Innovative approaches and Infection prevention How to deal?

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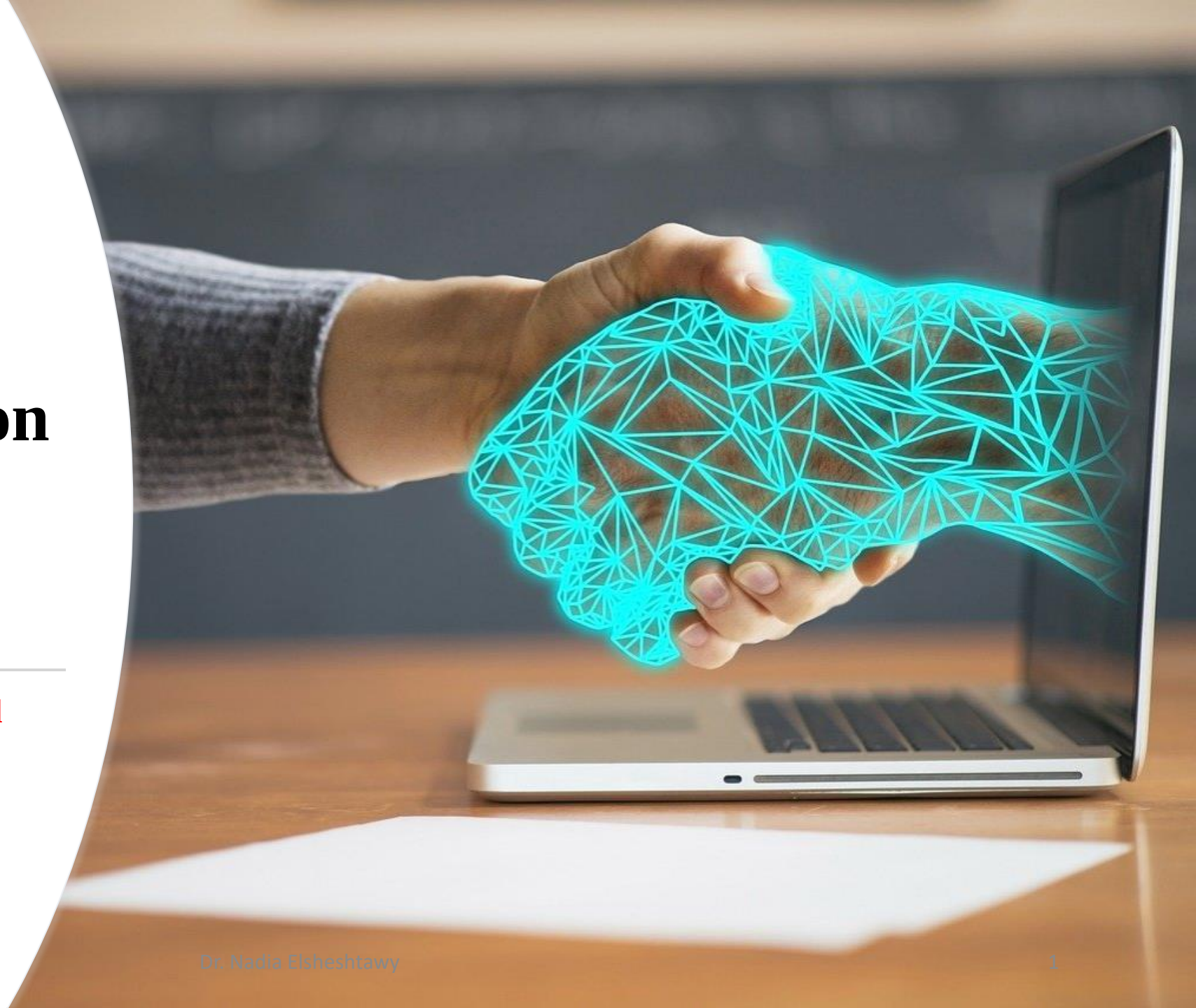


Goal

- Infection Preventionists are facing too many challenges with the rapidly growing technologies either in infection prevention or in the new Medicine Modalities.
- Infection prevention (IP) practices must keep up with the advancing technology, to follow the dictum “first, do no harm,”.
- So, Hospital leaders must remain vigilant in their prioritization of patient safety and seek new technologies to align with the Hippocratic oath.

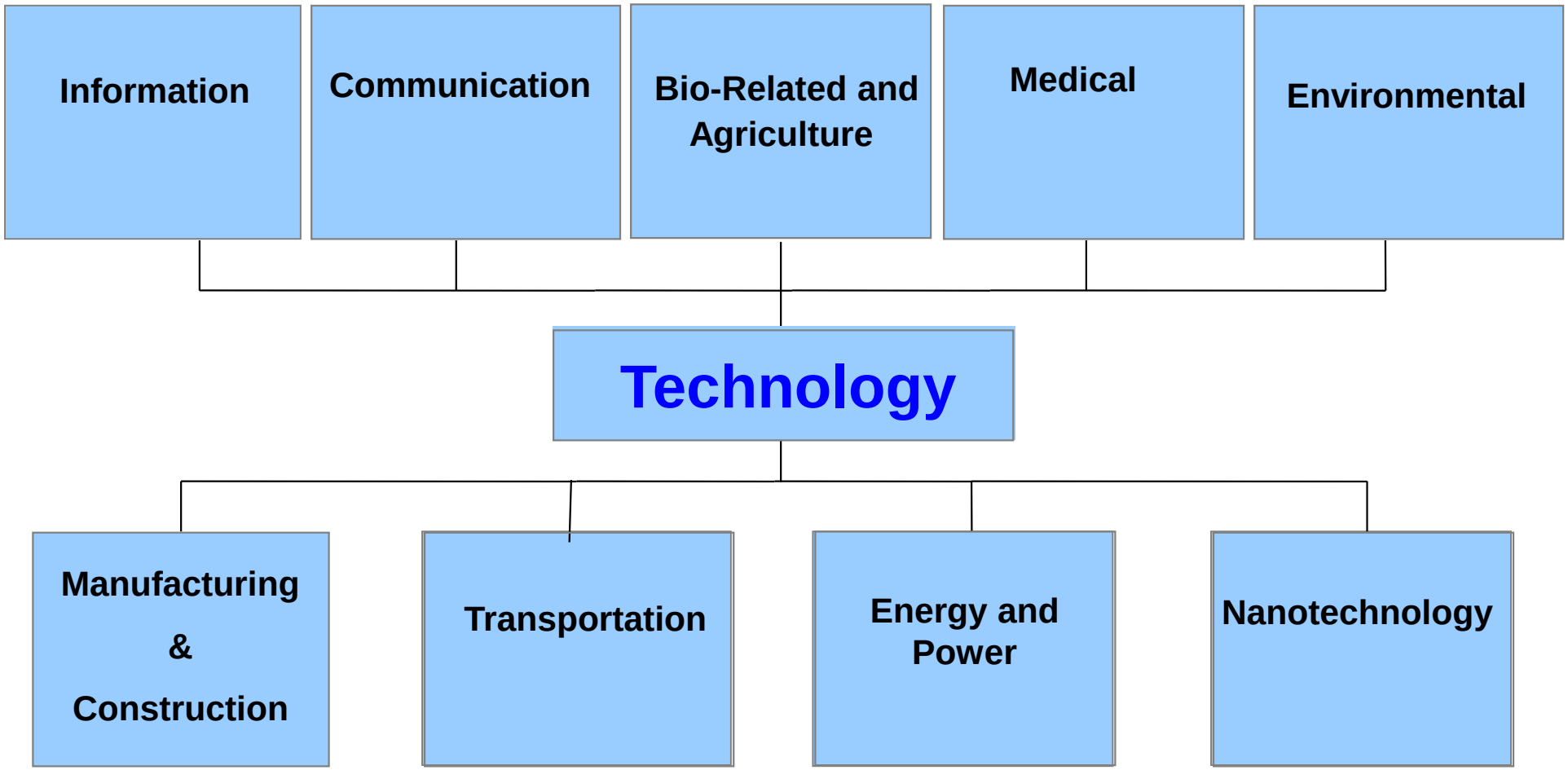
- Some recent developments in IP technologies include electronic hand hygiene monitoring systems, antimicrobial textiles, ultraviolet C (UV-C) devices. Also, new technologies like CHG sponge, antiseptic/antibiotic impregnated central lines have played a critical role in reducing HAIs.
- We are reaching the era in which **utilizing new technology to improve outcomes is superior to changing behaviour.**


We need to be prepared!!
HOW?

