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BIOMEDICAL & CLINICAL ENGINEERING

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Impact of clinical engineering on quality of patient care

by Iyad Mobarek

Within the 21st International Operations & Maintenance Conference in the Arab Countries

An Initiative by
OMAINTEC
المجلس العربي للتشغيل والصيانة
Arab Operations & Maintenance Council

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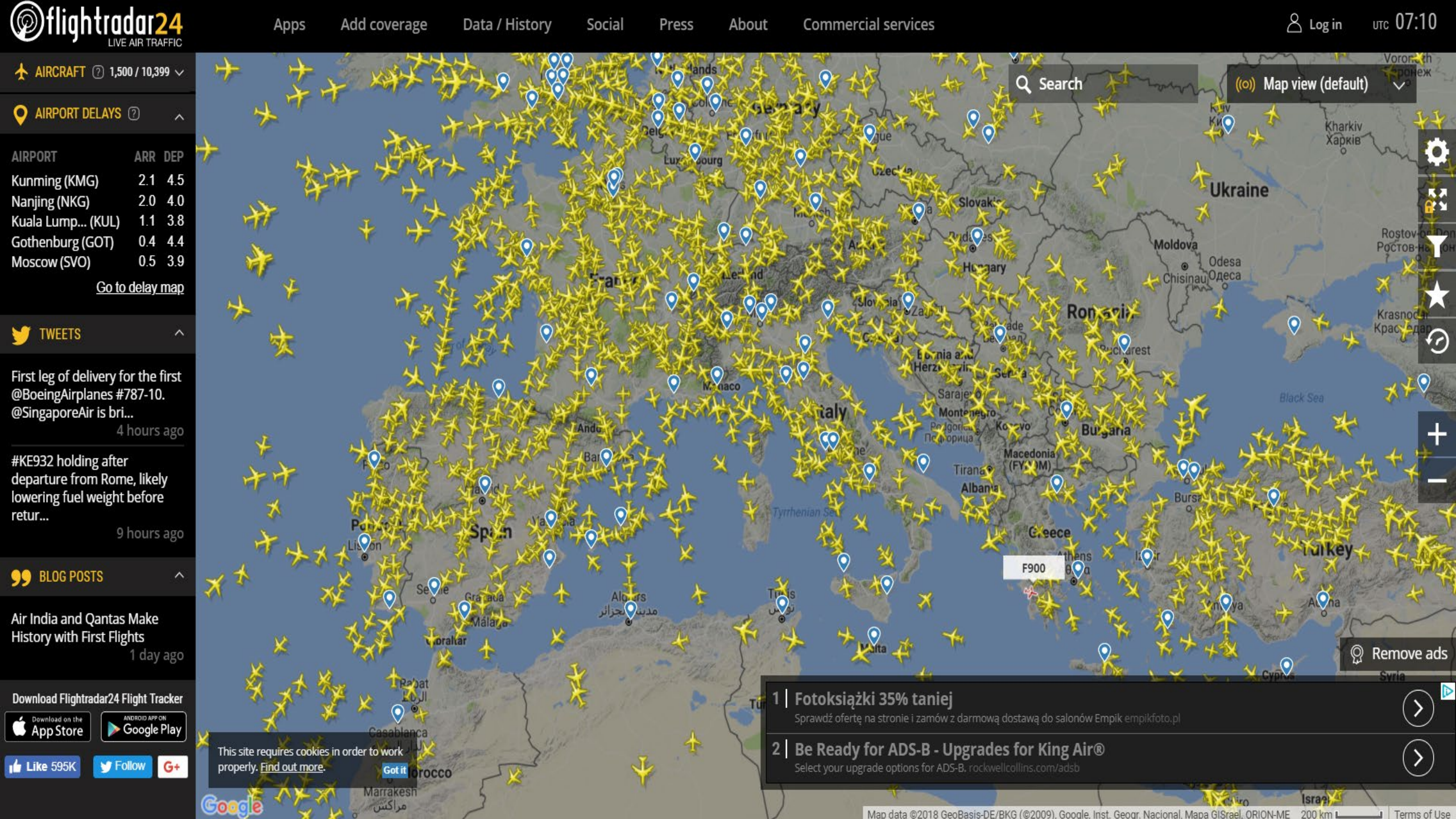
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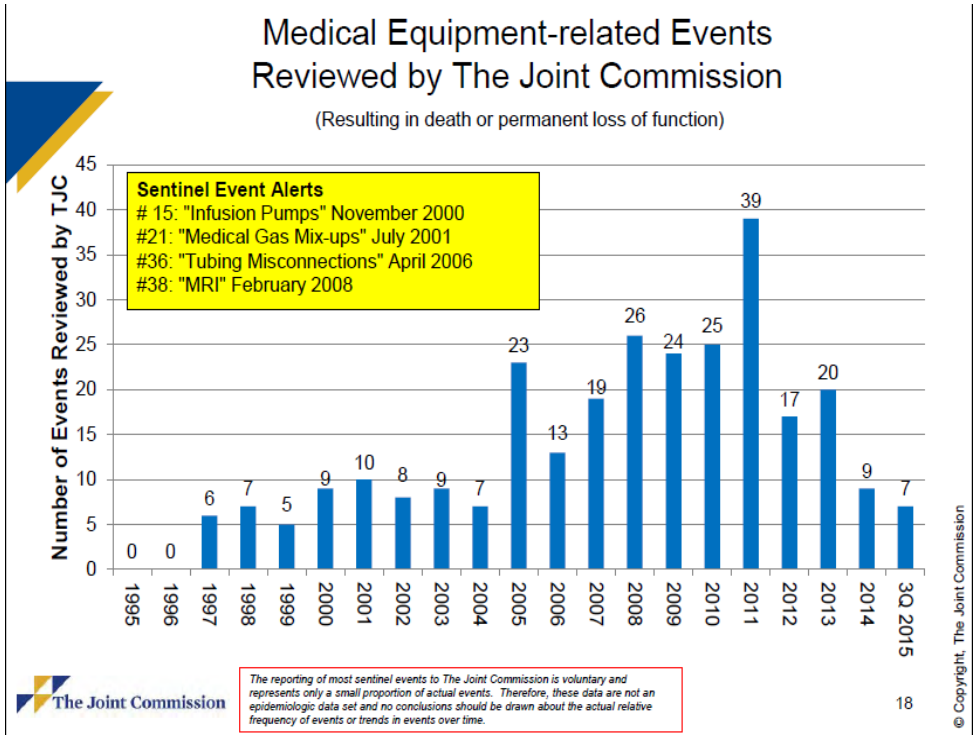
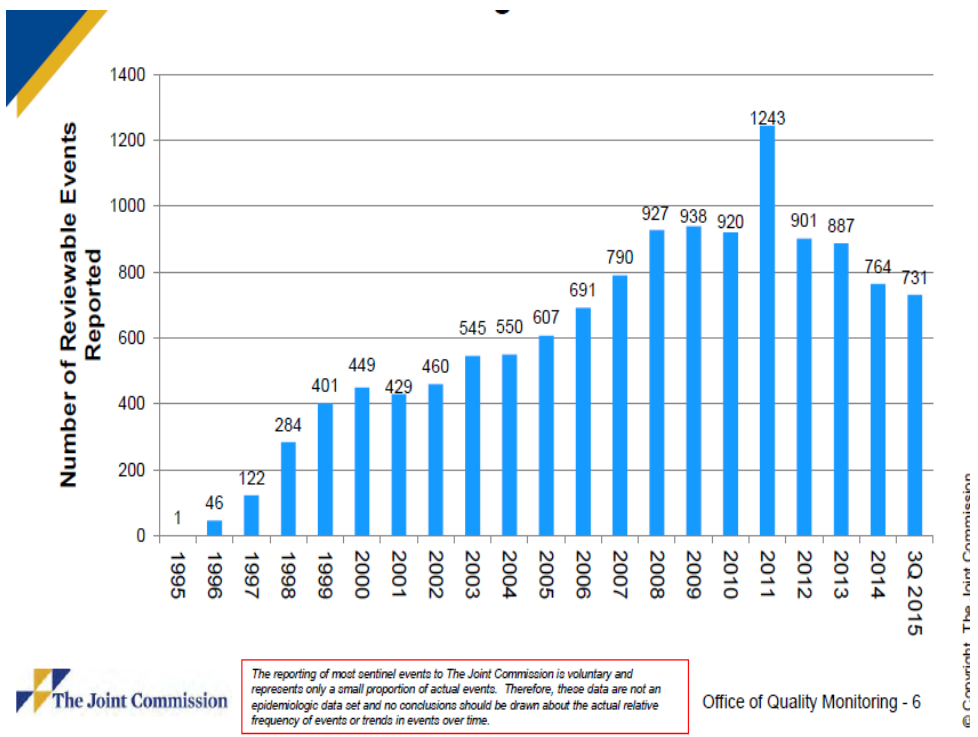
Preventable Medical Errors

