

**SUSTAINABLE
TECHNOLOGY
ASSESSMENT FOR
MRI & CT SCAN**

BY:


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CPDM

SR. No:

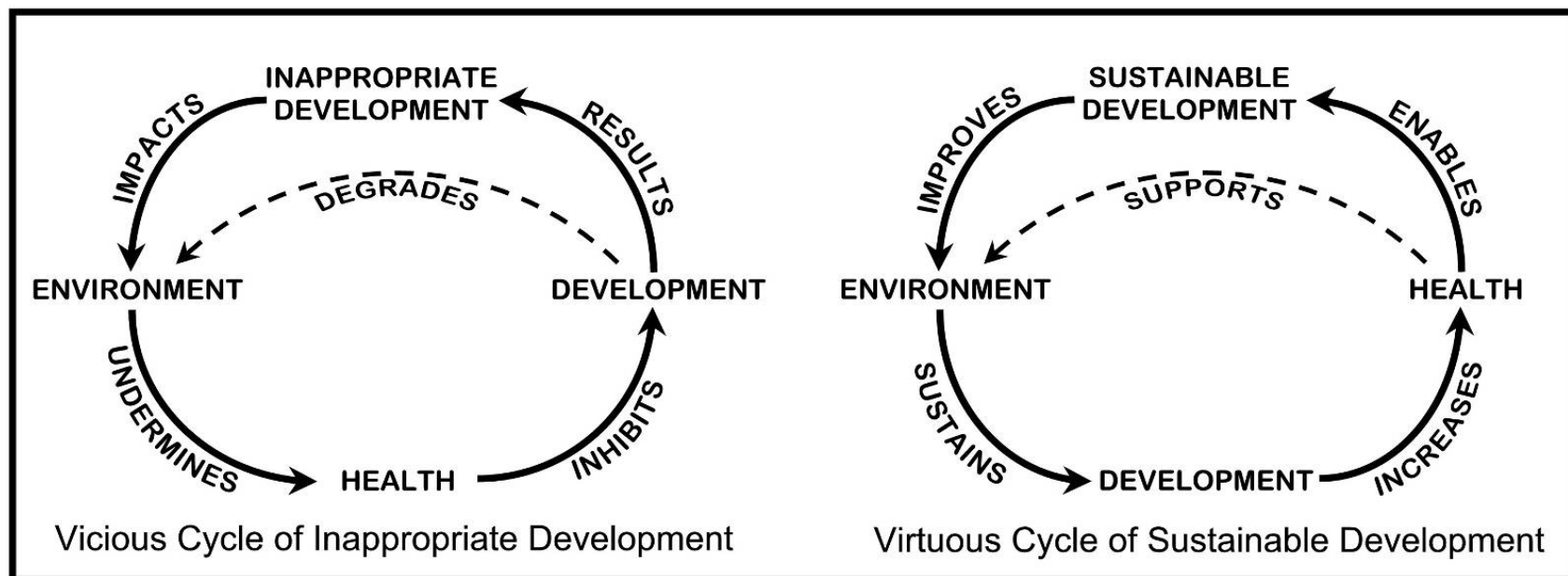
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OVERVIEW

- 
- ❑ SUSTAINABILITY
 - ❑ UNDERSTANDING MRI & CT SCAN TECHNOLOGY
 - ❑ TECHNOLOGY & MORPHOLOGY
 - ❑ SOCIETAL / ECONOMICAL / ENVIRONMENTAL CHANGES
 - ❑ SUSTAINABILITY OF THIS TECHNOLOGY IN ABOVE CONTEXT
 - ❑ SYSTEM UNDERSTANDING & SIMULATION
 - ❑ SIMULATION RESULTS
 - ❑ CONCLUSION

SUSTAINABILITY

- ❑ IF IT CAN BE **CONTINUED** INDEFINITELY
- ❑ **WITHOUT DEPLETING** ANY OF THE MATERIAL OR ENERGY RESOURCES REQUIRED
- ❑ NOT ERODE THE **ECOLOGICAL, SOCIAL, OR POLITICAL** SYSTEMS



SUSTAINABILITY...



