Gumbs *et al. Art Int Surg* 2022;2:207-12
DOI: 10.20517/ais.2022.41

Artificial Intelligence Surgery

Editorial

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Why Artificial Intelligence Surgery (AIS) is better than current Robotic-Assisted Surgery (RAS)

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How to cite this article: Gumbs AA, Gayet B. Why Artificial Intelligence Surgery (AIS) is better than current Robotic-Assisted Surgery (RAS). *Art Int Surg* 2022;2:207-12. https://dx.doi.org/10.20517/ais.2022.41

Received: 22 Dec 2022 **Accepted:** 26 Dec 2022 **Published:** 28 Dec 2022

Academic Editor: Hengrui Liang **Copy Editor:** Ke-Cui Yang **Production Editor:** Ke-Cui Yang

When we were first asked to edit a new journal, it was initially going to be called *Intelligent Surgery*. We were immensely flattered and surprised, but then became intrigued and asked if we could have a section entitled *Artificial Intelligence Surgery* Centers of the World, so that we could highlight centers of excellence that had been pushing the envelope in artificial intelligence (AI) surgery for years. With that, the journal titled *Artificial Intelligence Surgery* (*AIS*) was born. We discussed the title with colleagues who would become future Editorial Board members and we mulled over the question of whether the world was ready for a journal exclusively about AI and surgery.

Because we believed that the world did not really need just another surgery journal, we decided to go for it and risk not having enough papers to publish and, thus, possibly perishing. Luckily, however, we could not have been more wrong. Not only were surgeons ready for *AIS* they seemed starved for it. This is probably due to a combination of fascination with the technological possibilities and new treatment options that may be on the horizon. An additional factor may be much more practical. There are rising concerns that as increasing numbers of healthcare workers retire or change fields, there will be a continued rise in burnout of those that stay, resulting in a perpetually worsening dearth of healthcare providers. There is hope that AI

can help with this by streamlining the delivery of care and by reducing redundancies and the ever-increasing amount of documentation and paperwork that seems to be necessary.

Another factor that may help our journal grow is our emphasis on inclusivity. We have committed to supporting women in our journal and we are proud to continue being the Official Journal of Women in Surgery-Italia (WIS-Italia). In fact, the two founders of WIS-Italia, Dr. Isabella Frigerio and Professor Gaya Spolverato, are also Associate Editors of *AIS* and chaired our second annual *AIS* Webinar on November 18, 2022. Multiple studies have well-documented the lack of support that women get in the Science, Technology, Engineering and Technology (STEM) sectors. Our goal is to one day have 50% representation of women on our Editorial Board. To that end, our first Special Issue was entitled "Women in Surgery Meets *AIS* Journal," guest edited by Drs. Frigerio and Spolverato, and it is currently still active[1].

Our next active Special issue is entitled the "Role of Artificial Intelligence in HPB Surgery," and is being guest edited by Professors Derek A. O'Reilly and Henry A. Pitt[2]. This topic highlights the main current incorporation of AI in the field of surgery, specifically as a tool to help with data analysis, data collection, enhanced diagnosis and clinical decision making[3]. Future special issues will try and shed light on the ways that AI can enhance our ability to perform screening, diagnosis, and treatment of specific diseases. To that end, Professor Ronan Cahill is guest editing an issue entitled: Application of Artificial Intelligence to the Screening, Diagnosis and Therapy of Colorectal Cancer" and Professor Timothy G. Wilson will guest edit "Artificial Intelligence in Urology Surgery: Ready for the Future?" Because some of the most exciting advances in *AIS* have come from radiologists, we have also asked Professors Beat Peter Müller-Stich and Thomas Baptist Brunner to guest edit an issue on the Application of AI and Radiobiology in Gastrointestinal Surgery. Although we are interested in the way that AI can be incorporated into the pre-operative and post-operative phases of the surgical patient, we also strive to understand the best and safest way towards more AI during surgery itself.

As mentioned above, in our first Editorial that we specifically called our journal *AIS* and not AI "in" Surgery to emphasize the goal of our journal, more autonomous actions during surgery, a.k.a. *AIS*[4]. As a result, it must be reiterated that we consider surgery to include all interventional fields in healthcare, including but not limited to endoscopy, interventional radiology, and interventional cardiology. We published a White paper: definitions of artificial intelligence and autonomous actions in clinical surgery that begins to scratch the surface of this next phase of surgical evolution[5]. As new devices with more autonomy are coming onto the market, we have begun to re-evaluate the current system of Levels of Risk for the evaluation of new technologies. We believe that we need more levels of risk when evaluating new technology and believe a new Risk level of 5 should be designated for devices that have level 4 or 5 of surgical autonomy [Figure 1]. Alternatively, we wonder if a Risk level 0 should be developed to incentivize the development of more intelligent surgical devices, specifically those that encompass levels 2 and 3 of surgical autonomy.

