PD233: Design of Biomedical Devices and Systems

(Lecture 4)

What is a Medical Device?

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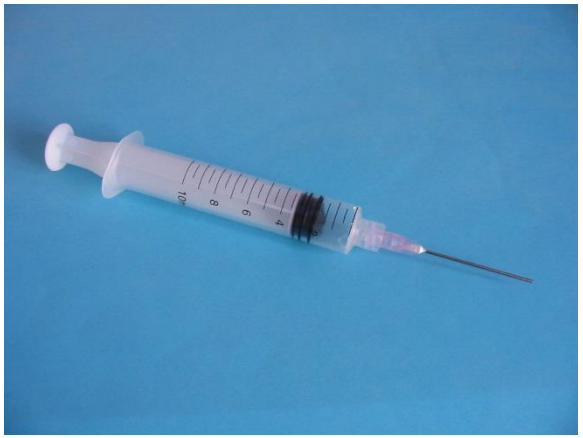
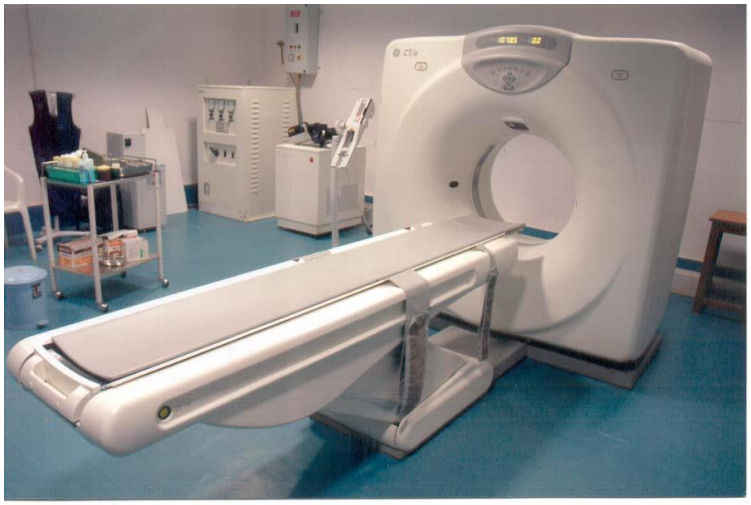
Course Website:
http://cpdm.iisc.ac.in/utsaah/courses/

What is a medical device?





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What is a Medical Device?

Any instrument, appliance, apparatus, material or other article, whether used alone or in combination, including the software necessary for its proper application, intended by the manufacturer to be used for human beings for the purpose of:

- Diagnosis, prevention, monitoring, treatment or alleviation of disease
- Diagnosis, monitoring, alleviation of or compensation for an injury or handicap
- Investigation, replacement or modification of the anatomy or of a physiological process
- Control of conception

and which does not achieve its **principal intended action** in or on the human body by pharmacological, immunological or metabolic means, but which may be assisted in its function by such means. -Medical Device Directives (EU)

United States- Food and Drug Administration (US-FDA) definition:

Medical machine, contrivance, implant, *in vitro* reagent, or other similar or related article, including a component part, or accessory that is:

- Recognized in the official National Formulary, or the United States Pharmacopoeia, or any supplement to them
- **Intended for use** in the diagnosis of disease or other conditions, or in the cure, mitigation, treatment, or prevention of disease, in man or other animals
- Intended to affect the structure or any function of the body of man or other animals,

and **does not achieve any of its primary purpose** through chemical action within or on the body of man or other animals and does not depend on metabolic action to achieve its primary purpose.

