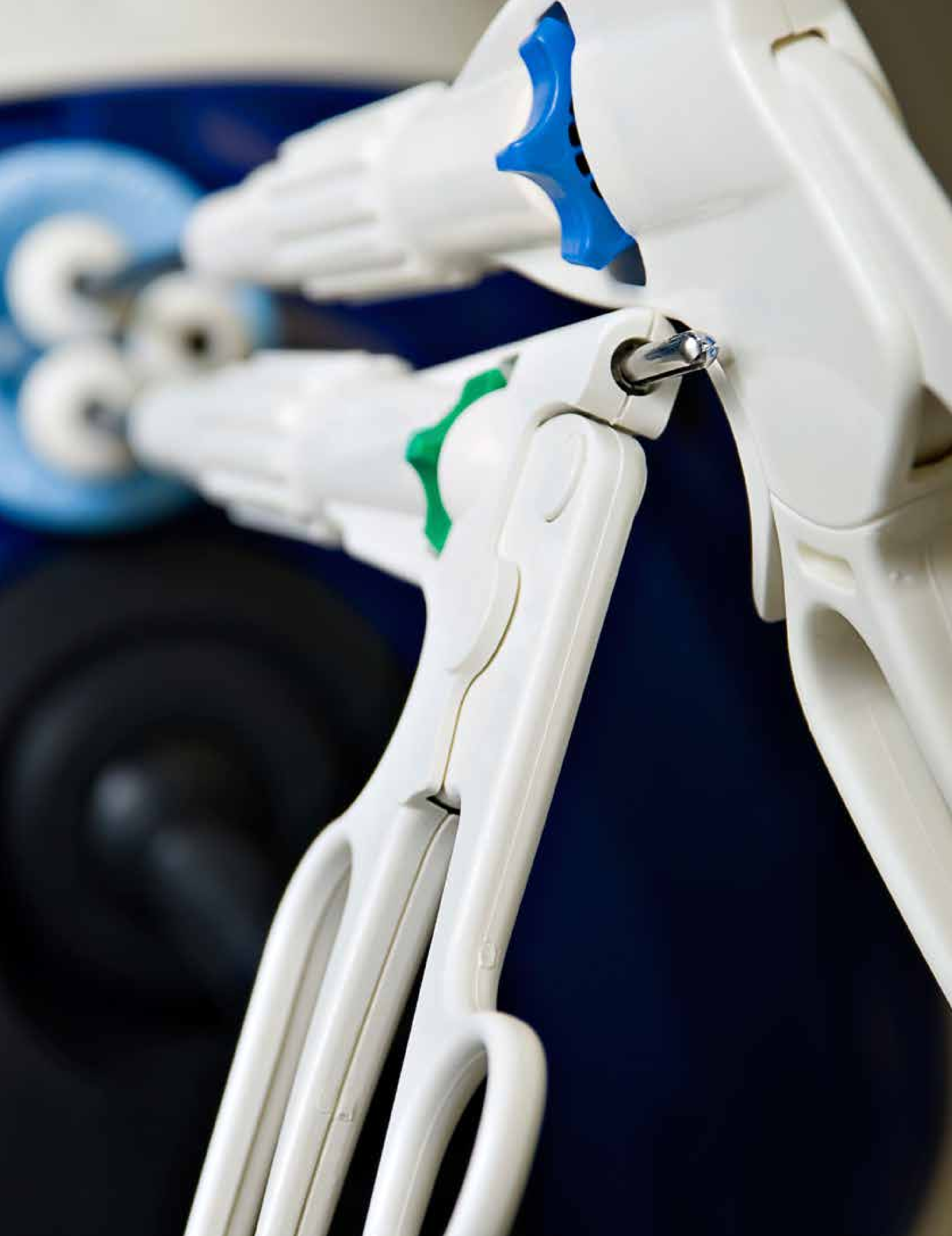

A Safety Approach to Robotic Surgery

By Gianine M Streber, CST

When it comes to laparoscopic-assisted robotic surgery safety is the upmost priority. The robotic team needs to be educated and in-serviced on all areas of robotic surgery. Although all types of surgery deems risks and potential injury to the patient, robotic-assisted surgery presents greater risks due to the complexity of the robotic system. Safety measures must be taken throughout the process from positioning the patient to port placement, docking the robot, instrument insertion and exchange, controlling clarity and insufflation through smoke evacuation and undocking the robot. While all of these are important aspects in this new technology of surgery, none of this can be accomplished without constant communication and teamwork.