- DEVELOPMENT THAT MEETS THE **NEEDS OF THE PRESENT** WITHOUT COMPROMISING THE ABILITY OF **FUTURE GENERATIONS** TO MEET THEIR OWN NEEDS

- ❖ THE WORLD COMMISSION ON ENVIRONMENT AND DEVELOPMENT

- SUSTAINABLE DEVELOPMENT SEEKS...TO RESPOND TO FIVE BROAD REQUIREMENTS:

1. INTEGRATION OF **CONSERVATION** AND **DEVELOPMENT**

2. SATISFACTION OF **BASIC HUMAN NEEDS**

3. ACHIEVEMENT OF **EQUITY** AND **SOCIAL JUSTICE**

4. PROVISION OF **SOCIAL SELF-DETERMINATION** AND **CULTURAL DIVERSITY**

5. MAINTENANCE OF **ECOLOGICAL INTEGRITY**

- ❖ INTERNATIONAL UNION FOR THE CONSERVATION OF NATURE

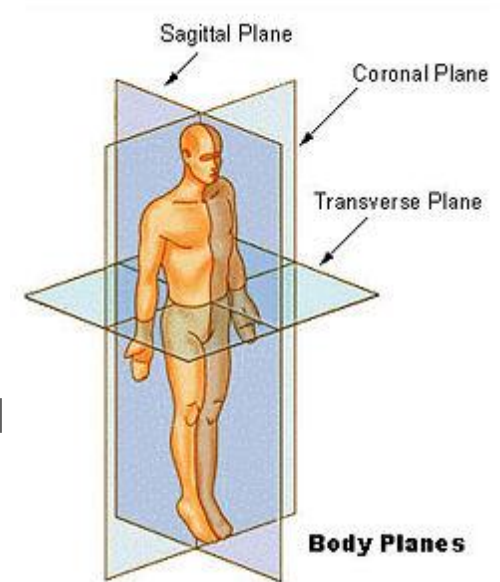
MRI & CT SCAN

□ WHY?

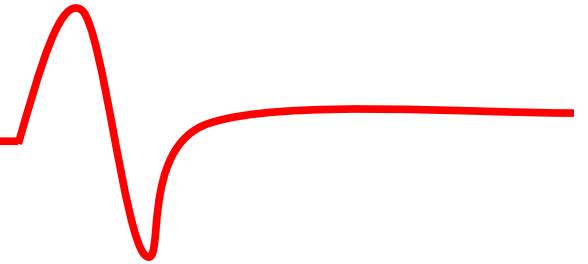
- TO UNDERSTAND THE BODY
- TO LOOK INSIDE
- ADVANTAGES OVER PROJECTION

RADIOGRAPHY:

- ELIMINATES THE SUPERIMPOSITION OF IMAGES
- TISSUES WITH VERY LESS DENSITY DIFFERENCE
- MULTIPLANAR REFORMATTED IMAGING



MRI & CT SCAN...



□ HOW IT WORKS?

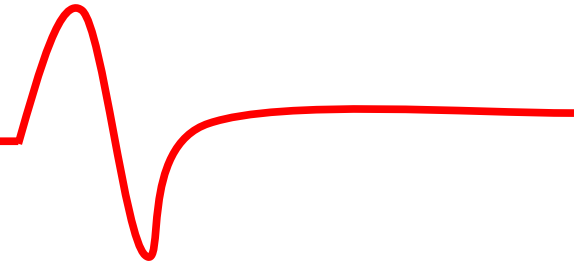
- CT: (COMPUTER TOMOGRAPHY)

- MOVING THE X-RAY SOURCE AND DETECTOR

- ANATOMY AT THE TARGET LEVEL REMAINS SHARP,
WHILE STRUCTURES AT DIFFERENT LEVELS ARE
BLURRED

- ABILITY TO SEPARATE ANATOMICAL STRUCTURES

MRI & CT SCAN...