Up to 440,000 Americans are dying annually from preventable medical errors *

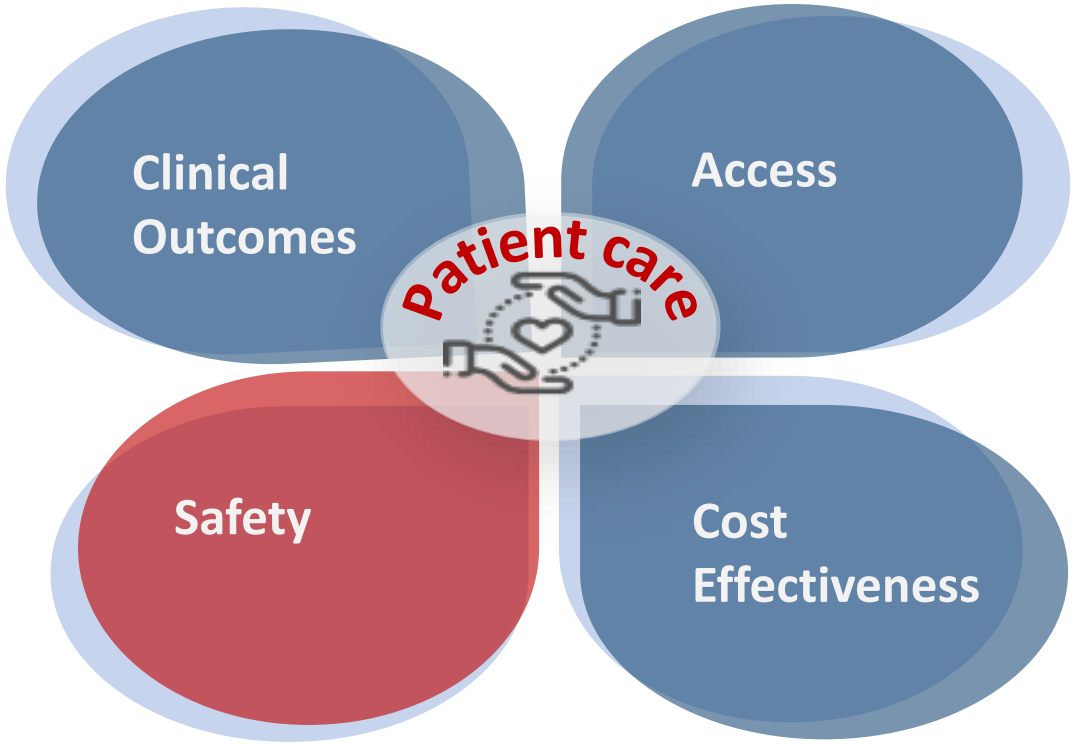




http://www.hospitalsafetyscore.org/newsroom/display/hospitalerrors-thirdleading-causeofdeathinus-improvementstooslow

The Institute of Medicine determined that 70 percent of all medical errors are preventable

Vision of Healthcare organizations



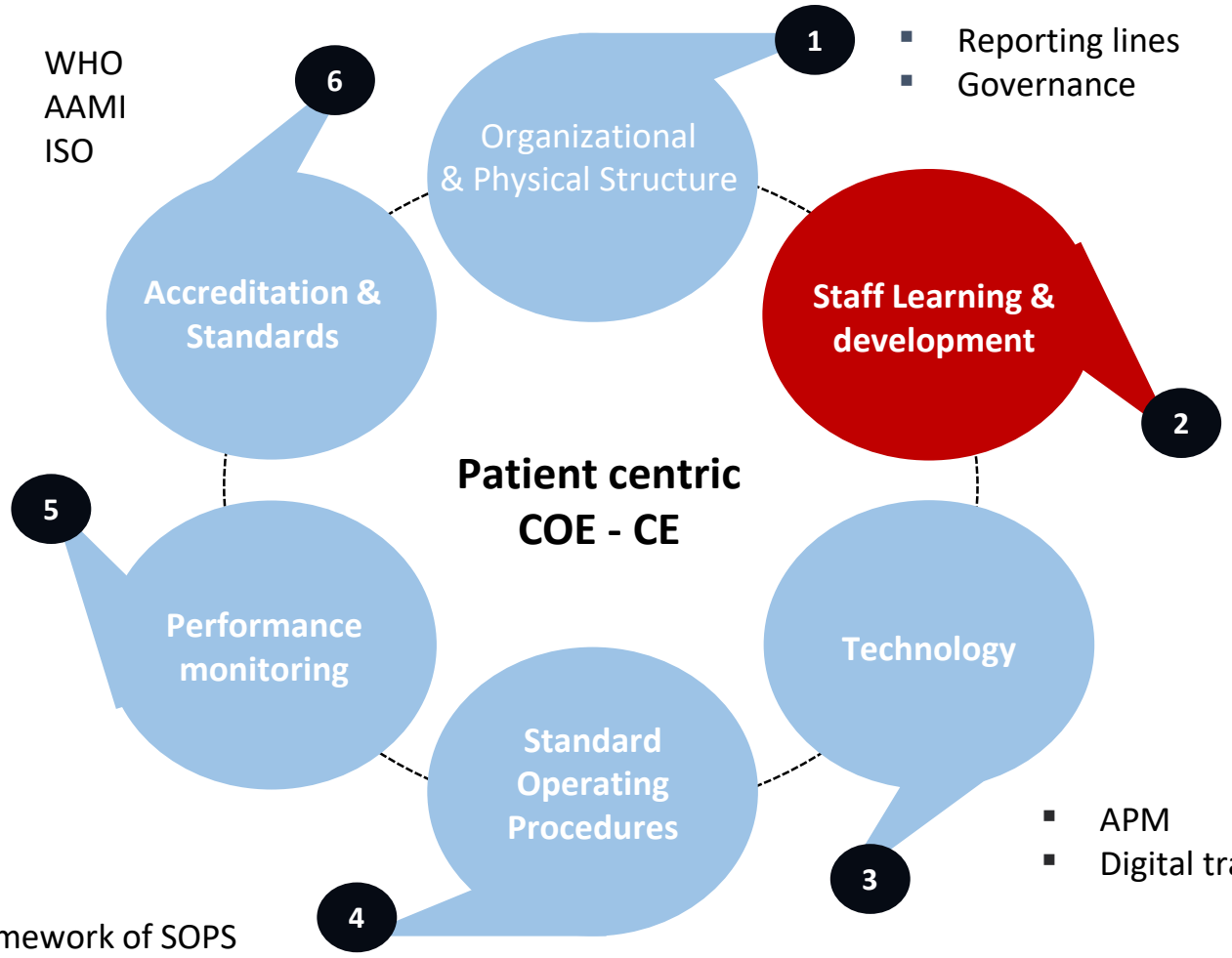
THE 4 MAIN CAUSES OF PREVENTABLE MEDICAL ERRORS
By Brown & Barron, LLC August 16, 2022;