India draft regulation (2016)

Any instrument, apparatus, appliance, implant, material or other article, whether used alone or in combination, including the software, intended by its manufacturer to be used specially for human beings or animals for one or more of the specific purposes of,-

(i) diagnosis, prevention, monitoring, treatment or alleviation of any disease or disorder;

(ii) diagnosis, monitoring, treatment, alleviation or assistance for, any injury or disability;

(iii) investigation, replacement or modification or support of the anatomy or of a physiological process;

(iv) supporting or sustaining life;

(v) disinfection of medical devices;

(vi) control of conception;

which **does not achieve the primary intended action** in or on the human body or animals by any pharmacological or immunological or metabolic means, but which may be assisted in its intended function by such means, and covered under sub-clause (iv) of clause (b) of section 3of the Drugs and Cosmetics Act, 1940 (23 of 1940);

Medical Device Rule 2017, GoI

Gazette notification of 31 Jan 2017

"medical device" means,-

(A) substances used for in vitro diagnosis and surgical dressings, surgical bandages, surgical staples, surgical sutures, ligatures, blood and blood component collection bag with or without anticoagulant covered under sub-clause (i),

(B) substances including mechanical contraceptives (condoms, intrauterine devices, tubal rings), disinfectants and insecticides notified in the Official Gazette under sub-clause (ii),

(C) devices notified from time to time under sub-clause (iv),

of clause (b) of section 3 of the Drugs and Cosmetics Act, 1940

Effective in India from 1st Jan 2018

Quiz?

Are these medical device:

- Tooth brushes, dental sticks, dental floss, dental chewing gums
- Baby nappies, mattress protectors
- Contact lenses intended to provide color to the eyes
- Instruments for tattooing
- Deodorants
- Air conditioner

No unless they make a medical claim – intended use

Medical Device Classification

- Due to large diversity of products and risk associated same regulation cannot be used for all the medical devices – hence the need for classification

US-FDA classification: Class 1

- **Nonlife sustaining**

- However premarket notification, registration, device listing, GMPs, and proper record keeping are all required (in United stated)

E.g. Stethoscope, Tongue depressor

US-FDA classification: Class 2

- Also **nonlife sustaining** but must comply with specific performance standard

- Registration, device listing, GMPs, and proper record keeping are all required (in United stated)
- Usually exempt from the need to prove safety and efficacy

E.g. sphygmomanometers (BP apparatus), CT machine

US-FDA classification: Class 3

- **Life sustaining**, must comply with specific performance standard
- Need to prove safety and efficacy

- Registration, device listing, GMPs, and proper record keeping are all required (in United stated)

E.g. pacemaker, heart value, ventilator

How to classify Medical Device under US-FDA system

https://www.accessdata.fda.gov/scripts/cdrh/cfdocs/cfpcd/classification.cfm

https://www.fda.gov/MedicalDevices/DeviceRegulationandGuidance/Overview/ClassifyYourDevice/default.htm

Classification under CE Mark (EU markets)

- Rule based classification under Medical Device Directive (MDD)
- Medical Devices are classified as:
  - Class I, IIa, IIb, III

Risk	**Low → High**			
Design controls	Low → High			
EU Class	I	IIa	IIb	III
US Class	I	II		III

- Further directives apply to In-vitro diagnostic (IVD) devices and Active Implantable (AIMD)

Factors influencing expected risk :

Duration of use

- **Transient:** *Normally intended for continuous use for less than 60 minutes.*
- **Short term:** *Normally intended for continuous use for not more than 30 days.*
- **Long term:** *Normally intended for continuous use for more than 30 days.*

Invasiveness

- **Invasive devices :** *A device which, in whole or in part, penetrates inside the body, either through a body orifice or through the surface of the body*.
- **Body orifice :***Any natural opening in the body, as well as the external surface of the eyeball, or any permanent artificial opening, such as a stoma*.
- **Surgically invasive device:** *An invasive device which penetrates inside the body through the surface of the body, with the aid of or in the context of a surgical operation*.

- **Reusable surgical instrument**

Instrument intended for ***surgical use by cutting, drilling, sawing, scratching, scraping, clamping, retracting, clipping or similar procedures****, without connection to any active medical device and which can be reused after appropriate procedures have been carried out* (Section 1.3 of Annex IX of Directive 93/42/EEC).

- **Implantable device**

Any device which is intended:

- ***to be totally introduced into the human body or****,*

- ***to replace an epithelial surface or the surface of the eye****,*

by surgical intervention which is intended to remain in place after the procedure.