What is Technology?

Technology is **the application of scientific knowledge to the practical aims of human life** or, as it is sometimes phrased, to the change and manipulation of the human environment.

How Does Technology Address Human Needs and Wants?

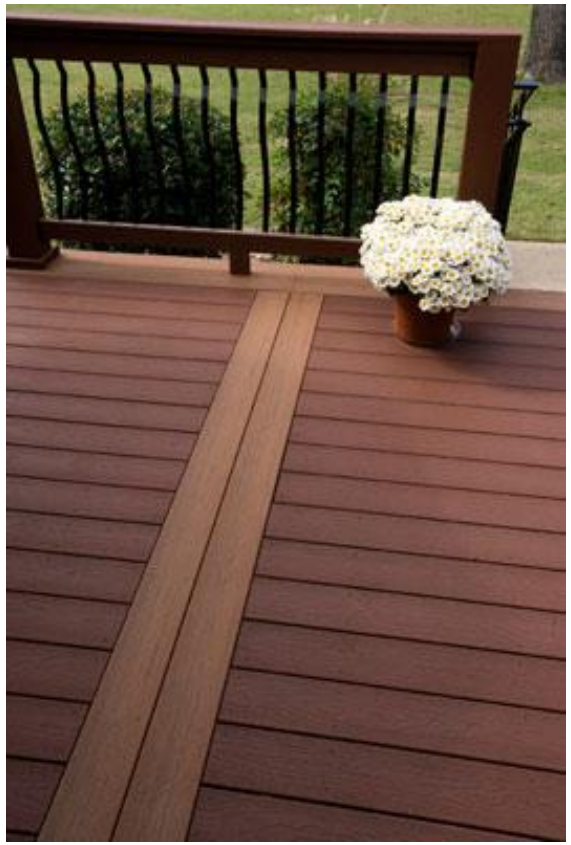


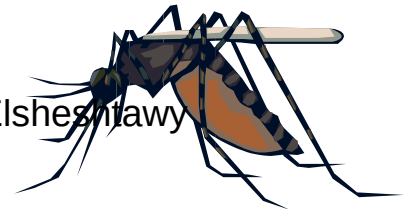
Medical Technology

- ***Medical Technology*** creates tools to treat disease and injury.
- Examples: Lasers, prostheses, ultrasound, medications

Materials Technology

- The development of materials with outstanding combinations of mechanical, chemical, and electrical properties that make other advances possible.
- Examples: Mosquito repellent clothing, artificial skin grafts for burn victims.



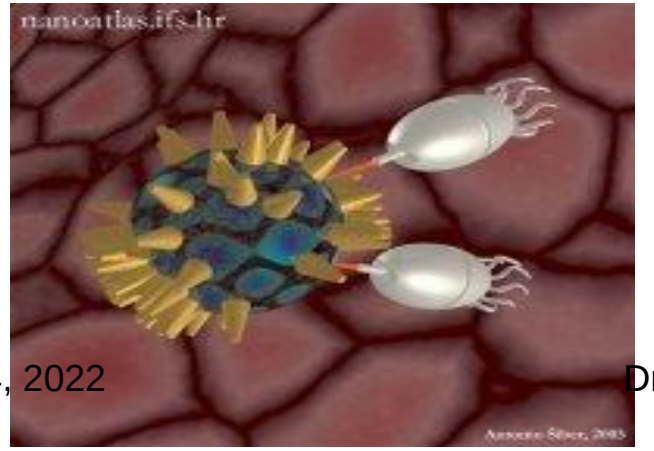


New Modalities

- This engineering designed feature takes the **human error element out** of the equation.
- Engineering controls that can do this are more likely to protect the person using the device.

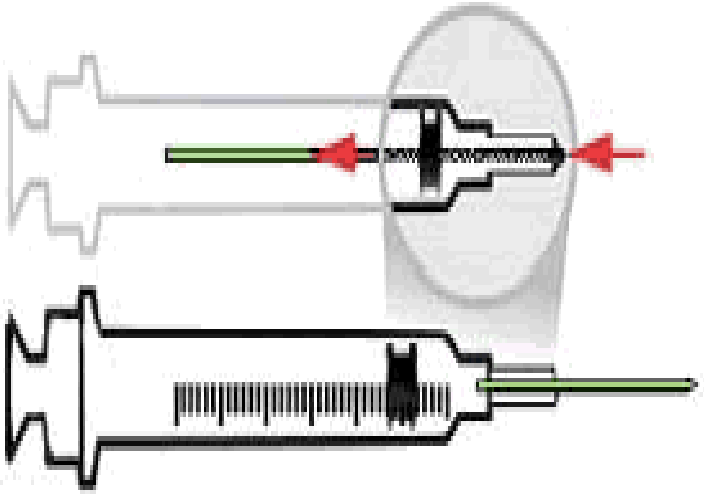
Nanotechnology

- Nanotechnology is a multidisciplinary field that makes use of nano-sized particles and devices for various applications.
- Nanoparticles such as gold and silver have been used in biomedical and diagnostic applications, for the detection of viral particles
- Nanoparticles can act as antiviral drug delivery systems; they can interact and bind to a virus .
- Nanomedicine has already been used in drug delivery. In the case of an RNA-based vaccine



Self sheathing needles

- Needleless systems or self sheathing needles are available for the administration of medications and fluids and for any other procedure involving the potential for exposure to blood borne pathogens due to percutaneous injuries from contaminated sharps.



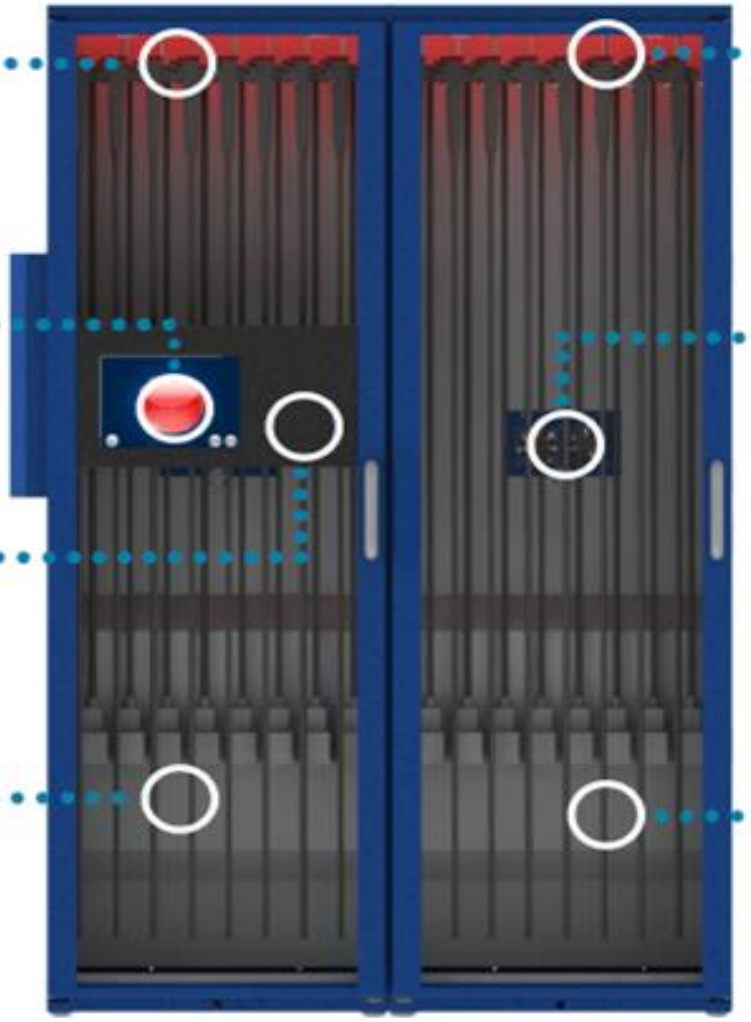
New endoscopy storage cabinets

Storage Hooks For Any Scope or Probe
Convenient design for scopes and probes so they won't touch or damage each other. Store 7-9 scopes or probes in a single cabinet. Several configurations to match your scope inventory.

