The da vinci surgical system nursing essay

Imagine a situation where you have just been diagnosed with an illness requiring surgery. You have only two options: either to conduct a traditional surgery with large incisions, or laparoscopy which uses small incisions but is only available for simple procedures. However, you now have a viable option to conduct a minimally invasive surgery, many thanks to the advancement of surgical technology. Minimally invasive surgery is a concept existed prior to the inception of robots, referring to surgical procedures that are conducted by avoiding long cuts as surgeons introduce long-handled medical instruments to operate on body tissues via small incisions.

The Da Vinci surgical system, also known as a telesurgical system, is currently the pioneer device in the robotic field made by Intuitive Surgical, Inc. A telesurgical system requires the surgeon to maneuver the robot during the procedure instead of allowing it to function from an encoded software. This surgical system is named such as a tribute to Leonardo Da Vinci, whom broke new ground in anatomical accuracy and the epitome of the era of Renaissance. He was highly regarded for his ability to bring life to his architectural drawings of futuristic automations. This particular device is meticulously designed to aid in complex surgery such as cardiac valve repair, prostatectomies and gynecologic surgical procedures by a minimal approach of 1-2cm incisions. Such ultimate breakthrough opens a new platform, beneficiating patients, surgeons, hospitals and the medicine field as a whole.

Imagine major surgery performed with minimal incisions on the patient’s body. Imagine a faster treatment, better recovery rate and minimal duration spent in the hospital as well as better clinical outcomes. This is all made

possible with the inception of Da Vinci surgical system. Da Vinci reforms surgery. It gives a whole new concept to surgery, omitting the painstaking experiences that patients had to face before its invention. In this proposal, we will be introduced to this bizarre medical equipment that is capable of improving the surgical field, in terms of its history, features, unprecedented benefits, criticisms, the future as well as recommendation of the latest Da Vinci surgical system.

History

Robot assisted surgical procedure first hit its limelight in 1985 when the PUMA 560 robotic surgical arm was used in a neurosurgical biopsy which is non-laparoscopic. The successful surgery posed greater precision which ultimately lead to the first laparoscopic procedure involving a robotic system, a cholescystecotomy, in 1987. It is then in the following year, the same PUMA system performed a transurethral resection. Consequently in 1990, Food and Drug Administration (FDA) approved its first robotic surgical system, AESOP system, the brainchild of Computer Motion for its endoscopic surgical procedure.

The Da Vinci surgery system became known in 2000 for being the first system approved by the FDA for general laparoscopic surgery. This approval became groundbreaking as the Da Vinci system is all-encompassing of surgical instruments and necessary equipments for surgery. It has been approved in urological surgeries, general laparoscopic surgeries, general non-cardiovascular thoracosopic surgeries and thoracoscopically assisted cardiotomy procedures, applicable to both adults and pediatric procedures.

Da Vinci surgical system is a proud creation of Intuitive Surgery, Inc. This company is the global pioneer in robotic-assisted minimally invasive surgery (MIS). Initially, the US Army funded Intuitive Surgical to develop a system to perform battlefield surgery. However, they realized the potential of such technology to accelerate the application of a minimally invasive surgery. Intuitive Surgical was then established in 1995 to further develop this technology to a wider range of procedures. The Da Vinci surgical system was launched in January 1999 and it became the first robotic surgical system to gain approval by the FDA for general laparoscopic surgery. Subsequently, the FDA cleared this device for chest surgery, cardiac procedures, urologic and gynecologic procedures.

Headquartered in Sunnyvale, California, Intuitive Surgical expanded its force by acquiring its principal competitor, Computer Motion, reinforcing its world monopoly in robotic-assisted surgical systems. It sustains growth excessively by 25% and has successfully expanded to more than 900 academic and community hospital sites. As of today, more than a thousand Da Vinci Systems are installed in hospitals worldwide.