Any device intended to be ***partially introduced*** *into the human body through surgical intervention and intended to remain in place after the procedure for* ***at least 30 days is also considered an implantable device****.*

- **Active medical devices**

Any medical device operation of which depends on a source of ***electrical energy or any source of power*** *other than that directly generated by the human body or gravity and which acts by converting this energy. Medical devices intended to transmit energy, substances or other elements between an active medical device and the patient, without any significant change, are not considered to be active medical devices.* ***Stand alone software is considered to be an active medical device.***

- Rule 1-18
- MDD_classification_en.pdf

SUBJECTS

- Non invasive devices – Rules 1, 2, 3, 4
- Invasive devices – Rules 5, 6, 7, 8
- Active devices – Rules 9, 10, 11, 12
- Special rules – Rules 13, 14, 15, 16, 17, 18

Device classification in India

Four Class Medical Devices (MD) as well as IVD

- Low risk - Class A;
- Low moderate risk- Class B;

State Govt. Regulated

- Moderate high risk- Class C;
- High risk- Class D.

Central Govt. Regulated

Assignment 2

Review the 2017 Gazette notification on regulations of medical devices by GoI and list of notified medical devices

Copies available on course website:

http://cpdm.iisc.ac.in/utsaah/wp-content/uploads/2016/07/GOI_MedicalDeviceRules_notificationJan2017_eng.pdf

http://cpdm.iisc.ac.in/utsaah/wp-content/uploads/2016/07/india_cdsco_notice_29_6_2017.pdf

Prepare a flow chart for classifying medical devices as per this regulations. Due date **10th Sept 2019**

Regulatory Pathways

Pathway a medical device follows depends on the class of medical device (and whether or not similar device exist in market).

- US-FDA system
  - 510 (k)-exempt
  - 510(k), Premarket Notification to establish **Substantial Equivalence**
    - Special 510(k), Abridged 510(k)
  - Pre Market Approval (PMA)
    - Investigational Device Exemptions (IDE)