On Cabinet Display Screen
Associate patients to scopes, look up current scope locations, and return scopes to storage, all with the touch of a button.

Bar-Code Reader
Built-in bar-code reader allows your staff to scan the patient's bar-code to minimize their effort when removing a scope.

3D RFID Antenna
Patented, one-of-a-kind technology that keeps track of your scopes in real-time.



LED Illumination
Lights built in for visibility even in low lighting. In case of potential cross-contamination issues, lights will turn red to signal users that an issue needs to be addressed.

Positive Air Pressure
Constant, HEPA-filtered airflow helps to dehumidify the inside of the cabinet and improves the drying of the scopes.

Optional Channel Drying Feature
Make sure the inner channels of your endoscopes are dry to promote the highest safety standards.

Transparent Design
Look for the scopes you need without opening the door and introducing outside elements to your clean scopes.

New “Touchless” Technologies: Room Cleaning Robots

- Devices include hydrogen peroxide (HP) or UV-light emitting machines.
- Manual cleaning remains an important precursor step, as gross organic soil must be removed from surfaces to allow penetration of germicidal vapor/aerosol or radiation.
- The HP or UV light is toxic to humans, used only in empty patient rooms, after a patient discharge.
- UV and HP devices are costly, and cost-effectiveness has not been well established. They also require human resources to deploy.

Pulsed UV Disinfection

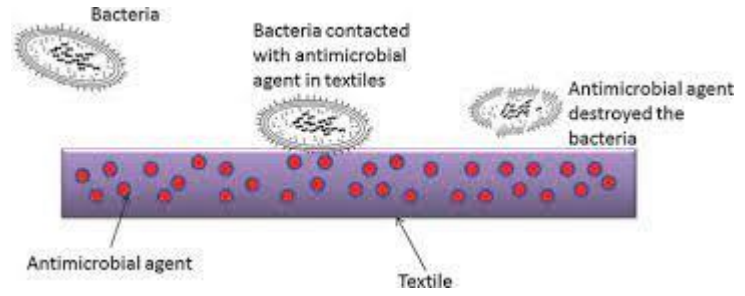
- Where manual disinfection may not hit every spot, UV disinfection can reach every microorganism, without the same margin for human error.
- There are three types of UV lights, they are UV-A (315 to 400nm), UV-B (280 to 315nm), and UV-C (100 to 280nm).
- UV-A and UV-B rays are what caused the sunburns on humans.
- UV lamps used in disinfection are commonly UV-C type; these can emit 20 joules per square meter per second (at 1-meter distance) of 254-nanometer light.
- Surfaces are only exposed directly for a couple of minutes since the UV radiation can cause damages to human if the exposition is longer, especially in eyes and skin.
- A common way to disinfect areas and spaces with UV is with mobile systems such as robotic carts .

Fogging Machine.

- Fogging machines are particularly useful in large clinical settings; especially if there's been an HCAI outbreak.
- Coating an area with tiny liquid droplets, a fogging machine can reach areas that cleaning by hand might struggle to reach, or even notice.
- As the droplets are so small, they can cover a wide surface area without much effort; the top, bottom and sides of a surface will all be treated.

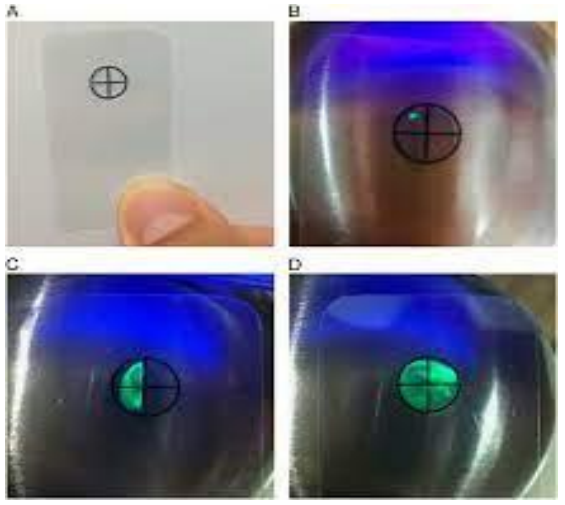
Antimicrobial Textiles

- Textiles with antimicrobial properties show promise in the laboratory setting. Some materials have a **documented ability to kill bacteria after a few hours of contact time.**
- In the clinical environment, antimicrobial scrub garments and patient room curtains have been evaluated with mixed results. Some studies have shown reduction in the burden of important hospital microbes from silver curtains (Vancomycin resistant Enterococcus) and quaternary ammonium impregnated provider scrubs (MRSA).
- However, other studies have reported no difference in contamination rates.
- An important consideration in the adoption of antimicrobial linens is wastewater management. These linens are more expensive than traditional hospital linens, so investigators must continue to study whether the savings hospitals may realize through reduction of HAIs through antimicrobial linens is worth the cost of purchasing them.



New Technologies to Improve Cleaning Monitoring

- Adenosine triphosphate (ATP) levels and fluorescent markers have been used as surrogates of contamination to assist in monitoring of cleaning.
- ATP levels represent the organic load, or general cleanliness of a surface.
- Fluorescent markers are placed on surfaces prior to cleaning, then reassessed with black light for their persistence after cleaning efforts



Chlorhexidine-impregnated patch

- The Biopatch is a chlorhexidine (CHG) impregnated patch **designed to inhibit bacterial growth for days**.
- Chlorhexidine gluconate **may help reduce bloodstream infections and bacterial infections associated with the central line**.
- Chlorhexidine-impregnated dressing is beneficial in preventing catheter colonization and, more importantly, CRBSI and warrants routine use in patients at high risk of CRBSI and CVC or arterial catheter colonization in ICUs.

Hand Hygiene Monitoring System

- Devices were used in a clinical trial within the NHS and it increased the quality of hand hygiene by 197% and the number of hand wash events by 147%. The results were published in the American Journal of Infection Control in February 2020.

Electronic Hand Hygiene Monitoring Systems

- Electronic hand hygiene monitoring systems (EHHMSs) offer hospitals large data sets of hand hygiene (HH) compliance among health care workers (HCWs) who wear their badges.
- Despite the benefits of EHHMSs, barriers exist to widespread adoptability, including negative perceptions as wearable technologies require staff to continuously wear the technology, device functionality, device design, size, or weight may be perceived as a barrier to providing patient care, or indeed an IPC risk itself given most commercially available wearables which are designed to be worn on the wrist.

Robotic surgical system

- **Referred to as robotic surgery, RAS devices enable the surgeon to use computer and software technology to control and move surgical instruments through one or more tiny incisions in the patient's body (minimally invasive) for a variety of surgical procedure:**
- **Robotic Gynaecologic Surgery.**
- **laparoscopic procedures. ...**
- **Robotic Prostate Surgery. ...**
- **Robotic Kidney Surgery. ...**
- **Robotic Colorectal Surgery. ...**
- **Single-Site Robotic Gallbladder Surgery**

- The technology consists of:

✓**Surgical arms** with tiny instruments with wrists at the tip.