Robotic surgery dates back to the 1980s. Surgeons used the PUMA 5 for neurosurgical biopsies, urologists used the Probot for transurethral resection of the prostate, and orthopedists used the Robodoc to maneuver the femur in hip replacement surgeries. Scientists from NASA developed telesurgery as a way for surgeons to perform surgery in a different room or geographical location. Telesurgery led to the production of the surgical robot used in operating rooms today. Robotic assisted laparoscopic surgery is being performed in many specialties: gynecology for hysterectomy, BSO, myomectomy and sacrocolpopexy; general surgery for right, left, lower colectomy, single site cholecystectomy, ventral and hiatal hernia repairs and gastrectomy; urology for prostatectomy and nephrectomy, cystectomy; ENT for cancer lesions at base of tongue and trans oral procedures; and cardio-thoracic for lung biopsy, wedge resection, mitral valve repair, CABG and pediatrics for pyloroplasty, just to name a few.

As compared to laparoscopic surgery, the advantages of robotic surgery are stability of instruments, dexterity of the wrists, depth perception, camera stability, three-dimensional visualization, capability

LEARNING OBJECTIVES

- Learn about the risks and potential injuries to the patient during robotic-assisted surgery
- Identify the procedures that robotic-assisted surgery are commonly used for
- Examine the role of each team member during robotic surgeries
- Review the history of robotics in surgery
- Realize how team work and communication play critical roles in making robotic-assisted surgeries a success


Jose Rodriguez, CST, CSFA; and Ruben Ortiz, CST, CSFA; attend a robotics workshop in 2012.

to perform microanastomosis and a surgeon's ergonomics. As for the patients who have had robotic-assisted surgery, they experience reduced surgical time, scarring (smaller incision means reduced risk for adhesions), blood loss, less pain, infection, length of hospital stay, recovery and decreased recovery time compared with that of traditional laparoscopic surgery. Along with the advantages, there are risks of injury associated with robotic surgery. Some of those risks involve surgical burns to arteries or organs, tears or perforation of bowels, clipped ureters and malfunctioning of the system. The robotic also lacks textile and force feedback, and the surgeon has less control over the patient's safety when at the console.

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The daVinci robotic system is the only actively marketed system that has been approved by the FDA for use in robotic-assisted laparoscopic surgery. The instruments have seven degrees of freedom which allows the surgeon a wide range of motion. It consists of three components: patient cart, video cart and a surgeon's console. When a hospital decides to purchase a daVinci robot the selected teams members are required to go through an online modular training as well as physically observing how a robotic team operates. Once the team has completed the online modules and observation, they are ready for hands-on training in their own facility, which is provided by a daVinci representative. The representative will be with the team during robotic procedures until the team feels comfortable and confident. The daVinci representative will be there to instruct the surgeon on proper port placement; positioning of the patient cart in the correct position, which allows the surgeon to perform the operation in a smooth manner; trouble shooting; and educating the team in various aspects concerning the instrument arms and video tower. The daVinci representative along with the department robotic coordinator will provide in-services, education and competencies that relate to positioning, trocar placement, docking, instrument placement and exchange, insufflation and smoke evacuation for exposure, undocking and trouble shooting. Out of all the competencies and training required, the most important is communication. The following is a breakdown of the processes involved in robotic surgery and the safety components and recommendations.