Problem Statement

In tandem with the advent in science and technology, the field of robotic surgery is mushrooming. Robotic surgery is defined as the use of robot to assist in surgery procedures. The need for robotic surgery is subsequently demanded in the medicine field to overcome problems arise from surgery with traditional approach. Two decades ago, surgeons began developing a concept known as Minimally Invasive Surgery (MIS) in which microscopic cameras called endoscopes or laparoscopes were slotted into the patient’s

body through small ports. However, MIS stumbled upon major roadblocks to advancement as surgeons were operating through standard two-dimensional monitor that lacked visualization while fixed-wrist instruments and poor ergonomic design limited the surgeon’s dexterity. Consequently, MIS was deemed suitable for narrow range of surgical procedures. To counter this problem while maintaining the concept of MIS, robot-assisted surgery was then make-believe. With the inception of Da Vinci surgical system, the medical and surgical fields have revolutionized wherein surgeons and patients both benefit from it.

Da Vinci Surgical System – Mechanism

Surgeon’s Console

This is where the surgeon is seated in a comfortable manner while scrutinizing the body’s interior at a magnified 3D image through highly powered objective lenses. The system’s three-dimensional and high resolution view screen enables the surgeon to observe the incision area in clarity.

By manipulating the master controls located beneath the display screen, the surgeon’s hands and wrists are positioned perpendicularly to his or her eyes. The master controls consist of a pair of foot pedals and hand controllers each. The surgery can then be performed as Da Vinci translates the surgeon’s open-surgery hand movements from the master control, which acts like forceps, into a much precise movements of miniaturized instruments at the patient-side cart. The following illustrates a surgeon’s console from the Da Vinci surgical system.

Patient-side Cart

The patient-side cart includes three or four interactive robotic arms that function to execute the surgeon’s commands from the surgeon’s console. Two or three of the arms are designated to hold medical instruments such as scalpel, scissors and other dissecting materials; while the remaining arm is an endoscopic camera, equipped with a pair of lens, also known as the EndoWrist, provides a stereoscopic vision on the display screen. The laparoscopic arms shaft at the 1-2cm operating ports, omitting the need for using tissue of the incision walls in the patient for leverage, thereby minimizing tissue damage. Such miniaturized operating arms proven a significant advancement from earlier inventions such as the PUMA 560. Apart from that, assisting medical officers will facilitate in incorporating the right instruments for surgery, provide the 1-2cm port in the patient’s body and supervise the situation to eradicate errors as the tools are being utilized.

EndoWrist Instruments

Patented by Intuitive Surgical, the EndoWrist Instruments are another exclusive feature of the Da Vinci System that allows surgeons to operate with dexterity over a maximum range of motion. Designed after the structure of a human wrist, this device can expand beyond the capabilities of a human hand by providing a plethora of surgical techniques. Internal cables of the EndoWrist Instruments mimic the human tendons, providing specific surgical mission such as clamping, accurate suturing, dissection and tissue manipulation. This state-of-the-art device has extraordinary features, such as 7 degrees of freedom motion, 90 degrees of articulation, intuitive motion,

fingertip control, motion scaling and tremor reduction. All these contribute to a smooth running surgery as surgeons operate with ambidexterity and unparalleled precision. This device is also available in a broad range of selection according to the requirement of a particular surgery. The product line includes various forceps, needle drivers, scissors, monopolar and bipolar electrocautery instruments, scalpels; all available in 5 mm and 8 mm diameters to heed a surgeon’s need. This instrument is also user-friendly in terms of recognizing different types and functions of instruments incorporated to the Da Vinci system. It detects the instruments via a unique interface; therefore it is easier to identify instruments that require replacements.

Vision System

EndoWrist Instruments are first introduced into the patient’s target anatomy through a series of dime-sized incisions to allow viewing of the body’s interior at a highly magnified three-dimensional image. These images are displayed via the vision system, designated with high-resolution three-dimensional endoscope and image processing equipments, previewing the exact condition of the body. By having image synchronizers, illuminators with adjustable intensities and camera control units, the operating images are well-enhanced, offering superior visualization of over a thousand frames of the instrument position per second. The vision system also has a built-in video processor that filters background noise. Meanwhile, the endoscope is designated prevent fogging by regulating the temperature of the endoscope tip. Surgeons are allowed to rapidly switch views on the display screen through a simple use of the foot pedal.

How The Mechanism Function As A Whole

In short, the Da Vinci system consists of four main mechanisms–surgeon’s console, patient-side cart, EndoWrist instruments and the vision system. These features function as a whole in the same room under the conduct of a surgeon and few supporting medical officers. The relationship between the four mechanisms is illustrated as shown in the adjacent figure.