✓**Special camera** that provides enhanced magnified 3D views of the surgical area.

✓**Surgical console** where the surgeon controls the instrument and camera's every move.

Advantages of robotic surgery

- **Smaller incisions**.
- **Greater precision:** The robotic arm's movements are more exact than a human hand. And their range of motion is greater. The arms rotate instruments in tight spaces in ways that aren't otherwise possible.
- **Better visualization**: A sophisticated camera provides magnified, high-definition views of the surgical area. It also has 3D capabilities for imaging that are superior to the naked eye.
- **Less pain** during recovery.
- **Lower risk of infection**.
- **Reduced blood loss**.
- **Shorter hospital stays**.

Disadvantages of robot-assisted surgery :

- **Only available in centers** that can afford the technology and have specially trained surgeons.
- **Need to convert to an open** procedure with larger incisions if there are complications.
- **Robotic malfunction**, which is extremely rare.
- **Sophisticated manual** for cleaning and disinfection **(Spaulding Classification)**
- **Robotic instruments are of complex design** consisting of irrigation ports, a shaft and a distal end with a double-jointed system accommodating various instruments such as forceps, needle holders or scissors…..which recommends predisinfection and cleaning that is dependent on the staff member executing them.

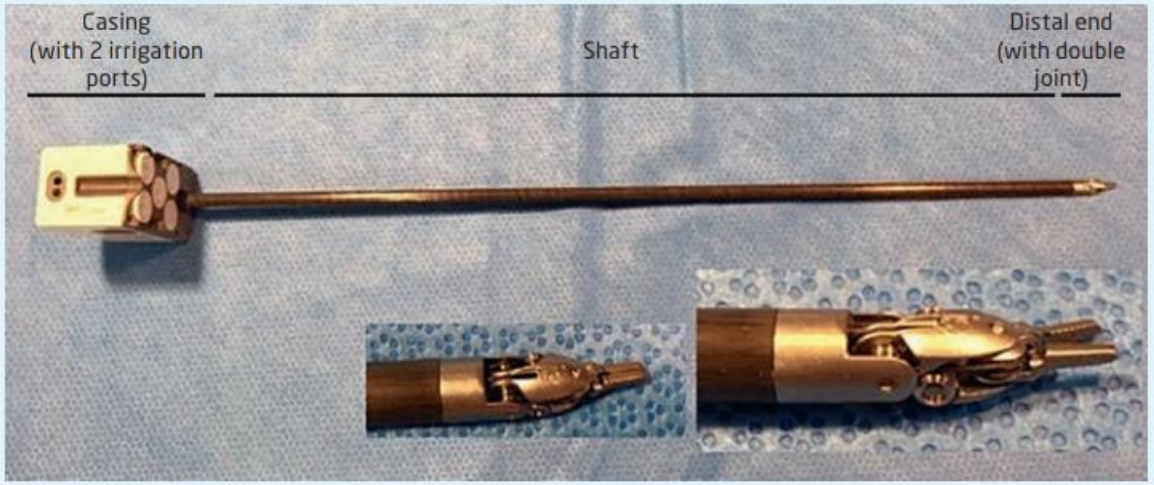


Photo 1: Design of the da Vinci Xi® robotic instrument

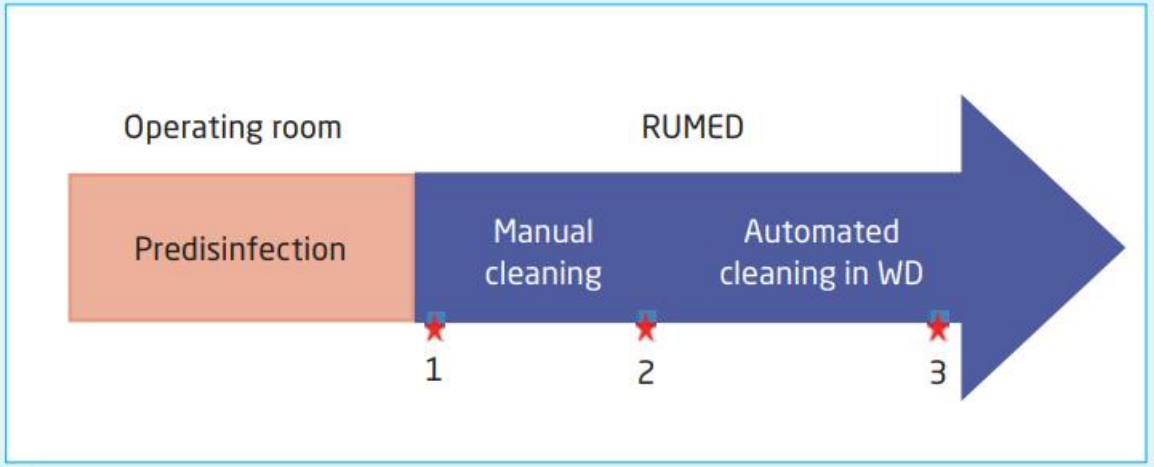


Fig. 1: Sampling time points when cleaning the instruments

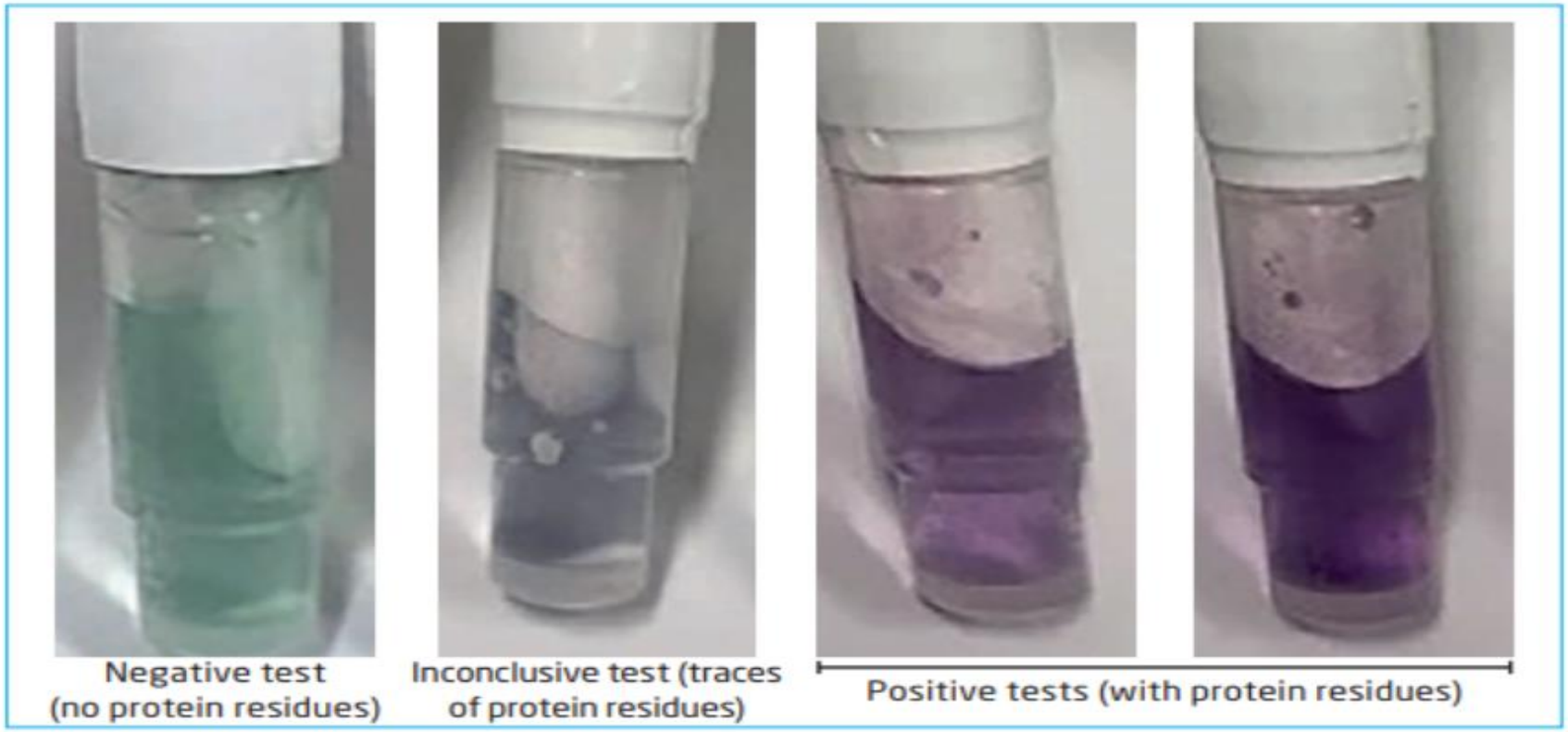


Photo 2: Colour of Clean-Trace® test in relation to the amount of protein residues

- It is therefore necessary to verify the absence of residual soils at the end of the cleaning process.