□ HOW IT WORKS?

▪ MRI: (MAGNETIC RESONANCE IMAGING)

– STATIC FIELD :

- POWERFUL MAGNETS TO POLARIZE AND EXCITE HYDROGEN NUCLEI IN TISSUES

– GRADIENT MAGNETS:

- TURNED ON AND OFF VERY RAPIDLY,
- THEY ALTER THE MAIN MAGNETIC FIELD ON A VERY LOCAL LEVEL TO PICK EXACTLY THE AREA WE WANT.

– RF GENERATOR:

- PULSE CAUSES THE PROTONS IN THAT AREA TO ABSORB THE ENERGY AND THEN RE-EMIT : RESONANCE

– IMAGING:

- PICK SIGNALS
- FOURIER TRANSFORM

TECHNOLOGY

DIMENSIONS	FUNCTIONAL CHARACTERISTICS CONSIDERED UNDER EACH DIMENSION	OPTIONS
Knowledge Content or Physical Entity	Source	Obtained through Technology Transfer
	Disciplines Involved	Multi-Disciplinary
	Industrial Category	Health and Social Work
	Level of Technology	LEVEL 4: Extensive Know-how, Equipment with Advanced Technologies, Substantial R&D Programmes, Use of Advanced Commercial
Other Features	Product/Process Technology	Product
	Manifestation of Technology	Embodied
	Generic/Specific Technology	Specific
	Active/Passive Technology	Active
	Is it a Systems Technology?	Yes
	Is it an Infratechnology?	No
	New/Obsolete Technology?	New
	Stage	Consolidation
	Geographic or Socio-Economic Scale	Planetary/Global
	Relevance/Impact	Social
		Economic
		Environmental
		Strategic
Organizational Scale	Global/Multinational	
Sector of Deployment	(Tertiary)	
Functional Deployment	Services	

MORPHOLOGY (MRI)

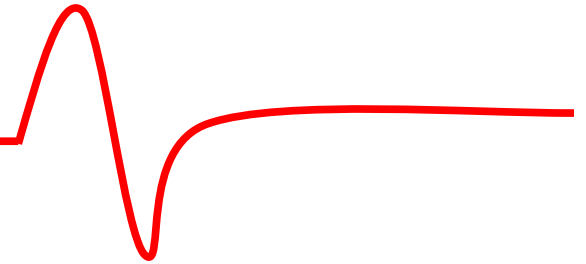
Dimensions	Options									
Closure	Open					Closed				
Field Type	Horizontal			Vertical			Angular			
Scanning Plane	Sagittal	Coronal		Axial			Oblique	Double Oblique		
Type of Magnet	Resistive			Permanent			Super Conducting			
Type of Gradient Coil	Maxwell Coil			Saddle Coil			Golay Coil			
Type of RF Coil	Surface Coil					Volume Coils				
Type of Contrast Agent	Positive Contrast Agent					Negative Contrast Agent				
Magnet Strength	0.15T	0.2T	0.3T	0.5T	1.0T	1.5T	2.0T	3.0T		
Gradient Strength	20mT/m			23mT/m		30mT/m		33mT/m		
Effective Strength	25mT/m			30mT/m			35mT/m			
Slew rate	77T/M/s					120T/M/s				
Coils Array	Head	Neck	Spine	Knee	Shoulder	Wrist	Abdominal	Medium	Large	X-Large
Spectroscopy	Possible					Not Possible				
Pulse Sequences	Standard			Angiography			Phase Contrast			
	SE	IR	2D/3D GRE	time of flight angiography (TOF)	phase contrast angiography (PCA)	contrast enhanced magnetic resonance angiography	2D/3D FSE	2D/3D FGRE	FSPGR, SSFP, FLAIR, EPI	Special Imaging
Imaging Modes	2D Single Slice		multi Slice			3D Image, multi Slab		Cine		
Field of view	←————— Various value e.g. 1cm to 48cm —————→									
Slice Thickness	2D					3D				
	←————— 0.7mm to 20mm —————→					←————— 0.1mm to 5mm —————→				