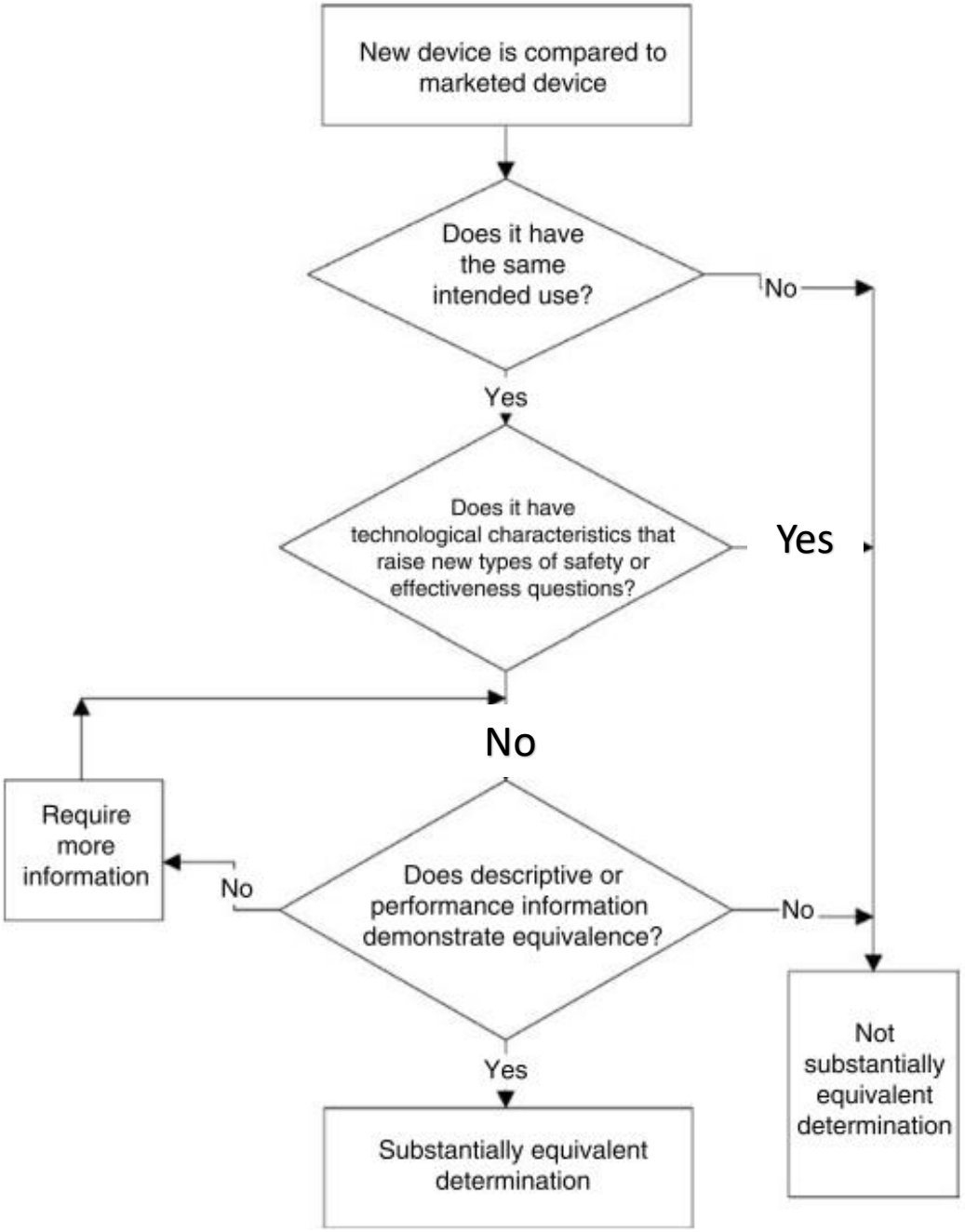
King & Fries, Chapter 16 & 17

510 (k)

- Each person who wants to market in the U.S., a Class I, II, and III device intended for human use, for which a **Premarket Approval application (PMA) is not required**, must submit a 510(k) to FDA **unless the device is exempt from 510(k)** requirements and does not exceed the limitations of exemptions in .9 of the device classification regulation chapters (e.g., 21 CFR 862.9, 21 CFR 864.9)
- If FDA determines that a device is **not** substantially equivalent, the applicant may:
  - resubmit another 510(k) with new data,
  - request a Class I or II designation through the De Novo Classification process
  - file a reclassification petition, or
  - submit a premarket approval application (PMA).

510(k)

Substantial Equivalence



Pre Market Approval

- Needed for all Class III devices or predicate device is cannot be established via 510(k)

- Investigational device exemption (IDE) allows the investigational device to be used in a clinical study in order to collect safety and effectiveness data.

MDD Process
(CE Mark for medical Devices)

- Analyse the device to determine which directive is applicable.
- Identify the applicable **essentials requirements** list.
- Identify any corresponding **harmonized standards**.
- Confirm that the device meets the essential requirements/ harmonized standards and document the evidence.
- **Classify** the device.
- Decide on the appropriate **conformity assessment procedure**.
- Identify and choose a **Notified Body**.
- **Obtain conformity certifications** for the device.
- Establish a declaration of conformity.
- **Apply for the CE mark**.

Choosing Appropriate Directive

- Active Implantable Medical Device Directive (AIMDD)
  - Applicable for Active Implantable Devices
- Medical Device Directive (MDD)
  - Applicable to medical device not covered by AIMDD or IVDMDD
- In-Vitro diagnostics Medical Device Directive (IVDMDD)
  - Applicable to medical devices for in-vitro diagnostics

Identify Applicable Essential Requirements

The **general requirements** for the essential requirements list take the following form:

- Device must be **safe**. Any risk must be acceptable in relation to the benefits offered by the device.
- Device must be **designed** in such a manner that **risk is eliminated or minimized**.
- Device must perform in accordance with the **manufacturer's specification.**
- Safety and performance must be maintained throughout the **indicated lifetime** of the device.
- Safety and performance of the device must **not be affected by normal conditions of transport and storage**.
- Any **side effects must be acceptable** in relation to the benefits offered.