- Technical errors (44 percent)
- Diagnosis (17 percent)
- Failure to prevent injury (12 percent)
- Errors in the use of a drug (10 percent)

Clinical engineers have a major role in improving patient care

Clinical Engineering System

Regardless of size and type of the healthcare organization, the clinical engineering system must be developed to include the main elements illustrated below to function as a COE, thet can provide services up to best international practices that contributed to improve quality of patient services



- Reporting lines
- Governance

- Competency based L&D
- User training

- APM
- Digital transformation

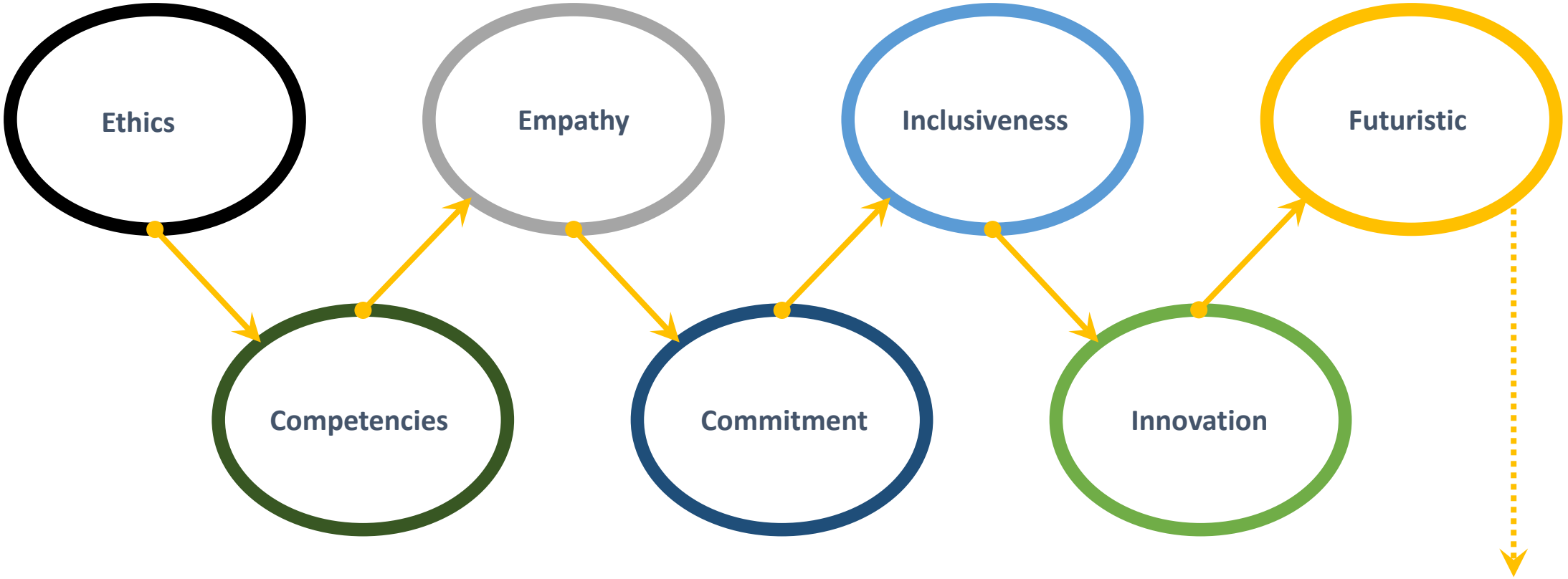
- Framework of SOPS

- Equipment performance KPIs
- Patient quality related KPIs

- WHO
- AAMI
- ISO

- ✓ Digitization(APM) minimizes human error
- ✓ Propper CM
- ✓ PPM Libraries
- ✓ Test equipment calibration
- ✓ Incident reporting
- ✓ User training

Value driven CE Leadership



- ✓ **Precision Medicine:** Biomedical engineering will enable personalized medicine, tailoring treatments to an individual's specific genetic makeup and health condition, resulting in more effective and targeted therapies.
- ✓ **Artificial Intelligence (AI):** The integration of AI in biomedical engineering will revolutionize diagnostics, treatment planning, and patient monitoring, leading to more efficient and accurate healthcare delivery.
- ✓ **Nanomedicine:** Biomedical engineers will harness the power of nanotechnology to develop targeted drug delivery systems, diagnose diseases at a molecular level, and create micro-devices for precise medical interventions.
- ✓ **Regenerative Medicine:** Tissue engineering and regenerative medicine will continue to advance, enabling the creation of fully functional organs, tissues, and bones, ultimately eliminating the need for transplantation in many cases.
- ✓ **Wearable Health Devices:** The development of wearable devices that continuously monitor vital signs, detect diseases early, and provide real-time feedback will empower individuals to take control of their health and well-being.