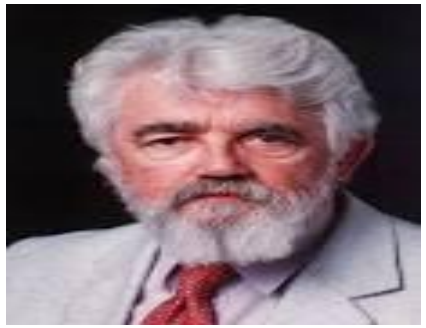
Engineering role is Important!!!!!

- In today's technology dependent modern medical practice, engineers of various specialties play a vital role in patient care and by adopting a professional approach they can make a significant contribution towards achieving high levels of patient safety.

Engineering Responsibilities

1. Medical equipment selection.
2. Incoming inspection.
3. Installation.
4. User training.
5. Developing user policy
6. Periodic performance evaluation.
7. Safety testing.
8. Preventive maintenance, breakdown maintenance.
9. Safe disposal.

What is Artificial intelligence (AI)?



- AI which stands for artificial intelligence refers to **systems or machines that mimic human intelligence to perform tasks and can iteratively improve themselves based on the information they collect**.
- ***John McCarthy***, created the term "artificial intelligence" and was a towering figure in computer science at Stanford most of his professional life.

Artificial Intelligence VS. Robot

- Programmed to think
- Social Interaction
- Learns

Programmed to do

Low level interaction

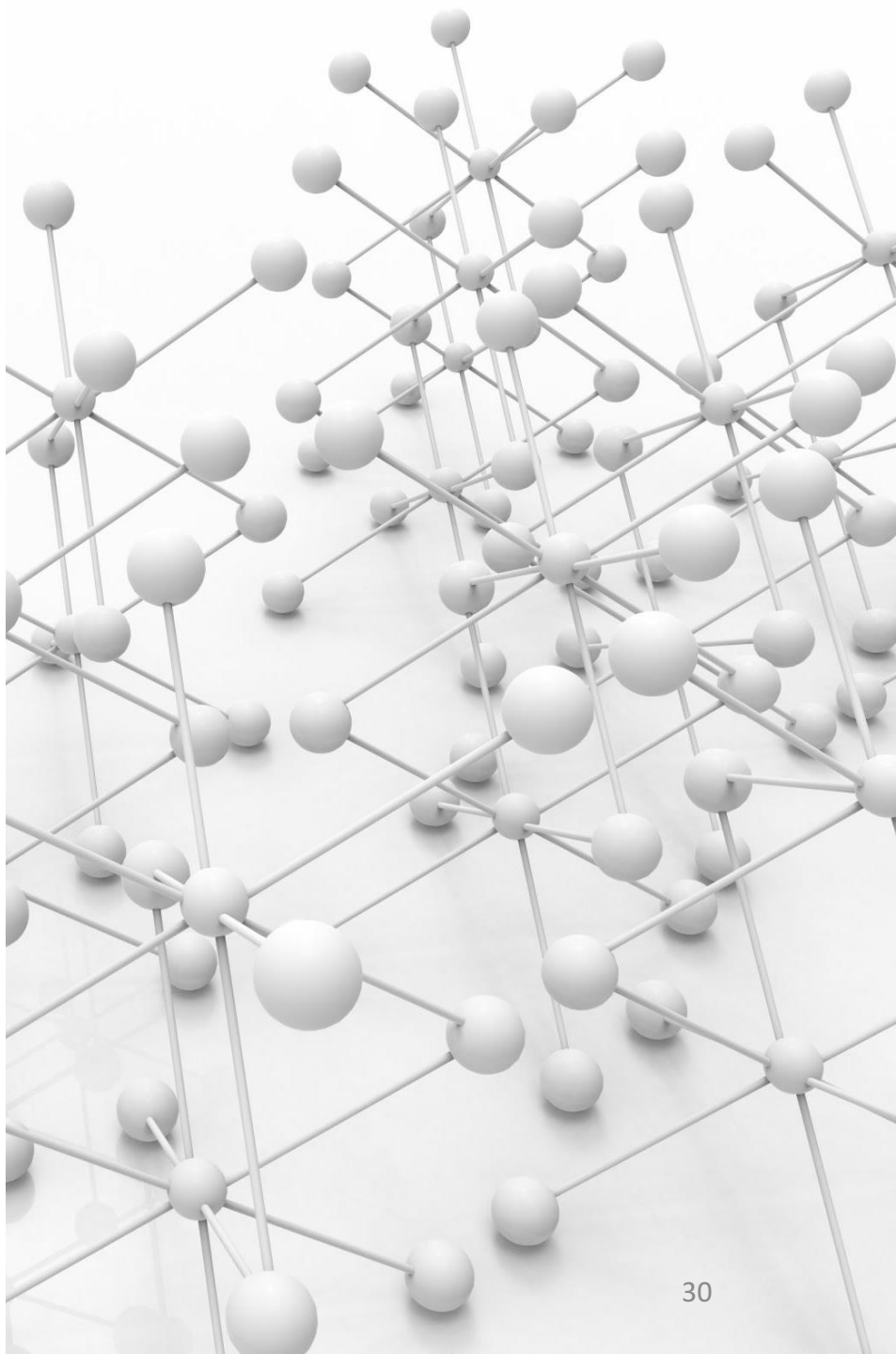
Only as smart as program

Artificial intelligence (AI) **Machine learning**

- AI uses mathematical tools, to iteratively learn patterns within training data and when these patterns are found in new data, the AI translates this into a decision and this has delivered a significant increase in accuracy of diagnosis.

- The neural network builds the algorithms automatically by finding novel relationships between inputs and outputs.

- The algorithms cannot be analysed by humans as they involve 1,000,000 s of small decisions about data.



Artificial Intelligence for Early Detection of Sepsis

- Artificial intelligence (AI) has surfaced as a new tool that can help rapidly detect sepsis.
- Using AI algorithms, the tool detects several key risk factors in real time by monitoring patients' electronic medical records as physicians input information.
- **Flagging high-risk patients** can help facilitate early intervention, which can improve outcomes, lower healthcare costs and save lives.