POSITIONING:

The goal of positioning is to provide optimal access to the surgical site without compromising patient safety. There are a variety of positions used for different types of surgery. Most typical is lithotomy, steep trendelenburg, lateral and supine. The position with the most risks of injury to the patient is lithotomy in steep trendelenberg, which is mainly used in robotic-assisted laparoscopic prostatectomy, hysterectomy and similar gynecological procedures. The robotic-assisted prostatectomy requires the patient cart to be placed between the legs to allow for the best access to the patient's deep pelvic area. Steep trendelenberg is 40 degrees from horizontal, arms are tucked and legs are in stirrups. The risks involve sliding and sheering, pressure ulcers, compartment syndrome, peroneal nerve injury, DVT venous pooling, diminished lung capacity, back strain, blood pooling in upper torso, increased blood pressure, increased intracranial pressure, fluid shifts, congestion and atelectasis and pulmonary complications. The most common complication is brachial plexus injury. To prevent brachial plexus injury, the head should be in midline position, arms at the side, elbows gently fixed to unload the median nerve, forearm supinated and wrists in the neutral position. Shoulder braces should be avoided in order to decrease the pressure on the patient's shoulder. If shoulder braces are unavoidable, care should be taken by using padding. Some facilities' practice is not to use shoulder pads, but rather a gel pad that the patient lies on with a narrow draw sheet underneath the gel pad and arms tucked with cradle foam. Steep trendelenberg causes the patient to slide toward the head, especially if the patient is overweight. Sliding will cause dermal injuries and can alter the original position, which can cause potential damage to the organs due to the robotic arms fixed in the abdomen. If the patient has to be in steep trendelenburg for the procedure, a gel pad from head to buttock is placed on the OR bed. A sheet never should be placed between the patient and gel pad as it reduces friction and provides a greater chance of the patient sliding. Bean bags also can be used to prevent injuries in steep trendelenberg, but are mostly used for the lateral position. DVTs can be prevented with the use of anti-embolic or sequential compression stockings if the surgery is greater than two hours. Minimizing the degree of trendelenberg and also minimizing the length of surgical time is recommended. For every hour a patient is in lithotomy and steep trendelenberg, the patient has a 100-fold increase in the risk of nerve injury involving peripheral nerve, brachial and ulnar nerve damage. When a prostectomy lasts longer than two hours, the circulator should re-assess the patient's positioning and watch for signs of sliding. As in lithotomy, it is important to maintain the patient's normal body alignment in relation to knees and hips so not to be internally or externally rotated. The goal of positioning requires a team effort from the circulator, surgical technologist, anesthesia and the surgeon. Positioning is crucial because once the patient cart is docked the bed cannot be repositioned without undocking.

Michele Kunkle, CST, CSFA, during a hands-on training robotic workshop in Houston in 2012.

Vickie Kutzle, CST, experiences robotic training first-hand in Houston in 2012.

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TROCAR PLACEMENT AND DOCKING:

Trocar placement is based on the target anatomy. The goal is to maximize the instrument arms range of motion. Setting the "sweet spot" provides the maximum range of motion for the instruments and camera. Keep in mind that there should be a forty-five degree angle between the instrument arms. The surgeon has to know how the instruments articulate inside the abdomen so he or she can strategically place the trocars to prevent instrument collision inside the abdomen. It is recommended that a DaVinci representative is present when a surgeon is new to robotic-assisted surgery to guide the surgeon and assist with proper port placement. It helps to have a ruler and marker on the Mayo stand so the surgeon can mark the abdomen where the ports will be placed. Once the ports are in place, the patient cart is driven into position. This is when the risk of contaminating the instrument arms is most likely to occur because the arms are spread out and in the highest position as the cart is moving toward the patient. If the patient is in lithotomy and steep trendelenberg, the arms of the patient cart need to be raised up and out to prevent the instrument arms from banging into the patient's legs. The surgical technologist needs to be aware of the arms as they come around and move in closer to the patient as not to come in contact with the overhead lights, video cart monitor, IV poles or surgeon's mask, head or shoulders. Contamination can occur when the surgeon has his or her back to the instruments arms as he or she is docking the camera. Draping a sterile towel over the patient's arms will prevent contamination from happening. Once the patient cart is docked, the bed cannot be repositioned. If the surgeon needs to change positions during the case, the instruments need to be removed, undock, reposition the table and then re-docked again. When docking is complete, the camera and instruments are then re-inserted.

There are six steps to docking the robot:

1. Position the patient and operating table, including table tilt.
2. Position the patient cart over the patient aligning the patient cart with the instrument ports and camera port.
3. Set the patient cart brakes.
4. Dock the camera arm.
5. Dock the instruments arms.
6. Check the system set up to ensure all the instruments are in proper position.