Perhaps the easiest way to show how we envision the future is to observe our latest Special Issue that is to be entitled "Future: AI Driven Surgical Robots," which is to be curated by guest editor Professor Zbigniew Nawrat who is a World-renown robotics expert. Our goal is not the development of another robotic tele-manipulator that will enable us to do the same surgery that we can now do via open or laparoscopic techniques, but to develop autonomously functioning tools that can enable us to do procedures better than we can do now and maybe even procedures that we cannot currently do. Perhaps the best example of this is the Smart Tissue Autonomous Robot (STAR), which has performed an in vivo robotic laparoscopic small bowel anastomosis[6]. The question is, how do we get to more autonomous actions in surgery? If tele-manipulation indicates the lowest form of autonomy (level 1), perhaps it is not the best way forward.

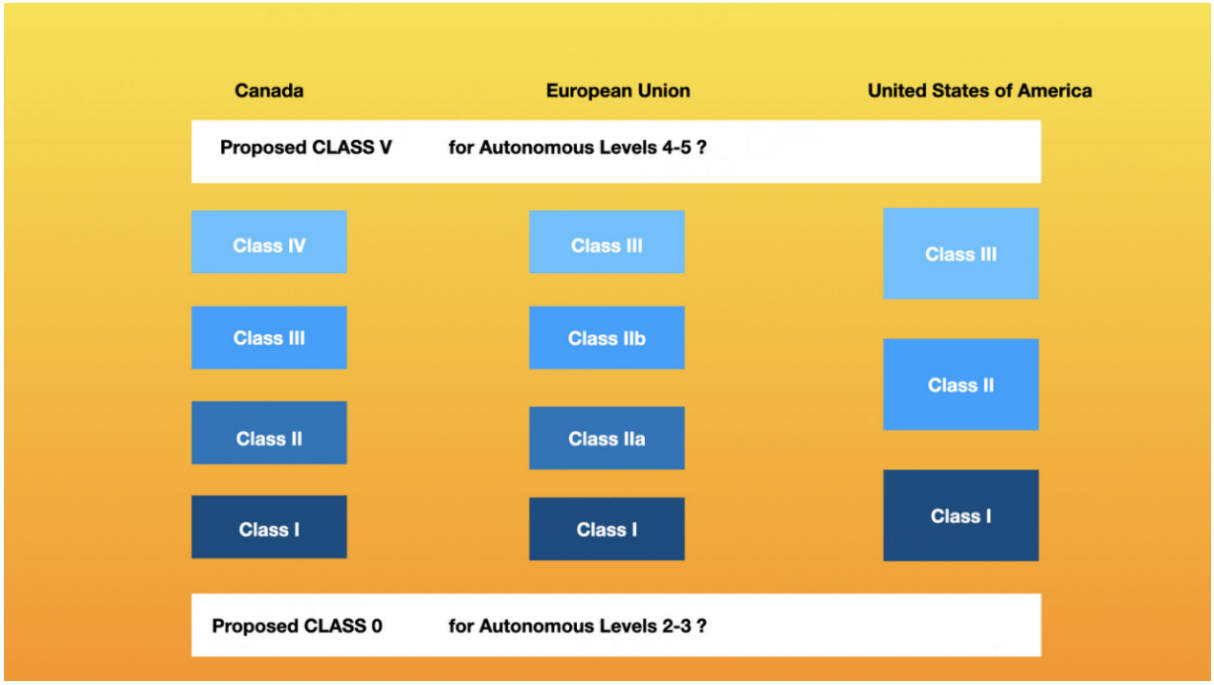

Figure 1. Levels of Risk for New Devices in Canada (levels I-IV) , the European Union (levels I-IV) and the United States of America (levels I-III). Proposed level 5 in white (would be 4 in the United States of America) for devices with level 4 or 5 of surgical autonomy; and proposed level 0 in white for devices with level 2 or 3 of surgical autonomy to incentivize the development of more intelligent surgical/endoscopic and interventional devices.

Like in industry, perhaps more collaborative robots (cobots) are needed with the surgeon remaining at the operating room table.

The reality is that there are fundamentally two diverging visions for surgery in the future. In one version, similar to the tele-manipulators da Vinci (Intuitive Surgical, Sunnyvale, CA, 86 USA) and Versius (CMR, Cambridge, UK), there is a robot operating by the patient while the surgeon is remote from the patient. Notably, industry has been fixated on essentially limiting robotic surgery to devices that perform this tele-manipulation. To date, there are 15 tele-manipulation systems in the market in various stages of availability around the world [Table 1]. They can broadly be divided into tele-manipulators with: (1) multiple robotic arms; (2) a single port configuration; and (3) systems that enable endoluminal surgery. In the other version, the surgeon is always at the bedside and an integral part of the procedure; they are more effectively still in the loop[7]. Although one could argue that complete robotic systems like the da Vinci Robot (Intuitive Surgical, Sunnyvale, CA, USA) are an example of a cobot, the fact that the surgeon is operating at a console far away from the patient, unsterile, and completely dependent on his scrub tech and surgical assistant argues against this.