AI in HAI surveillance program

- An HAI social network generated from electronic healthcare record (EHR) patient.
- Machine learning applications have been used to predict the risk of nosocomial *C. difficile* infection so the the IPC and clinical team could be alerted accordingly.
- **Models can be developed tailored to a particular healthcare facility or patient population**.
- Machine learning applications can also more readily cope with the dynamic nature of healthcare than traditional surveillance models

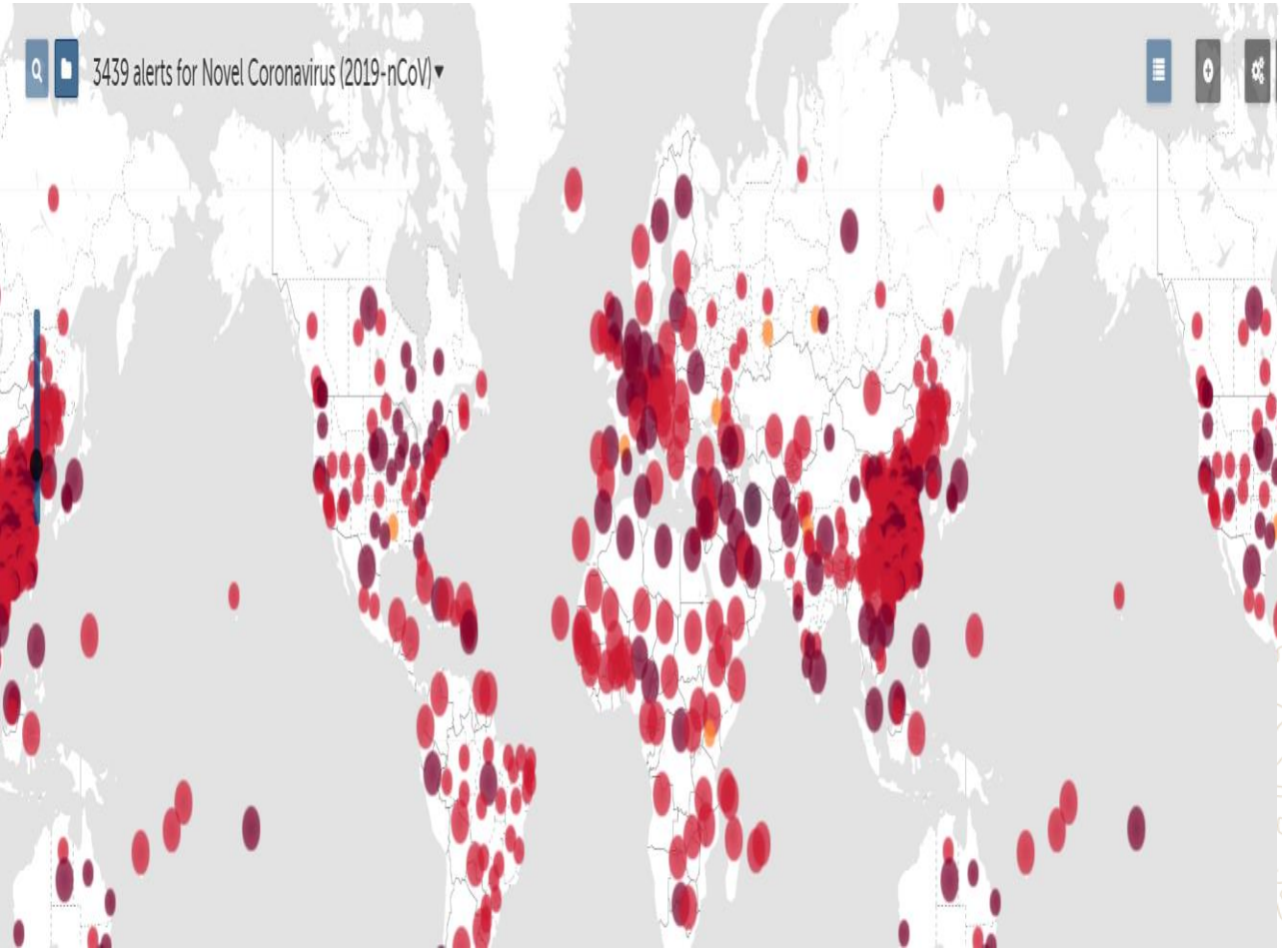
AI in the clinical microbiology laboratory

- Data mining of routine microbiology laboratory results could be used to detect and predict clusters/outbreaks of multidrug-resistant organism colonization and/or infection events
- This type of analysis could also facilitate detection of potential sources of these events which is frequently a difficult and time-consuming aspect of epidemiological investigation.
- Next-generation sequencing (NGS) is being increasingly used for pathogen identification, antimicrobial resistance (AMR) detection, and strain typing.

- AI offers the opportunity for more complex analysis of NGS-generated data with the potential to integrate and analyse diverse HAI and AMR data across the healthcare system. This type of integration could help predict patients most at risk of HAI and AMR events and facilitate timely detection of outbreaks with molecular analysis of transmission events and interactions between patients, staff, and the clinical environment in real time.
- AI-assisted microscopy opens possibilities for areas without clinical microbiologist expertise with the potential to send images to a central facility for review and appropriate clinical liaison regarding patient management.

AI in the novel coronavirus (COVID-19) outbreak

- AI facilitated decision-making when large amounts of data were emerging rapidly, by analysing data from a variety of sources (e.g., government and national reports, social media, news outlets) to generate applications as (https://www.healthmap.org/wuhan/).
- This can also speed up contact tracing by AI pattern recognition within the data, in addition to evaluation and optimization of IPC strategies to prevent further cross infection.
- AI platform Bluedot (https://bluedot.global/), which includes air travel data, uses natural language processing and machine learning to process vast unstructured text data, in multiple languages, to track outbreaks of over 100 different diseases. Bluedot first alerted on COVID-19 on December 31, 2019, almost a week ahead of national surveillance centers and the WHO.



30-Days of Clarity

Be the first to know with a 30-day free trial of BlueDot's infectious disease activity alerts & risk assessments, delivered directly to your inbox.

Sign up to unlock

- **Near real-time** infectious disease activity alerts
- **Expert-written** risk assessments
- **Bi-weekly summaries** of recent infectious disease activity
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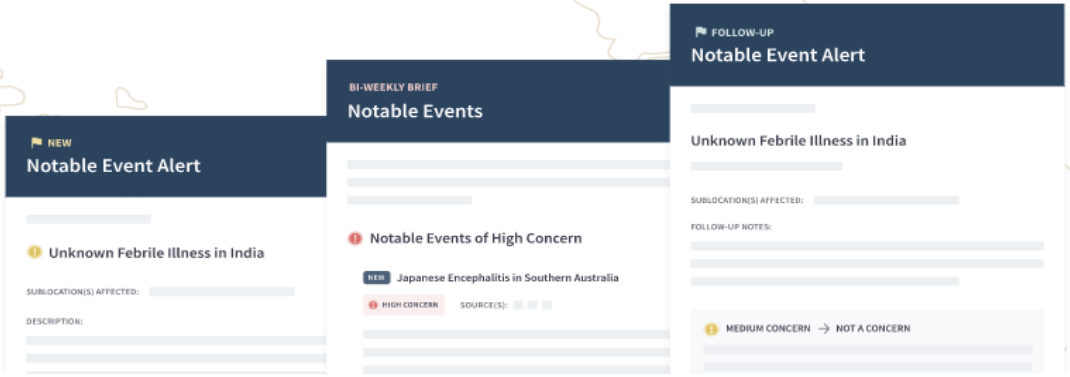


https://www.healthmap.org/wuhan/

https://bluedot.global/

Challenges

- Most studies to date assess performance retrospectively so there is a need for prospective evaluation in the real-life often chaotic clinical setting.

- AI is highly dependent on data quality and completeness, robust reference standards (which frequently do not exist in IPC), in addition to close collaboration with IPC experts to interpret outputs and ensure clinical relevance.

- Errors that are introduced during the machine learning training process can result in false negatives, misclassification, or lack of applicability.

- IPC practitioners also need to understand the limitation of AI for a particular application and context. Depending on how data is collected and the learning algorithms are designed, machine learning results can poorly classify new data (under-fitting) or lose the ability to recognize similar patterns in new data (overfitting). They may also reflect the underlying bias in the training data.

