Artificial Intelligence in Robotic Urologic Surgery

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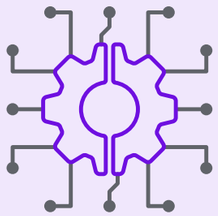
1. Artificial Intelligence[1]

Artificial intelligence

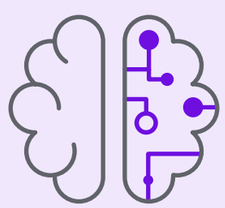
Any technique that enables machines to mimic human intelligence.

Machine learning



A subset of AI that uses statistical methods to enable machines to 'learn' tasks without explicit programming.

Deep learning



A subset of machine learning that uses artificial neural networks to mimic the learning process of the human brain.

2. Robotic Urologic Surgery[2-4]

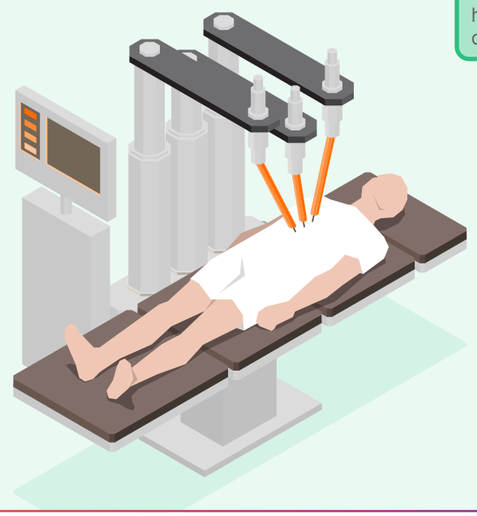
The da Vinci system™ remains the main robotic surgical system used since its first approval in 2000 by the US Food and Drug Administration (FDA).

ADVANTAGE ✓
Reduced surgeon fatigue

ADVANTAGE ✓
Smaller incisions: less blood loss, less pain, less risk of infection

ADVANTAGE ✓
Faster recovery, shorter hospital stay, faster return to daily life

ADVANTAGE ✓
Easier access to area being operated on



ADVANTAGE ✓
Enhanced visualisation: highly magnified, 3D high resolution image

ADVANTAGE ✓
Greater range of motion, dexterity, and precision

DISADVANTAGE ✗
Lack of experienced robotic surgeons and appropriate training programmes can lead to adverse events during robotic procedures

DISADVANTAGE ✗
High cost of robotic systems is a barrier in low- to middle-income countries

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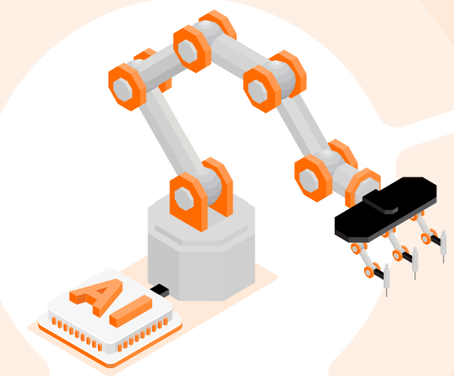
3. AI can overcome challenges in robotic surgery[5-7]

AI can be used as a **learning tool** for robotic surgeons at different stages of their careers (recording surgeries, stocking datasets, etc.).

AI can be used to **predict adverse events** during surgery, such as intra-operative bleeding, to improve patient safety, and evaluate risk of post-operative complications.



Integration of AI with **augmented reality** can boost the ability of surgical robotic systems to perceive complex *in vivo* environments, and perform tasks with higher precision, safety, and efficiency.

Intra-operative assistance by AI can tailor a personalised approach for each patient, by analysing surgeries as they are performed, and providing decision support to surgeons in real-time. AI can anticipate the next 15-30 seconds of an operation, and suggest safe or less safe locations for incision.

AI can also **provide algorithms** to identify patients in need of organ transplants, evaluate potential donors, and match donors and recipients, to improve transplant decisions, and optimally allocate donor organs.

4. What's Next for Robotic Surgery[8]

Minimally invasive procedures:
- Micro-robotics, for drug delivery, tissue repair, or exploratory surgery
- Single port robotic surgery

Ethical and legal frameworks for robotic automation, AI-driven decision-making, and safeguarding patient privacy.

Telesurgery to expand access to healthcare in remote, underserved, or disadvantaged regions.