Identify applicable essential requirements

The particular requirements for the essential requirements list address the following topics:

. Chemical, physical, and biological properties
. Infection and microbial contamination
. Construction and environmental properties
. Devices with a measuring function
. Protection against radiation
. Requirements for devices connected to or equipped with an energy source
. Protection against electrical risks
. Protection against mechanical and thermal risks
. Protection against the risks posed to the patient by energy supplies or substances
. Information supplied by the manufacturer

Checklist for Essential Requirements

Essential Requirement	A or N/a	Standards	Activity	Test Clause	Pass/Fail	Document Location
1. The device must be designed and manufactured in such a way that when used under the conditions and for the purposes intended, they will not compromise the clinical condition or the safety of patients, users, and where applicable, other persons. The risks associated with devices must be reduced to an acceptable level compatible with a high level of protection for health and safety.	A	Internal	Risk analysis Safety review			Design history file Design history file
2. The solutions adopted by the manufacturer for the design and construction of the devices must comply with safety principles and also take into account the generally acknowledged state of the art.	A	Internal	Specification reviews Design reviews Safety review			Design history file Design history file Design history file

Identify Harmonized Standards

- Horizontal Standard
  - Generic standards covering fundamental requirements common to all, or a very wide range of medical devices
    - Electrical safety, Electromagnetic compatibility (EMC)
- Semi-Horizontal Standards
  - Group standards that deal with requirements applicable to a group of devices (e.g. standards applicable to orthopaedic implants, x-ray equipment)
- Vertical Standards
  - Product-specific standards that give requirements to one device or a very small group of devices

List of Environmental Testing

Environmental Test	Specification Range	Applicable Standard
Operating temperature	5°C–35°C	IEC 68-2-14
Storage temperature	−40°C to +65°C	IEC 68-2-1-Ab
		IEC 68-2-2-Bb
Operating humidity	15%–95% RH noncondensing	IEC 68-2-30
Operating pressure	500–797 mm Hg	IEC 68-2-13
Storage pressure	87–797 mm Hg	IEC 68-2-13
Radiated electrical emissions	System: 4 dB margin	CISPR 11
	Subsystem: 15 dB	
Radiated magnetic emissions	System: 4 dB margin	VDE 871
	Subsystem: 6 dB	
Line conducted emissions	System: 2 dB margin	CISPR 11
	Subsystem: 2 dB	VDE 871
Electrostatic discharge	Contact: 7 kV	EN 60601-2
	Air: 10 kV	EN 1000-4-2
Radiated electric field immunity	5 V/m at 1 kHz	EN 60601-2
		EN 1000-4-3
Electrical fast transient immunity	Power mains: 2.4 kV	EN 60601-2
	Cables >3 m: 1.2 kV	EN 1000-4-4
Stability		UL 2601

Conformity Assessment Procedure

- Under MDD there are six conformity assessment procedures Annexes (II-VII)

Annexure	
II	Full quality assurance system for both Design and Manufacturing
III	Examinations procedures of Manufacturer submitted to Notified Body
IV	Examination procedures for Notified Body
V	Production quality system verified by Notified Body
VI	Quality system for final inspection and testing of product
VII	Technical documentation by manufacturer with no participation of Notified Bodies

Implication of Classification:

CONFORMITY ASSESSMENT PROCEDURES	CLASSES					
ANNEXES	I	I Sterile	I measure	IIa	IIb	III
II (+ section 4)						√
II (- section 4)		√	√	√	√	
III					√	√
IV		√	√	√	√	√
V		√	√	√	√	√
VI		√	√	√	√	
VII	√	√	√	√		

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Declaration of Conformity

We Company name
Company address

declare that the product(s) listed below

Product(s) to be declared

hereby conform(s) to the European Council Directive 93/42/EEC, Medical Device Directive, Annex II, Article 3. This declaration is based on the Certification of the Full Quality Assurance System by name of Notified Body, Notified Body No. XXXX.

Name (print or type) _____
Title _____
Signature _____
Date _____

FIGURE 17.3 Sample declaration of conformance.