3D Printing

- 3D printing is gaining traction in the healthcare industry for multiple applications like **printing lightweight prosthetics, bionics, and casts** for fracture repair. The use of inexpensive, lightweight biomaterials and smart materials ensures improvement in care delivery and time of production while reducing costs.
- 3D printing technologies are advancing the development of patient-specific models of organs and surgical tools, using the patient's own medical imaging.
- 3D scanning and printing technology develops a hygienic, waterproof, breathable, itch-proof, easily removable, and reusable support device that adapts immobilization to each patient's condition.
- The key benefit is onsite printing in a clinical setting, eliminating the time and cost of recasting with traditional materials.

Blockchain

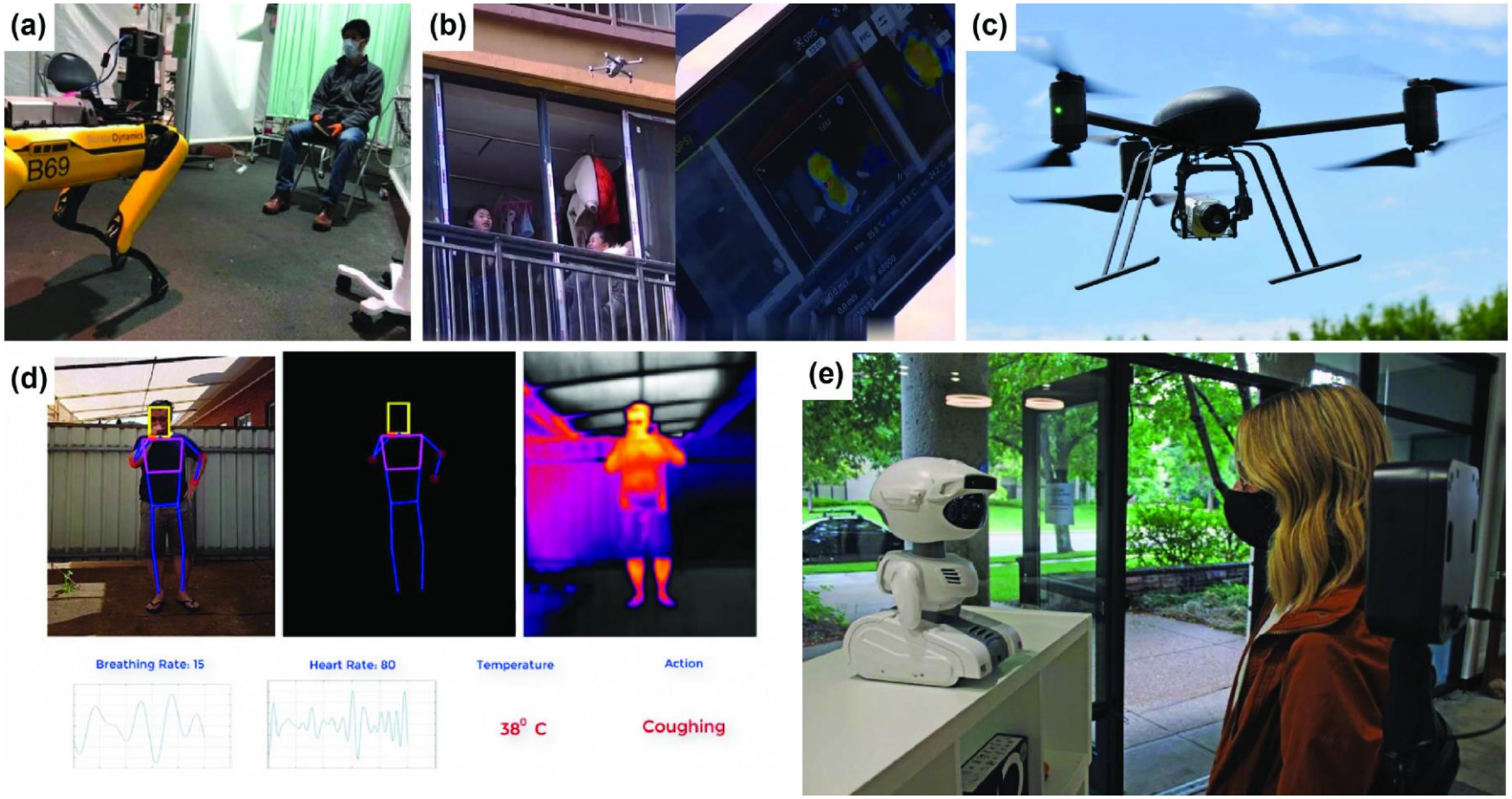
- **Blockchain technology** supports the management of FHIRChain (Fast Health Interoperability Records) for sharing clinical data. It also plays an important role in smart contracts, tackling drug counterfeiting, as well as storing, sharing, and retrieving remotely collected biomedical data.
- Blockchain-based drug traceability it integrates with multiple information systems and stores authenticated data on medicines stored , upon detection of a falsified medicinal product, the laboratories immediately alert which then adds the medicine to its flagged list.

Telemedicine

- The COVID-19 pandemic accelerated the adoption of telemedicine by many governments, healthcare systems, clinicians, and patients. To tackle the pandemic, governments issued telemedicine guidelines to decongest healthcare facilities.
- Telemedicine minimizes the load on facilities and reduces the use of personal protective equipment (PPE) as medical practitioners reach their patients via telecommunication.
- Telemedicine also aids to assist elderly people remotely, reduces bed space, and conserves clinical supplies.