MORPHOLOGY (MRI)

Dimensions	Options			
Cooling Type	Closed loop - water type: gradient		Cryogen - Helium / Liquid nitrogen	
Patient Handling System	Yes		No	
Patient Intercom	Yes		No	
Dockable patient table	Yes		No	
Magnetic Field Fluctuation Compensation Unit	Yes		No	
Flow Motion Compensation	Yes		No	
Fast Scanning Package	Yes		No	
Control Console	Airis II	--	--	
Image Processor	Airis II	--	--	
Image Archival / Data Acquisition	DICOM Complatable	DVD Writer	CD Writer	Independent Receive Channels
User Interface Softwares	<div style="text-align: center;"> ← Variuos UI Softwares → </div>			
Operating Software & Computer	Airis II	Windows2000		Vista
Environmental Control System	Yes		No	
Laser Camera	Yes		No	
Monitor	Color LCD	--	--	
UPS	Yes		No	

CHANGES

MEDICAL FIELD:

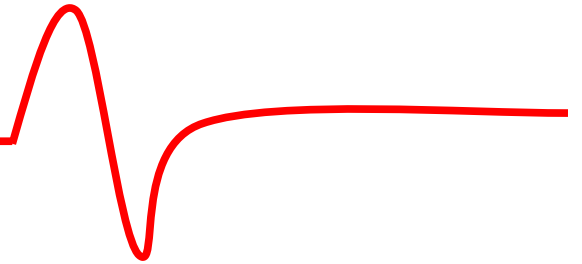


□ AMAZING IMPROVEMENT IN DIAGNOSTIC CAPABILITIES

- **ACCURACY** : “GOLD STANDARD”
- **LESS TIME** CONSUMING
- **RELIABLE** AS COMPARED TO CLINICAL METHODS
- **EFFECTIVE** IN **CRITICAL STAGE**
- **CAN DETECT BREAST CANCER** IN IT’S EARLY STAGE
 - IT IS COSTLY (\$1000 - \$1500)
 - **CAN GIVE FALSE ALARM**, AS IT IS IN DEVELOPMENT STAGE

CHANGES

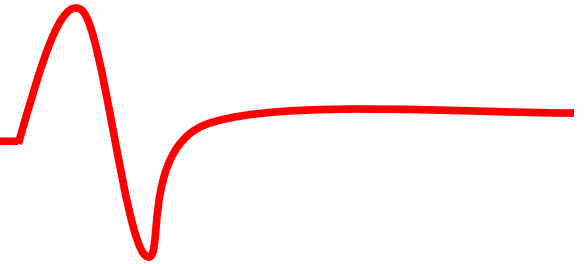
MEDICAL FIELD:



- ❑ **GUIDELINES (HEALTH CARE: GLOBAL LEVEL)**
 - FOR MRI SKULL, ABDOMEN, BREAST ETC
 - FOR CT BRAIN
- ❑ **CUT PRACTICING**
 - IS IT REALLY NEEDED TO DO MRI ?
 - HOW MUCH URGENT?
 - HOW MANY TIMES?
 - “I HAVE TO BREAK EVEN MONEY INVESTED IN MACHINES”
- ❑ **EVIDENCE OF INEFFICIENCY IN PUBLIC FACILITIES AND POSSIBLY UNETHICAL PRACTICES IN PRIVATE DIAGNOSTIC FACILITIES(JOURNAL BY CAMBRIDGE)**

CHANGES

MEDICAL FIELD:



☐ ...NOT DOING CLINICAL METHODS FOR DIAGNOSIS:

- OBSERVATION OF BODY PARTS:
 - EYES: COLOR, WET/DRY, PALE/FRESH ETC
 - THROAT: COLOR, TEXTURE ETC.
 - TOUCH: SENSING SPECIFIC AREAS

- PULSES

- TAPPING TO CHECK WATER INSIDE THE STOMACH

- CENTRAL NERVOUS SYSTEM: OBSERVING CNS CLINICALLY IS AN ART.