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Lifecycle responsibility

R&D – Production

- Marketing & Selling
- Production
- Clinical Trials
- Prototype
- R&D
- Clinical need
- Market Need

Clinical phase

- Request for new equipment — SOP
- Needs Assessment — SOP
- Tender requirements — SOP
- Tendering process — SOP
- Equipment Scrapping — SOP
- Budgeting
- Equipment purchase — SOP
- **Quality Control**
  - Performance monitoring
  - Incident reporting
  - Benchmarking
  - SOP
- Technical support CM and PM — SOP
- Spare parts & accessories — SOP
- Equipment delivery — SOP
- HMC contract Management — SOP
- User & technical training — SOP
- Equipment Acceptance — SOP
- Installation and operation — SOP

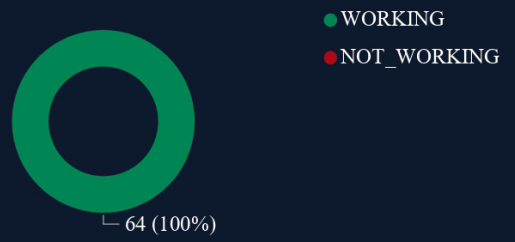
APM Dashboard

Asset Type: All | Status: All | Site Region: Al Ula

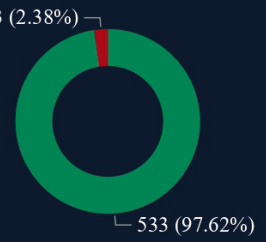
Inventories details

# of equipment	Down for Maintenance
610	13
# of sites reporting	**Working**
10	597

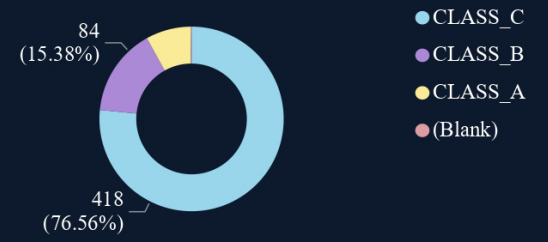
Device Status - Non-Medical



Device Status - Medical

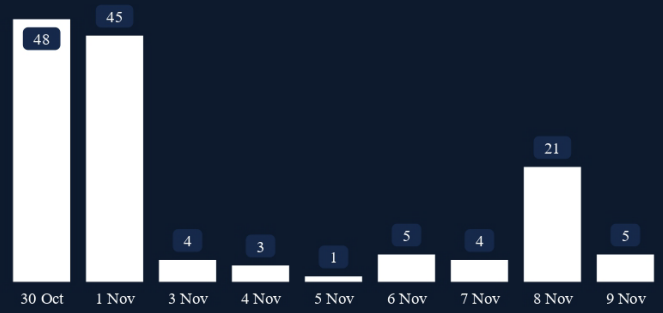


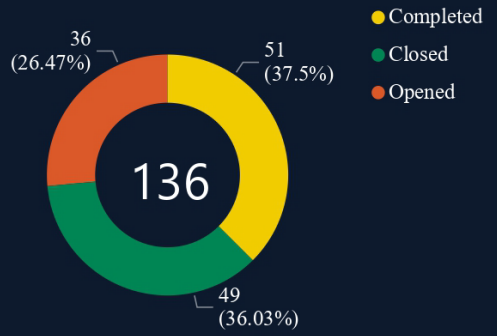
Devices by class



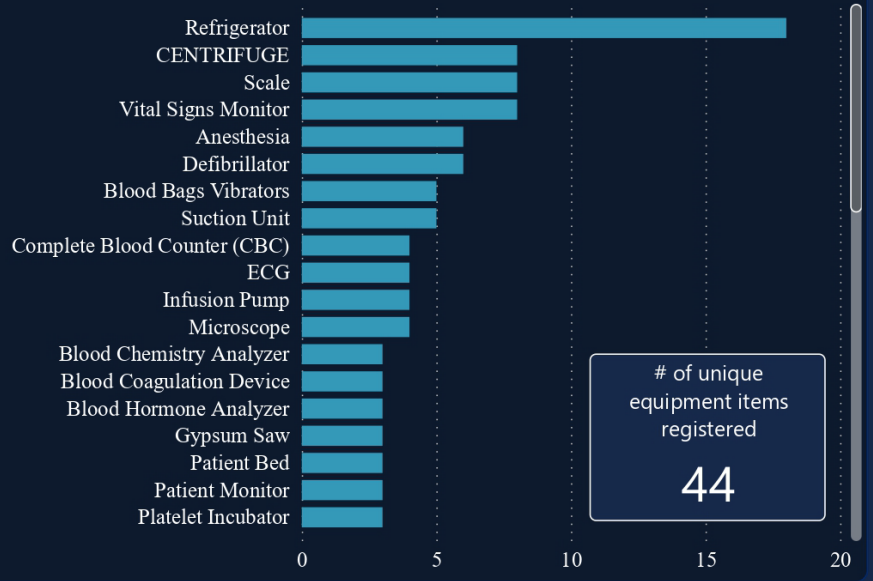
Site Name: All | Device Status: All | Equipment: All