To overcome these deficiencies, some complete robotic systems like Dexter (Distalmotion, Épalinges, Switzerland) have developed systems where the operating surgeon can remain sterile and go back and forth between the console and sterile field [Figure 2A and B], but there are other possible solutions. Specifically, non-console complete robotic systems like the Maestro (Moon Surgical, Paris, France) that has begun human trials [Figure 3], but also handheld robotic devices that have been around for over a decade[7]. These last two approaches have the benefit of keeping the surgeon in continuous contact with the patient and represent the best current way to maintain haptics during robotic-assisted surgery (RAS). Unlike other

Table 1. A list of the 15 currently available tele-manipulating/console robotic systems divided broadly into systems utilizing: (1) Multiple Robotic Arm; (2) Single Port; and (3) Endoluminal

	Tele-Manipulator	Multiple Robotic Arms	Single Port	Endoluminal
Da Vinci surgical Systems X and Xi	×	×		
Versius	×	×		
Hugo RAS system	×	×		
Dexter	×	×		
Avatera	×	×		
Bitrack	×	×		
Senhance surgical system	×	×		
Da Vinci SP	×		×	
Vicarious surgical robotic system	×		×	
Enos surgical system	×		×	
Hominis surgical system	×		×	
MIRA platform	×		×	
Ion endoluminal system	×			×
MONARCH platform	×			×
The endoluminal surgical system from colubrisMX	×			×

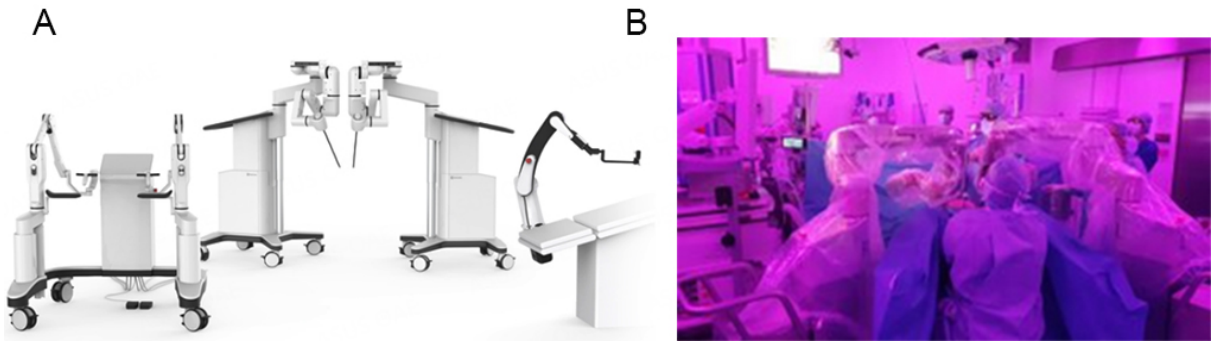

Figure 2. (A) The Dexter Complete Surgical System utilizing laparoscopic instruments. (B) an example of a console robotic system enabling the operating surgeon to remain sterile during surgery so that rapid and continual contact with the patient can be maintained throughout the entire procedure. (https://otjonline.com/featured-articles/distalmotion-dexter/)

forms of RAS, they also have the potential to eliminate the need for surgical scrub assistants (i.e., surgeon assistants, physician assistants or surgical nurses), which is particularly relevant because of the rising scarcity of doctors and nurses around the world after the Covid-19 epidemic, as mentioned above.

In conclusion, it will be interesting to see if robots like the STAR evolve more as an adjunct to a tele-manipulator, or if they will enhance non-console robotic surgery with the surgeon and robot remaining at the bedside. Although it is possible that autonomous robots may be incorporated into both paradigms in the short-term, to figure out which future is best in the long term, surgeons, endoscopists and interventionalists need to know intimately how AI and robotics work so that we as a body can dictate the safe implementation of autonomous actions in surgery and not have this solely dictated by industry. It is hoped that our journal *Artificial Intelligence Surgery* will help educate and spread the word on issues involving AI to surgeons, but it is also hoped that more surgeons will pursue additional training in the field of AI in the form of Master's and even PhD's and that medical schools, Residencies and Fellowships will start to incorporate the fundamentals of AI into their curricula. Until this happens, we are currently drafting White Papers on the Ethics of AI Surgery and another on Data Collection and Management in the Age of

Figure 3. The Maestro robotic platform enabling the surgeon to remain in contact with the patient throughout the entire procedure, an example of a non-console robotic system.

AI. Lastly, our 3rd *AIS* Webinar is entitled "Artificial Intelligence Surgery > Robotic-Assisted Surgery" and will be organized by Professors Konrad Karcz and Nawrat and is tentatively scheduled for May of next year. In 2022, *AIS* has enjoyed great support from the surgeon's community working in this field, and we thank everyone for their contributions. We look ahead to greater success in 2023 and serving the surgeons in the field of intelligent surgery.

DECLARATIONS

Authors' contributions

Drafting of manuscript and editing: Gumbs AA, Gayet B
Editing and administrative support: Gumbs AA, Gayet B

Availability of data and materials

Not applicable.

Financial support and sponsorship

None.

Conflicts of interest

All authors declared that there are no conflicts of interest.

Ethical approval and consent to participate

Not applicable.

Consent for publication

Not applicable.

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