CHANGES

SOCIO-ECONOMIC:



- ❑ **COST PER SCANNING: ~ Rs.4000-5000/-**
- ❑ **21.8% OF INDIA IS STILL BELOW POVERTY LINE.**
- ❑ **RURAL POPULATION OF INDIA = 72.22%**
- ❑ **MOSTLY ONLY IN THE PRIVATE SECTOR AND IN THE URBAN AREAS OF THE REGION**
- ❑ **THE STUDY SHOWS THAT THERE ARE OBSERVABLE PROBLEMS IN TERMS OF EFFICIENCY, EQUITY, AND QUALITY OF MRI SERVICES.**

CHANGES

SOCIO-ECONOMIC:



NOT AVAILABLE IN RURAL AREAS

NOT EVERY HOSPITAL HAS THIS FACILITY

NOT IN CIVIL HOSPITALS

.....(AND IF IT IS, IT DOESN'T WORK)

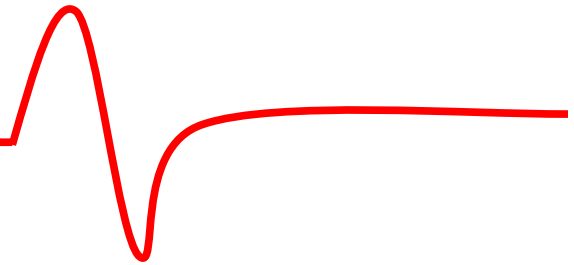
NOT IN ECONOMICALLY BACKWARD COMMUNITY AREAS

NOT TO DOCTORS AT DISTANT PLACES (E.G. SOLDIERS)

NO RADIOLOGISTS IN SUCH AREAS

CHANGES

ECONOMIC:



- ❑ HIGH-END MEDICAL DEVICE **INFLOWS ROSE** DURING THE 1990s
- ❑ AVERAGE NUMBER OF MRI MACHINES INSTALLED VARIED FROM LESS THAN **0.5 TO MORE THAN 5** MACHINES PER MILLION POPULATION
- ❑ **UTILIZATION INCREASED 14.18 %** COMPARED WITH THE PREVIOUS YEAR & SPENDING INCREASED **17.71 %** IN 1999
- ❑ **OVERUSED.**

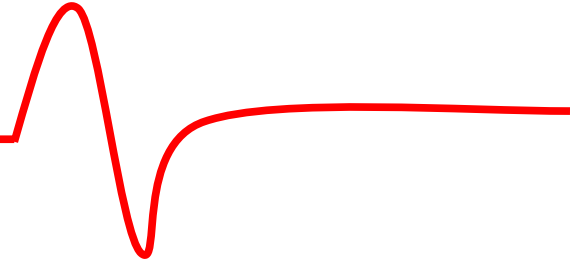
Table 1. Annual Rate of CT or MRI Utilization for Outpatient and Inpatient, 1998–2001

Variable	1998	1999	2000	2001	Annual growth rate ^a (%)
CT uses/1,000 people	27.28	29.81	30.26	31.14	4.51
Outpatient CT uses/1,000 people	1.21	1.29	1.36	1.38	4.48
Inpatient CT uses/1,000 people	94.24	93.06	90.23	87.28	-2.52
MRI uses/1,000 people	5.42	6.92	7.62	8.56	16.46
Outpatient MRI uses/1,000 people	0.27	0.35	0.41	0.45	18.54
Inpatient MRI uses/1,000 people	13.83	14.87	14.96	15.96	4.90
CT units per million people	13.40	13.03	13.78	14.10	1.71
MRI units per million people	2.56	2.86	3.24	3.71	13.16

^a Annual growth rate = [(2001-year data/1998-year data)^{1/3}] - 1.
CT, computed tomography; MRI, magnetic resonance imaging.