Preventive Maintenance



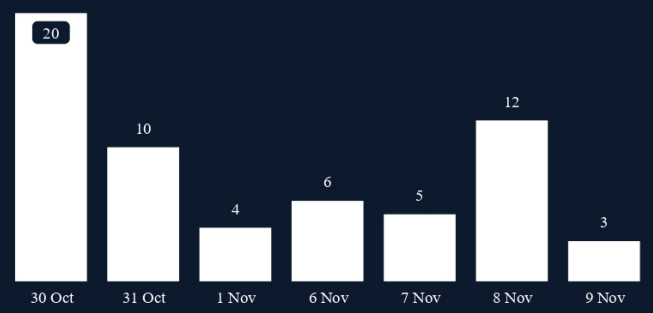


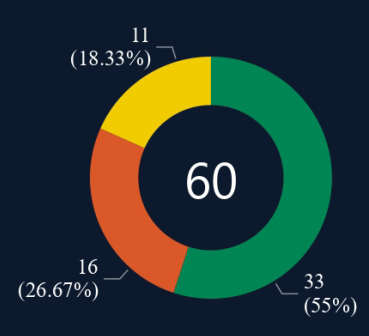
Site Name
- PRINCE ABDULMOHSEN HOSPI…



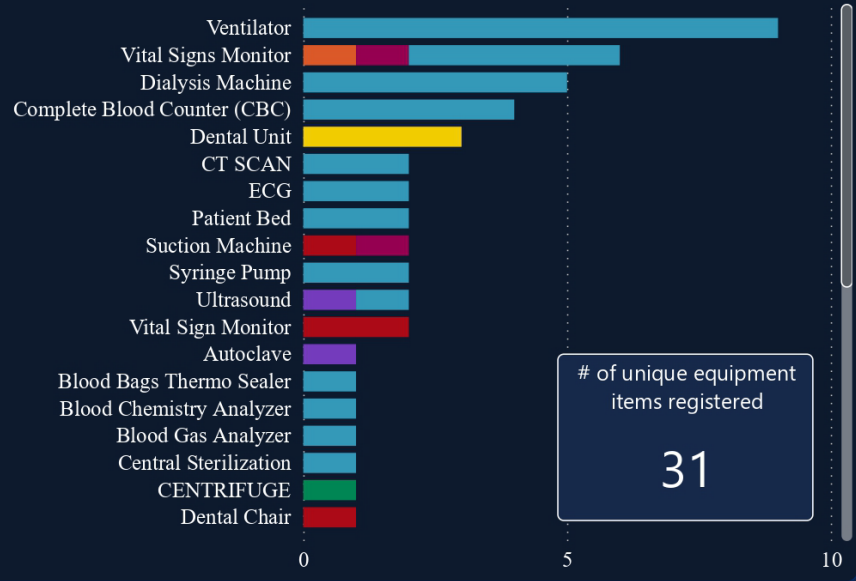
# of unique equipment items registered: 44

Corrective Maintenance





Site Name
- Al Atheeb PHC
- Al Jadedah PHC
- Al Mogayra PHC
- AlMunshia PHC
- AlSukhairat PHC
- Hae Al Derah PHC
- Hae Al Jamaa' PHC
- Madaen Saleh PHC
- PRINCE ABDULMOHSEN HOSPI…



# of unique equipment items registered: 31

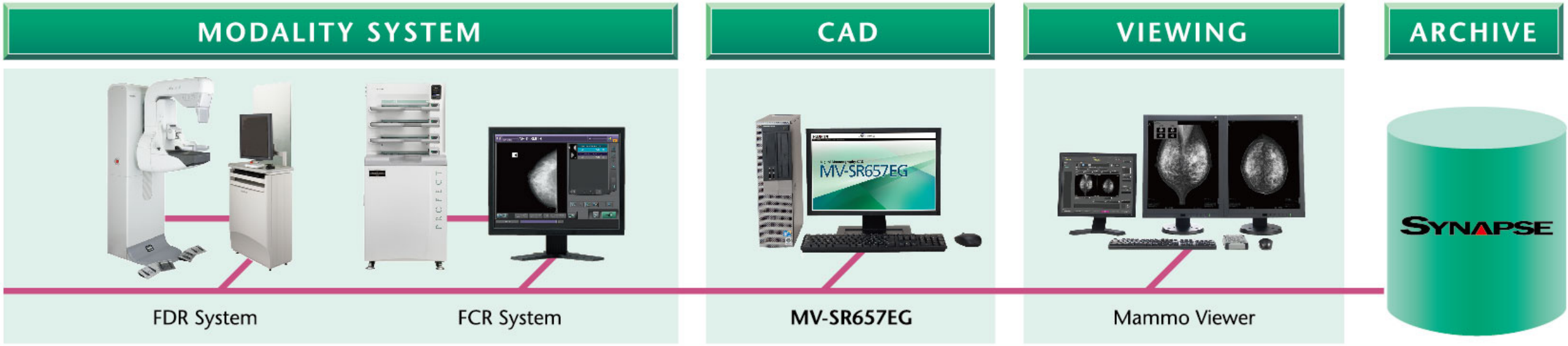
Prevention and patient safety

Prevention

- Screening & early detection of diseases
  - mammography screening for early detection of breast cancer (…Mammographic CAD systems)
  - *Cervical cancer screening **
    - *cytology-based screening programs using Pap smears*
    - *screen using either VIA or HPV DNA testing*
- Vaccination and all involved technologies