INSTRUMENT PLACEMENT AND EXCHANGE:

Once the robot is docked, the next process is to insert the camera and instruments. The endoscope camera is to be inserted first. After placing the camera into the sterile camera holder, the camera is gently turned side to side to ensure it is locked into place. The clutch button is pressed once to insert the camera into the abdominal field just beyond the cannula, and the clutch button is pressed again to set the camera arm in place. By doing this, the surgeon has control of the camera via the surgeon cart. The instruments are inserted next and only under direct visualization by the surgeon. At this point, the surgeon may proceed to the surgical cart and watch while the surgical technologist or surgical assistant insert the instruments (facilities' protocol may vary), or the surgeon may stay at the field and insert the instruments. Either way, communication is fundamental to safely inserting the instruments. The surgical technologist should always look for the cannula when inserting instruments. If the cannula cannot be seen, the surgical technologist needs to ask the surgeon to find it so the instrument can be inserted safely. If there is resistance as the instrument is being inserted, movement should be stopped immediately and the team should evaluate before continuing. Lack of insufflation or poor port placement may cause resistance.

The following are steps to properly and safely insert instruments:

1. Close the instrument tips.
2. Slide instrument into the cannula and sterile adapter until the instrument housing clicks into place and wait for the blue light on the arm to flash.
3. Use the arm clutch button to manually insert the instrument.
4. Ensure the instrument tips are in view at all times.
5. Stop insertion if resistance is met.
6. Press the clutch button to give the surgeon control of the instrument.

The initial instrument insertion is unguided and once the surgeon is satisfied with the location of the instrument inside the abdomen, the clutch will be depressed, and the light will turn blue indicating that the instrument is now in a guided tool mode. The guided tool mode allows the instruments to be exchanged and set at the exact location. When the surgeon is finished with an instrument and needs another one, a guided tool exchange is performed. It is important to ensure that the instrument being removed has the tips in the open position as to ensure there is no tissue attached. Tissue tearing can occur causing injury to the patient if the tips are attached to tissue as the instrument is removed. The screen always should be looked at when instruments are being removed so everyone on the team knows exactly which instrument is coming out.

Robotic instruments that generate heat or energy require the use of lubrication prior to inserting the instrument into the abdomen. This prevents the tissue from sticking to the instrument tips and reduces char and tissue sticking. The proper use of lubrication is to apply it to the instrument tips only and not the wrist area where the cable and pulleys

Armando Garcia leads robotic training at an ASA-sponsored workshop at Texas Memorial Hermann Surgical Innovation and Robotic Institute in 2012.

are. The monopolar scissors or hot shears have a protective tip that is to be applied. The use of the tip cover is to prevent arching of electrical current inside the abdomen. The proper way to apply the tip cover is to make sure it covers the orange portion of the shears. After the tip cover is, the lubrication can be applied.

INSUFFLATION AND SMOKE EVACUATION:

Insufflation and smoke evacuation are important to maintain and is one of the key responsibilities of the surgical technologist. Insufflation should be maintained between 12-15mm/hg. Anything below 12mm/hg is at risk for losing insufflation. Loss of insufflation can lead to collapsing of the abdomen causing loss of port placement, loss of vision for the surgeon and injury to the patient, especially when instruments are inserted in the abdomen. Injuries that can occur are mainly bowel perforation. When the ports are lost all instruments need to be removed, ports replaced and then insufflation can resume. The cause of losing insufflation can be due to a number of reasons including kink in the tube, disengaged from the port, port cover not properly seated, suction and excess use of the smoke evacuator. The surgical technologist needs to constantly monitor the insufflation reading and troubleshooting to avoid losing insufflation. The insufflation tubing used for robotic surgery is designed with a humidifier. This device warms the carbon dioxide by injecting 10ml of saline into a small compartment attached to the tubing itself providing constant moisture to the abdomen, which in turn provides the patient with less postoperative pain and shoulder pain, reduced hypothermia and less damage to tissues. The surgical technologist must monitor the amount of carbon dioxide filling the abdomen because if the surgery lasts longer than two hours, the surgical technologist must refill the compartment on the insufflation tubing with another 10ml of saline per every 150-200 liters of carbon dioxide used. The use of the smoke evacuator is to maintain a clear picture for the surgeon when electrical cautery is being used. This is especially challenging when a large amount of tissue is being cauterized, mainly during a hysterectomy when large myomas or fibroids attached to the uterus are being dissected off the uterus. With the use of excessive cauterizing due to thick fibroids, or bleeders, the abdomen can fill up with smoke quickly. The surgical technologist needs to maintain a clear view. The best way is to keep up with the smoke evacuation; however, excessive use of the smoke evacuator may cause a reduction in insufflation. During smoke evacuation, insufflation can go down to 10-11mm/hg; anything less than 10mm/hg is at risk of losing insufflation, the ports and causing injury to the patient. The use of the smoke evacuator also keeps a clear view for the surgeon as he or she is working in the abdomen. A constant watch is essential to keeping the balance between insufflation and vision. Keeping smoke to a minimum also prevents the camera lens from fogging, prevents excessive removal of the scope for cleaning, which reduces the time of surgery. When the lens needs to be cleaned, the surgeon needs to be notified before executing and the surgical technologist needs to have the cleaning solution and wipe readily available as to keep the transaction smooth. Insufflation and smoke evacuation are two features that can delay the progress of surgery. The surgical technologist has to constantly be aware and monitor the balance of both.

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UNDOCKING:

Once the surgeon has completed the procedure robotically, the patient cart needs to be removed. Only the surgeon will announce when to undock the patient cart. The first step is to remove the instruments under visualization and the endoscope is removed. After that, the ports must be detached from the robotic arms by releasing the tabs around the cannula. The cannula should always be held while releasing the instrument arms from the cannula. Using the port clutch button, instrument arm can be gently removed from the cannula keeping one hand on the cannula until the arm is free from the cannula. When all instrument arms are released from the cannulas, the instruments arms are moved away from the patient's body. It will be announced to the circulator that the patient cart can be backed away from the patient. This process ensures that the undocking is performed safely.

TROUBLESHOOTING:

Troubleshooting is the best way to avoid patient injury. The importance of knowing what to do when something goes wrong with the robot during the procedure is the key to avoiding incidences. Malfunctions can occur at any time during a robotic case. The daVinci robot has two types of faults: recoverable and non-recoverable. In the event of a recoverable fault, the instrument arms will flash yellow and a non-recoverable fault will flash red. In most instances the faults are recoverable. A recoverable fault will stop the system operations until the fault is identified. In the event where the patient cart is unplugged, the system will generate a recoverable fault and operation will continue on reserved power. Battery backup is only used for the safe removal of instruments only and not to continue the surgery. Once the fault is addressed and corrected, the procedure may resume. A non-recoverable fault requires restarting the system once the problem is solved. An example is when there is a power outage in the operating room. When there is a non-recoverable fault due to a power outage, the following steps should be taken:

1. Remove instruments and camera.
2. Disconnect cannulas from instrument arms.
3. Remove patient cart from patient.
4. Remove patient cart from table.
5. Report conversion to customer service.

Robotic surgery has many advantages and offers the surgeon great precision, increased range of motion, improved dexterity, improved access and enhanced visualization. As for the patients who have undergone robotic-assisted laparoscopic surgery experiences less pain, postoperative recovery time, bleeding, infection and scarring. As for the surgical technologist and circulator, robotic-assisted surgery has created a whole new process of perioperative care of the surgical patient. Continuing education, in-services and communication are essential components to providing robotic surgery in a safe manner.

AUTHOR'S NOTE:

Being a part of the robotic team where I am employed is rewarding as a surgical technologist. There is a great deal of education involved in learning the system. The surgeon relies more on his or her team's skills and knowledge in order to make the operation run smoothly and safely. The ability to follow his or her instructions, having confidence in one's own skills, being a team player and communicating are all essential components when it comes to robotic safety in the operating room. When all these steps are taken, the end result is satisfaction in each other and success in achievement in the safety of robotic surgery.

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