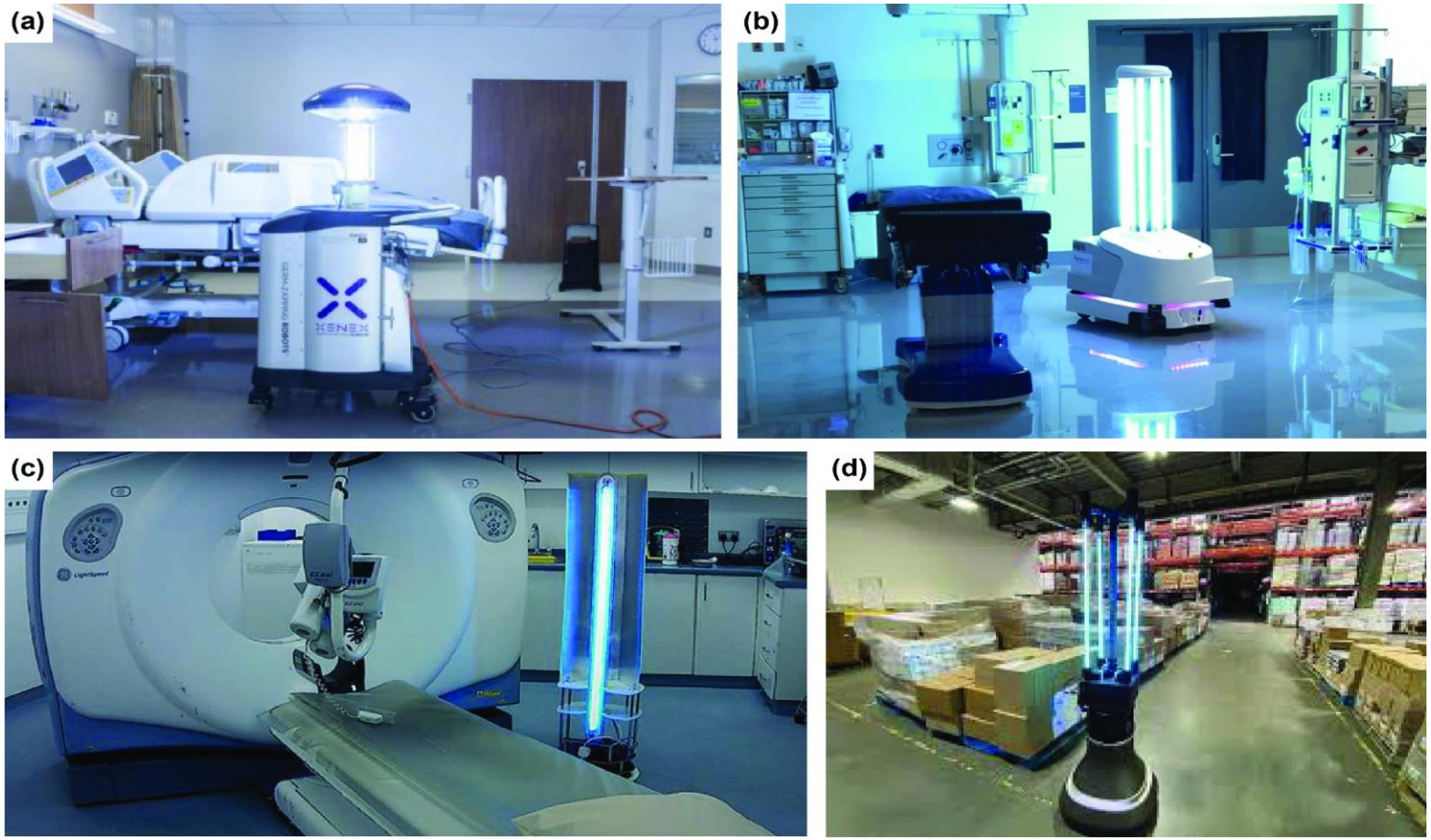
Robots during COVID pandemic

- Robots can work in risky environments, reducing the unnecessary contact between the medical staff and patients
- Robots can work extra long hours, reducing the fatigue of the doctors and nurses.
- Robot can automate many testing procedures (Oropharyngeal swab) and therefore increase efficiency and throughput.
- Robots developed during COVID-19 are equipped with multiple sensors such as cameras, thermal sensors, speakers, microphones, helping in temperature checking and questionnaires
- Robots can perform many tasks as a standalone unit, and share the information and build a complete network to better tackle this pandemic.



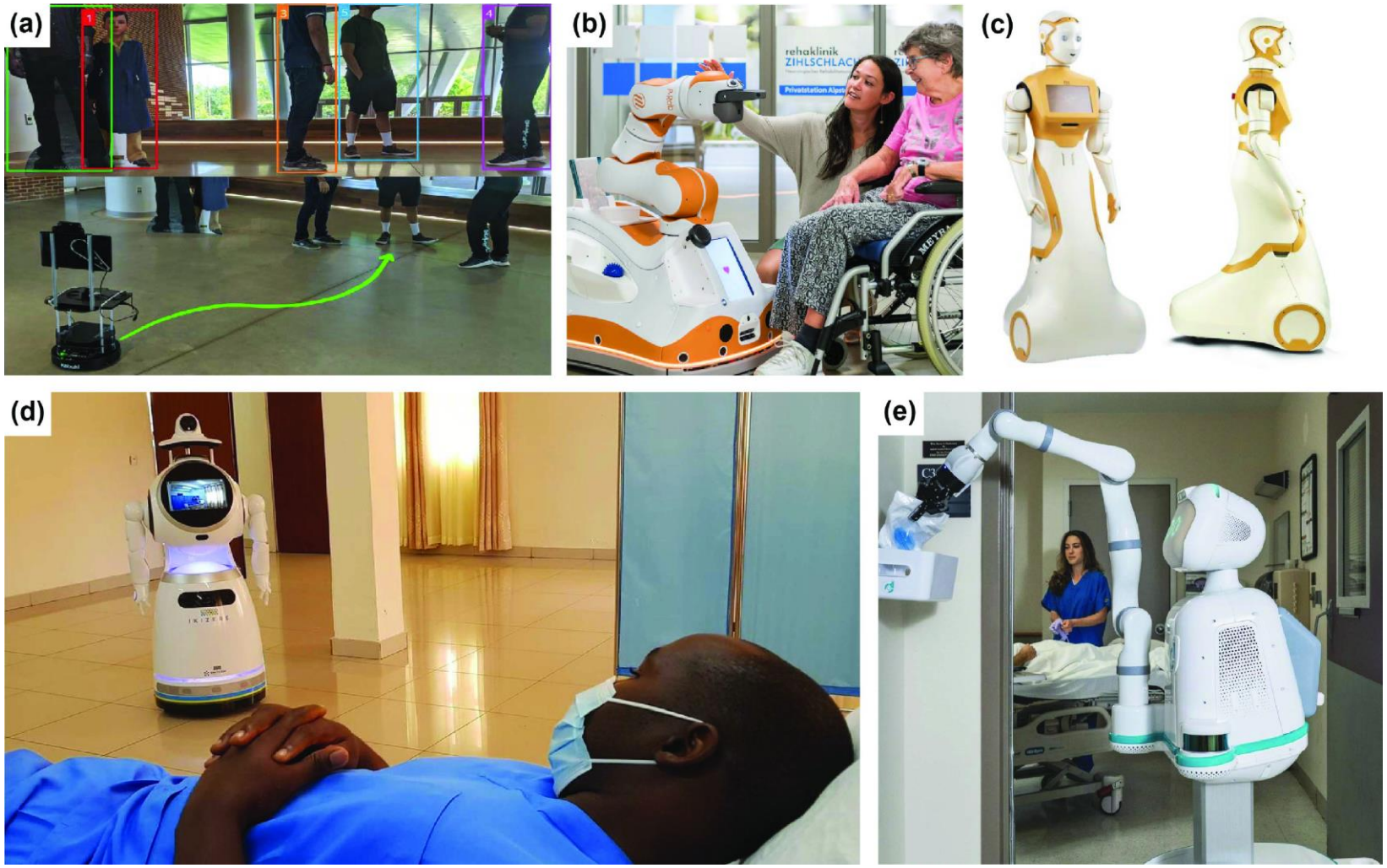
Robots for screening, mobile robotic platform for contactless vital signs monitoring

Robots for COVID-19 diagnosis.



UV-C robots.

A spray liquid disinfection robot

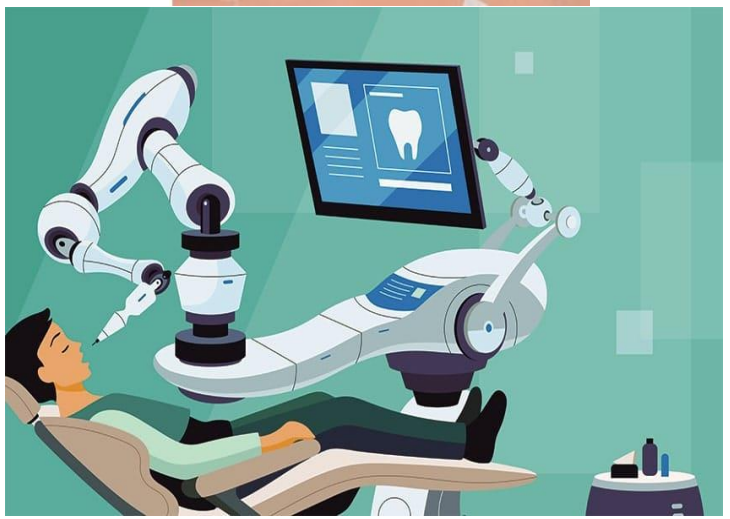


Social and care robots

Other uses

1) Autopsy:

- Researchers developed an autopsy equipment/robot that provides safety against COVID-19 and other airborne infections.
- The challenge of this application is how to design the control system to make it function as smoothly as a hand control or with the sensitivity of more refined .



2) Orthodontics:

- It has been reported that orthodontics robots may minimize the transmission risk of the SARS-CoV-2 virus from person to person, thereby protecting orthodontists and their patients during regular procedures .

Keep up

- Infection preventionists (IPs) juggle multiple responsibilities as they deal with new regulations and ongoing workplace challenges, they need to keep up!!

There are 3 types of people in the world

- Those who **MAKE** things happen
- Those who **LET** things happen
- Those who **WONDERED** what happened!

سَنبلغُ حُلمنا
لو بعد حِينٍ
فنحنُ بِحارُ
عَزمٍ إنْ أردنا

Thank you