Patient safety

- Hazards of medical devices



Diagnostic & radiotherapy systems

Radiation protection

- **National requirements**

  Servicer versus operator requirements

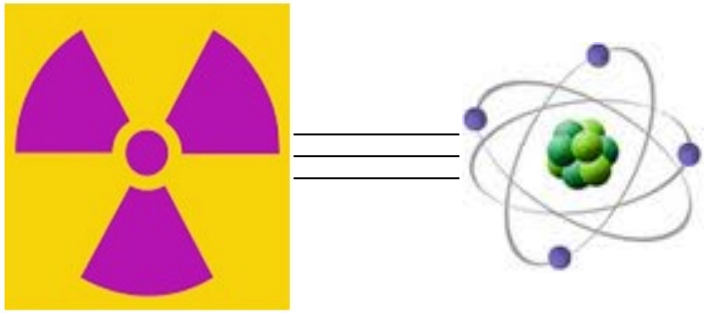
- **Control measures**

  PPE (shielding)

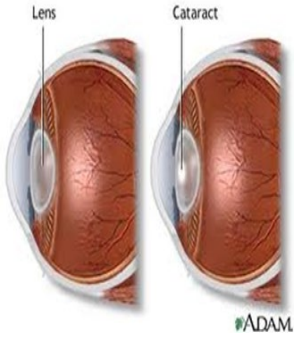
  Training for self protection

- **Optimization of protection** by keeping exposure As Low As Reasonably Achievable (ALARA) concept

- **Dose limits (ICRP 60)**



	Occupational	Public
Effective dose	20 mSv/yr averaged over 5 yrs.	1 mSv in a yr



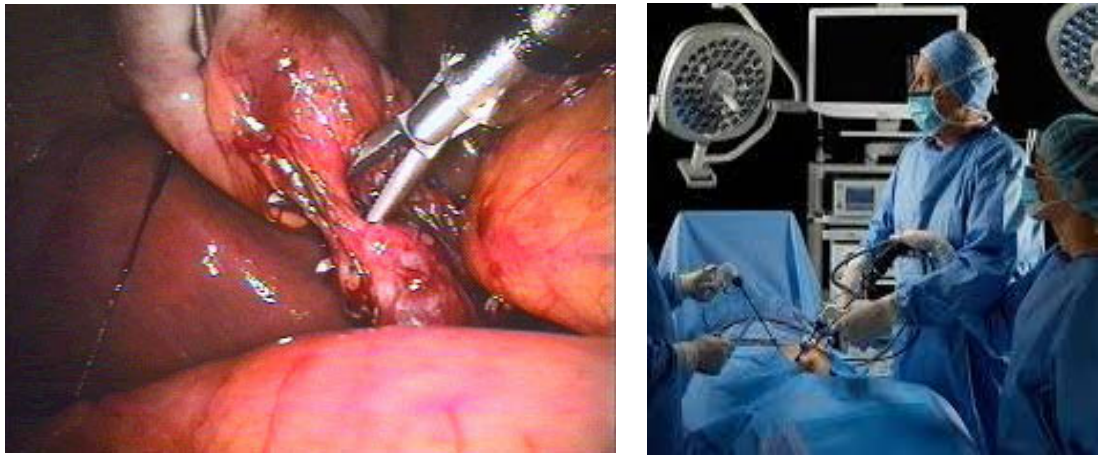
Treatment Systems

The Rapid advancement in Innovative Surgical and Interventional Procedures contributed big time to quality of patient care, cost effectiveness and clinical outcome;

- Minimum Invasive Surgery (MIS)
- Laparoscopic & Stereotactic guided surgery
- Interventional Radiology (IR)
- Arthroscopy

- ✓ A closer access to the different anatomic parts
- ✓ Accurate biopsies
- ✓ Avoiding major traditional surgeries
- ✓ reducing patient stay
- ✓ less risks of infection and post-op complications.

laparoscopic cholecystectomy



Interventional Radiology procedure

Image Guided interventions

Sentinel Event Alert # 25 Ventilator-related deaths

Anything we can do to help save lives ?