Advantages

Enhanced Visualization

Target anatomy in the body interior is previewed in true-to-life three-dimensional vision, forming crisp images in immense clarity. The endoscopic camera also offers immersive view of the surgical field with superior contrast and magnification for an accurate identification of tissue layers. Such improvement enables surgeons to perform dissection or reconstruction of delicate tissues with much precision, regardless of the space allotted.

Steady Movements; Take Control.

The limitation of human hands is overcome by Da Vinci’s ability to reduce tremors and control movements via proprietary EndoWrist instruments, enhancing control and intuitive motion. This enables pervasive use of avant-garde techniques, further reducing the learning curve since complex procedures can now be handled in an open surgery approach. Solo Surgery and two-handed intracoporeal suturing can become standard practice for interns with the addition of a fourth arm from the Da Vinci surgical system.

First-Class Ergonomics

Surgeon need not worry about the fatigue occurring from long hour surgery as the Da Vinci surgical system is designed to allow them to operate while seated in a comfortable posture. Such clinical advantage also implies that less surgeon assistance is required because medical instruments are mounted to the robotic arms. Moreover, with the robotic arms offering extra mechanical strength that is beyond human capabilities, higher-BMI patients can be treated in a minimally invasive approach.

Supreme Hospitality

Inception of Da Vinci marks a historical breakthrough to hospitals worldwide by increasing productivity and operational efficiencies. Patients can enjoy diminished post-operative pain, decreased risk of infections and surgery complications, less complicated nursing care and faster rate of recovery. Hospital stays are largely reduced by half, thus decreasing hospital costs by approximately 33%.

Criticism

Like many things good, Da Vinci surgical system also has its drawbacks. While this evolving technology has become almost like a necessity to medical services, critics are questioning the lacking of long-term results studies to prove Da Vinci superior to laparoscopic surgery. Besides, this technology costs an average of $1. 3 million, excluding the several hundred thousand dollars of annual maintenance fees. There is also no existing data to justify the increased costs and hospitals are having a hard time recovering the high cost. According to The American Journal of Surgery, 75% of

surgeons claimed that they felt financially limited by any system that cost more than $500, 000

Furthermore, a large portion of surgeons performed the surgery via Da Vinci surgical system on approximately 12 to 18 patients before they feel comfortable utilizing the device. Though training programs are offered by Intuitive Surgical, most surgeons find themselves intimidated by this device as they felt obstructed from grasping the texture of body tissues and ultimately, the loss of tactile or haptic sensation. The patient-side cart also occupies a large space that hinders the movement of assistant surgeon’s access to the patient.

The safety aspects of Da Vinci surgical system remain doubtful to most people as they still do not trust the ability of a robot wholly. Though this system operates in a Master-Slave relationship, some still find it unacceptable to risk lives of patients as robots have the potential to be fatal should they malfunction. Hence, a huge amount of cost is forked out to reduce these risks by adding safety features, making them financially inaccessible to some physicians. Apart from that, surgery utilizing this device takes forty to fifty minutes longer compared to traditional open surgery.

Recommendation

Conclusion – The Future

The Da Vinci surgical system offers a surgery experience like never before to practicing physicians. Its brilliance in translating the surgeon’s hand movements from the console into corresponding micro-movements of

EndoWrist instruments incorporated in the patient’s body interior has transformed the surgical fields in many aspects.

A major outlook for this invention is its potential to perform remote operations, as what it was initially designed for. This long distance operation can be made possible by linking the patient and doctor through a series of ports from the Da Vinci surgical system. Say, a doctor from United States will be able to operate on a patient from across the globe, such as Africa. However this is still at its theoretical stage and will be developed in near future to globalize the surgical field.

Albeit the criticisms, the Da Vinci surgical system is deemed as a mere preview of what to expect from future technology. From the high cost to the lack of touch sensation from surgeons’ feedback, the current Da Vinci surgical system has many hurdles to overcome before it can be wholly integrated into the healthcare system to satisfy everyone’s needs. To name a few, questions such as misconduct liability, credentialing, training prerequisites and licensing requirements for telesurgeons are still puzzling. However, Intuitive Surgical promises an improvement of Da Vinci surgical system in terms of size, haptic sensation and cost as their present focus before dealing with other relevant problems that are causing ambiguity to users.

