a feeding tube. Finally, technical failures of the PillCam have occurred at an overall rate of 9% in a retrospective study of 733 PillCam procedures [17]. Reasons for technical failures gaps in recording, limited battery life, failure of capsule activation, and failure in downloading data from the transmitter [17]. However, the diagnosis was hampered in only 3% of technical failures [17]. This means that, even with complications, the capsule was still able to visualize enough of the bowels for investigators to come up with a concrete diagnosis. Therefore, these complications are not detrimental enough to cause any significant harm or pain to the user, nor do they present any difficulty in diagnosis to doctors. When compared with the risks associated with a colonoscopy, including reported hemorrhaging, perforations, and even death, the PillCam is a significantly less dangerous intestinal screening method. This sustainable practice leaves patients feeling more secure about their procedure and doctors feeling more confident about the results.

**BENEFITS OF THE PILLCAM ASIDE FROM DIAGNOSTIC ABILITY**

For any medical device to be considered successful and practical, it must sustainable, which we consider to be the development of devices that improve quality of life by meeting the current needs of individuals. These needs include affordability and user convenience, which we define as patient comfort and length of procedure. Other than the distinguished diagnostic ability of the PillCam, the capsule presents other benefits over a traditional colonoscopy that classify the device as sustainable. These benefits are the PillCam’s speedy, comfortable procedure and reasonable price. The entire procedure time, including the preparation, the procedure itself, and the recovery time, is considerably shorter for the PillCam. The preparation for a PillCam before ingestion involves following a clear liquid diet the day prior, and some doctors recommend taking laxatives the night before and the morning of the procedure to clear out the contents of the colon for clearer visualization of the colon. Both the traditional colonoscopy and PillCam have similar preparation procedures, but the former is considered worse than the latter because the colonoscopy requires a liquid diet for multiple days prior to the screening instead of just one day. This helps define the PillCam as sustainable because the device focuses on patient comfort, ensuring that patients are not required to follow any drastic and extended diets. The PillCam procedure requires the patient to place a small data recorder on his or her waist that allows the video capsule to wirelessly transmit the images of the colon. This recorder is compact enough that everyday activities of the patient are not hindered by its presence. Since the wearer is not inconvenienced by the recorders size and placement, patient comfort is ensured and therefore sustainability is maintained.
The digestive system, with the sedation, effects. Additionally, the fact because the consuming portion of the procedure, and post-day. The entire process of a colonoscopy on the m since a sedative and pain medications to manage the inherently painful nature of the procedure. The patient then swallows the PillCam with a glass of water to ensure the capsule moves easily through the body. There is no need for sedation or supervision for the PillCam to be ingested, so the patient is free to go about his or her daily routine while the capsule moves through the digestive system and is not limited to the confines of outpatient care. Because the PillCam requires no form of IV sedation, which is both costly and uncomfortable, the device is sustainable for both users and doctors. Approximately 10 hours after ingestion, the PillCam passes through the bowels, and the patient gives the sensors and transmitters back to the doctor, who then examines the footage. The disposable PillCam capsule should pass naturally with a bowel movement usually within the first 24 hours without any discomfort.

The traditional colonoscopy, on the other hand, is a much more painful procedure. The patient gets an IV sedative and pain medications to manage the inherently painful nature of the procedure. After the colonoscopy, the patient stays in the recovery room until he or she is ready for discharge so that doctors can monitor any potential side effects. Additionally, since a sedation was given before the procedure, someone else must drive the patient home post-procedure. This is a burden on the patient’s families and takes valuable time out of their day. The entire process of a colonoscopy, with the sedation, IV, procedure, and post-procedure care, takes approximately 2 hours. On the other hand, the PillCam’s procedure, which only includes ingestion, takes a few minutes. The most time consuming portion of the capsule endoscopy process is the diagnostician’s analysis of the video and subsequent diagnosis, where the patient is not required to be present. Therefore, the PillCam’s total procedure time is significantly less than that of a colonoscopy.

Another benefit, aside from diagnostic ability, is that the PillCam procedure is cheaper than the procedure of a colonoscopy. Generally, a PillCam costs around $400, while the entire procedure of a colonoscopy, including hospital stay, sedation, and IV costs around $2,750 without insurance [20]. The cheaper cost of the PillCam is not only an attractive feature to doctors, patients, and insurance companies because they all pay less money, but it is also a sustainable feature. The affordability of the PillCam means more medical professionals can administer the capsule and more patients can take advantage of its benefits. This monetary advantage, combined with time and comfort advantages, prove the PillCam’s benefit aside from its diagnostic ability.

THE FUTURE OF INTESTINAL SCREENING

Capsule imaging devices have a promising future in the gastroenteritis field. The PillCam, through various case studies and clinical trials, has proven to be a sustainable, more sensitive and accurate method in detecting abnormalities of the colon. Its non-invasive and quick procedure, lower cost, and less severe side effects make it a superior intestinal screening device than the traditional colonoscopy. The number of people who need to receive intestinal screening has increased steadily each year, more people are being diagnosed with diseases of the intestinal tract, such as Bechet’s, Crohn’s, and colorectal cancer. Even though it is recommended for adults over 50 to receive a colonoscopy decennially, many choose not to pursue it because of the painful and invasive procedure. This non-sustainable practice exposes a troublesome fact because the serious diseases of the colon could go undetected; this explains why intestinal diseases have a high mortality rate. For that reason, many doctors are switching methods to those involving the use of the sustainable PillCam to diagnose diseases of the bowel with the goal of detecting potentially dangerous diseases at their earliest stages in order to give patients the best possible chance of recovery and survival.

SOURCES


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