- **Staffing**
- Inadequate training 87%
- Insufficient staff 35%
- **Communication breakdown**
- Among staff 70%
- With patient /family 9 %
- **Incomplete patient assessment**
- Room design limits observation 30%
- Delayed /no response to alarm 22%
- Monitor change not recognized 13%

- **Equipment**
- Alarm off or set incorrectly 22%
- No alarm for certain disconnects 22%
- Alarm no audible in all areas 22%
- No testing of alarms 13%
- Restraint failure (escape) 13 %
- **Distraction**
- environmental noise 22%
- **Cultural**
- (hierarchy/intimidation) 13 %

http://www.jointcommission.org/assets/1/18/SEA_25.pdf

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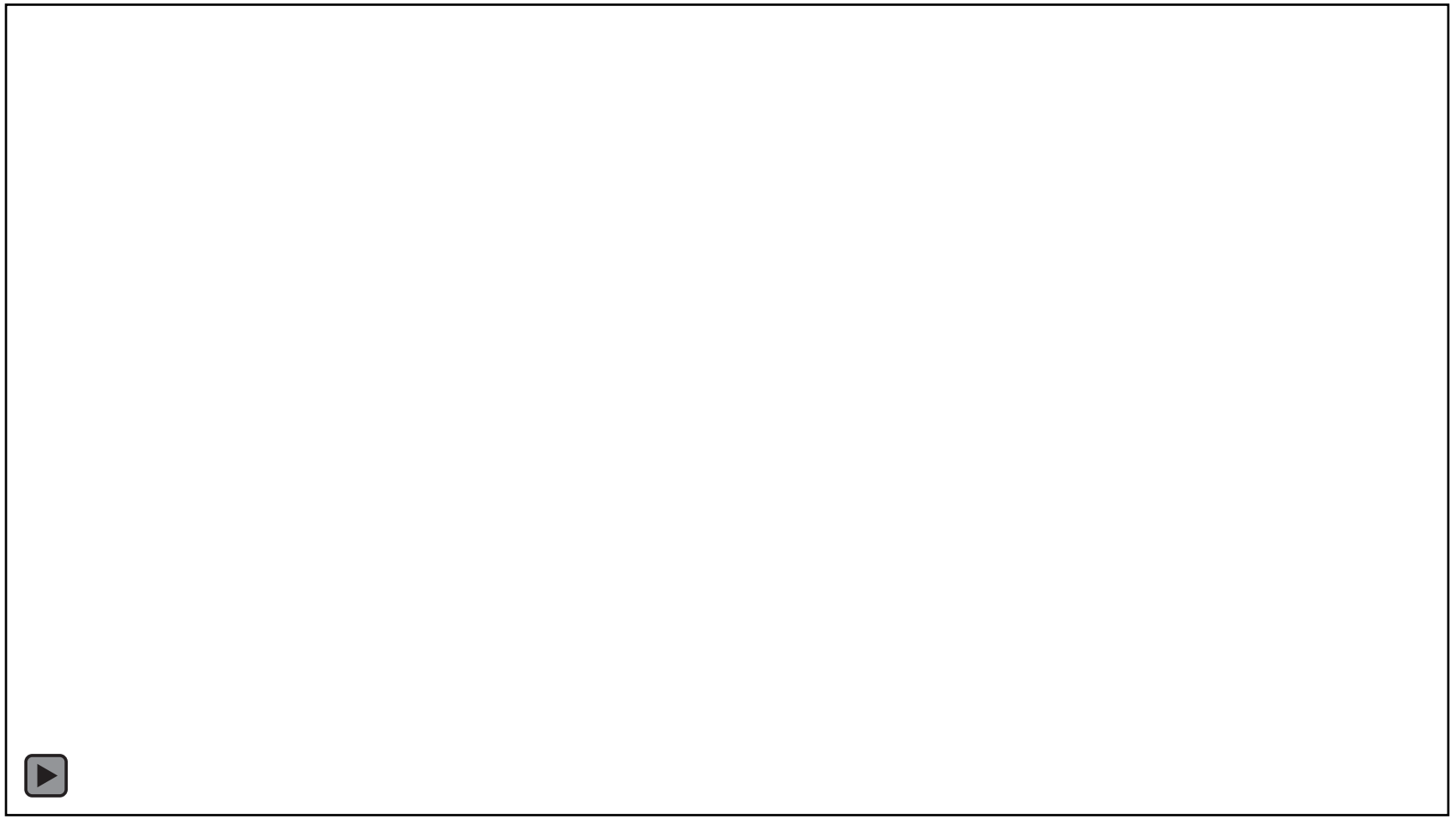
Video: Slow Motion



Resources

1. American Collage of Clinical Engineering (ACCE) www.accenet.org
2. World Health Organization www.who.int
3. Association for the Advancement of Medical Instrumentation (AAMI) www.AAMI.org
4. Emergency Research Institute documentations and website www.ecri.org
5. Health Information and Management System Society (HIMSS) www.himss.org
6. IEEE Engineering in Medicine and Biology www.ieee.org/embs/index.html
7. Iyad Mobarek, Computerized maintenance management system, WHO Medical device technical series, WHO 2011 www.who.int
8. Iyad Mobarek, et al, Fully Automated Clinical Engineering Technical Management System, Journal of Clinical Engineering: January/March 2006 - Volume 31 - Issue 1 - pp 46-60
9. Iyad Mobarek, et al, Fully Automated Downtime Protocol, Journal of Clinical Engineering: October/December 2010 - Volume 35 - Issue 4 - pp 195-214
10. https://utilitiesone.com/medical-marvels-the-impact-of-biomedical-engineering

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