Although robotic surgery is still at its infancy, many of its known advantages are sustaining its progress and it has verified itself to be worth the value, particularly in areas unattainable to traditional laparoscopic procedures. For instance, the complexity of movement controls and manifold degrees of

freedom by the Da Vinci surgical system offers minimal tremor and increased mobility which made it possible to go ahead of the human capacity. Robotic technology is aimed to bring surgery into the digital era and whether its advantageous usage can overcome the cost to execute it remains to be worked out. Despite being feasible to demands, further forthcoming research investigating efficacy and safety must partake for robotic surgery to take full root over conventional therapy.

Appendix

On the Market

Two robotic surgical systems have received FDA clearance to be marketed in the United States: The da Vinci Surgical System, made by Intuitive Surgical, Inc. of Sunnyvale, Calif., is cleared to perform surgery under the direction of a surgeon. The ZEUS Robotic Surgical System, made by Computer Motion, Inc. of Goleta, Calif., has been cleared by the FDA to assist surgeons.

“[The] da Vinci is cleared to assist in advanced surgical techniques such as cutting and suturing [sewing],” says Neil Ogden, chief of the FDA’s General Surgery Devices Branch in the Center for Devices and Radiological Health. “ ZEUS is cleared to assist in grasping, holding, and moving things out of the way, but isn’t cleared for cutting or suturing.” Clinical trials on ZEUS are underway with the goal of obtaining FDA clearance to assist in the performance of advanced surgical tasks in the United States, according to Paul Nolan, senior director of customer training and education at Computer Motion.

Here’s a profile of each system:

The da Vinci Surgical System

In July 2000, the FDA cleared da Vinci as an endoscopic instrument control system for use in laparo-scopic (abdominal) surgical procedures such as removal of the gallbladder and surgery for severe heartburn. In March 2001, the FDA cleared da Vinci for use in general non-cardiac thoracoscopic (inside the chest) surgical procedures – surgeries involving the lungs, esophagus, and the internal thoracic artery. This is also known as the internal mammary artery, a blood vessel inside the chest cavity. In coronary bypass surgery, surgeons detach the internal mammary artery and reroute it to a coronary artery. In June 2001, the FDA cleared da Vinci for use during laparascopic removal of the prostate (radical prostatectomy).

The da Vinci is intended to assist in the control of several endoscopic instruments, including rigid endoscopes, blunt and sharp dissectors, scissors, scalpels, and forceps. The system is cleared by the FDA to manipulate tissue by grasping, cutting, dissecting and suturing.

In use, a surgeon sits at a console several feet away from the operating table and manipulates the robot’s surgical instruments. The robot has three hands attached to a free-standing cart. One arm holds a camera (endoscope) that has been passed into the patient through small openings. The surgeon operates the other two hands by inserting fingers into rings.

The arms use a technology called EndoWrist – flexible wrists that surgeons can bend and twist like human wrists. The surgeon uses hand movements and foot pedals to control the camera, adjust focus, and reposition the robotic arms. The da Vinci has a three-dimensional lens system, which

magnifies the surgical field up to15 times. Another surgeon stays beside the patient, adjusting the camera and instruments if needed.

There are 50 da Vinci systems placed in U. S. medical centers, 34 placed in Europe and five placed in Asia.

ZEUS Robotic Surgical System

The FDA cleared ZEUS in October 2001 to assist in the control of blunt dissectors, retractors, graspers, and stabilizers during laparoscopic and thoracoscopic surgeries.

ZEUS has three robotic arms that are mounted on the operating table. One robotic arm is called the Automated Endoscopic System for Optimal Positioning Robotic System (AESOP). AESOP is a voice-activated robot used to hold the endoscope. The FDA cleared AESOP to hold and position endoscopes in 1994, and voice activation was added later. ZEUS differs from the da Vinci system in that the AESOP part of ZEUS responds to voice commands. For example, a surgeon might say: “ AESOP move right.” The positioning arm then would move right until the “ stop” command was given.

Like the da Vinci system, the other two arms of ZEUS are the extension of the left and right arms of the surgeon. Surgeons sit at a console and wear special glasses that create a three-dimensional image. Computer Motion has added a flexible wrist technology called Micro-Wrist, which is now included in FDA-approved clinical trials, Nolan says.

There are currently more than 30 ZEUS units installed in North America, 15 units installed in Europe and the Middle East, and five units installed in Asia.