CHANGES

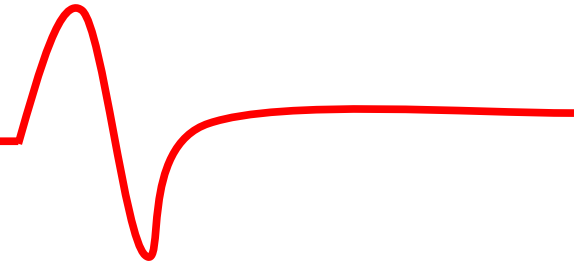
ENVIRONMENTAL



- ❑ ENERGY CONSUMPTION BY THESE MACHINE IS HUGE.
 - DEPENDING UPON MODEL
- ❑ NEED HIGH END PROCESSORS
 - MORE POLLUTION DUE TO LED, MERCURY USED IN CHIPS.
- ❑ NEEDS AIR CONDITIONED ENVIRONMENT
 - CFC
 - INSULATING MATERIALS.
- ❑ ENERGY REQUIRED TO MAKE THESE MACHINES

SUSTAINABILITY

FOR THIS TECHNOLOGY



☐ DEPENDENCY OF SOCIETY ON TECHNOLOGY

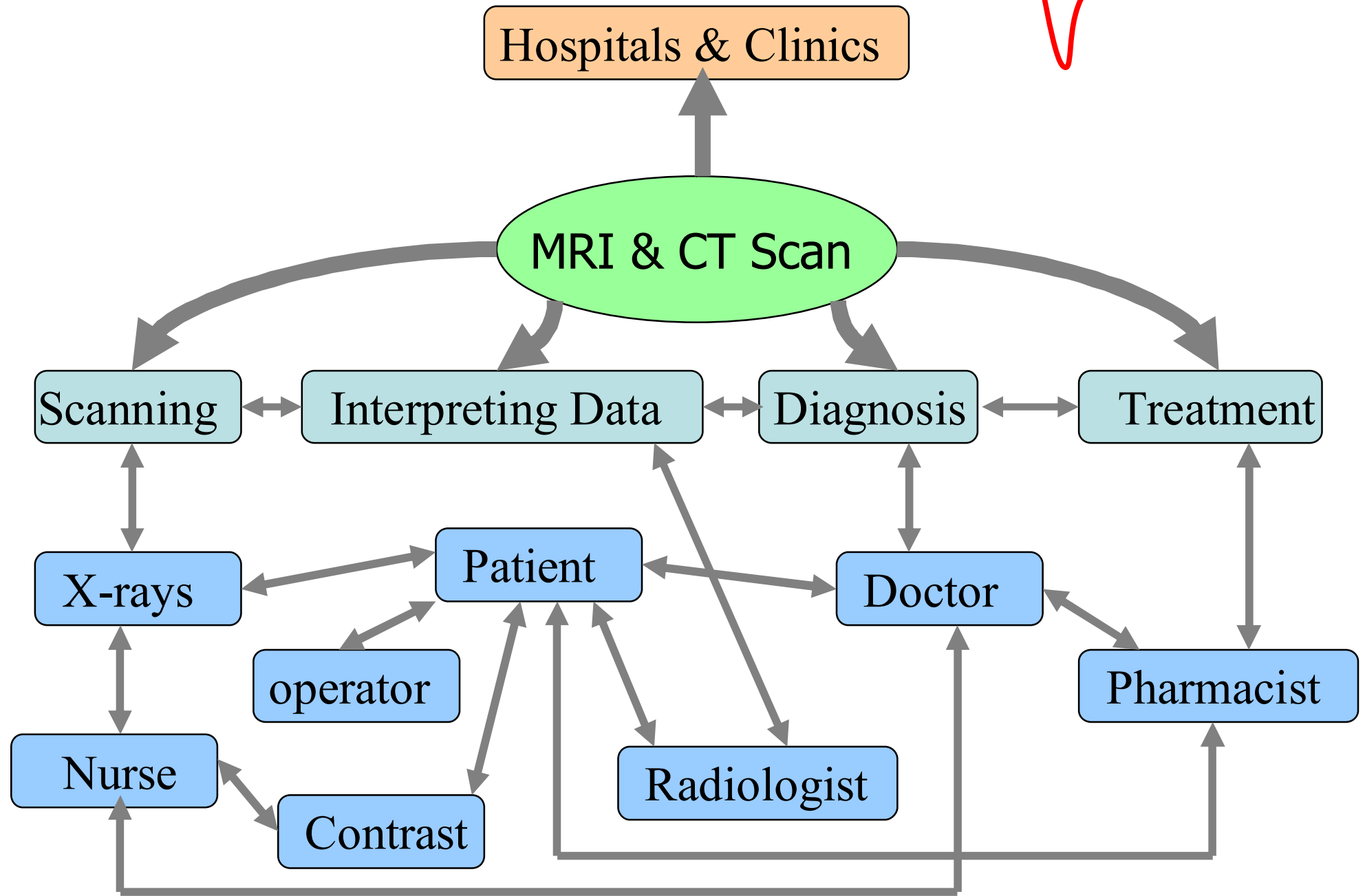
- DOCTORS & PATIENTS
- GEOGRAPHICAL

☐ DOCTORS MAINTAINING THEIR DIAGNOSTIC SKILL SETS

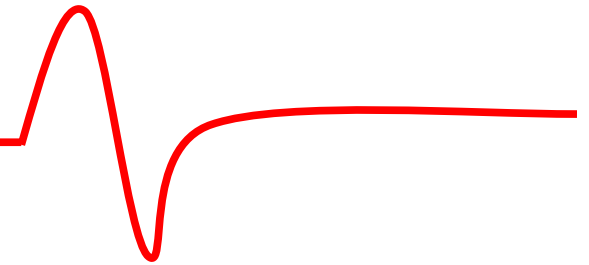
☐ EQUITY AND SOCIAL JUSTICE

☐ AFFORDABILITY & AVAILABILITY FOR EVERY ONE

SYSTEM SIMULATION



SYSTEM SIMULATION



☐ KANE'S SIMULATION METHOD

– CROSS-IMPACT ANALYSIS

☐ SYSTEM VARIABLES

☐ INITIAL VALUE (FOR TODAY) : 0 – 1

☐ CROSS IMPACT MATRIX OF VARIABLES

☐ IMPACT : -VE OR +VE : -1.0 TO +1.0

☐ VARIABLES TREND PREDICTED FOR 15 YEARS

SYSTEM VARIABLES



USABILITY

1. DEPENDENCY ON M/C BY DOCTOR
2. ACCURACY OF M/C
3. USE OF M/C
4. MALFUNCTIONING OF M/C
5. AVAILABILITY OF M/C
6. TRUST OF PATIENT ON M/C

ENVIRONMENTAL

1. HEALTH HAZARDS OF USING M/C ON PATIENTS
2. ENERGY CONSUMPTION
3. CREATION OF POLLUTING ELEMENTS

ECONOMICAL

1. COST OF SCANNING
2. PAYING CAPACITY OF PATIENTS
3. INITIAL INVESTMENT FOR M/C
4. NO. OF M/C PER UNIT AREA
5. MEDICAL EQUIPMENT MANUFACTURER'S GROWTH
6. DEVELOPMENT AND GROWTH OF AREA

SYSTEM VARIABLES



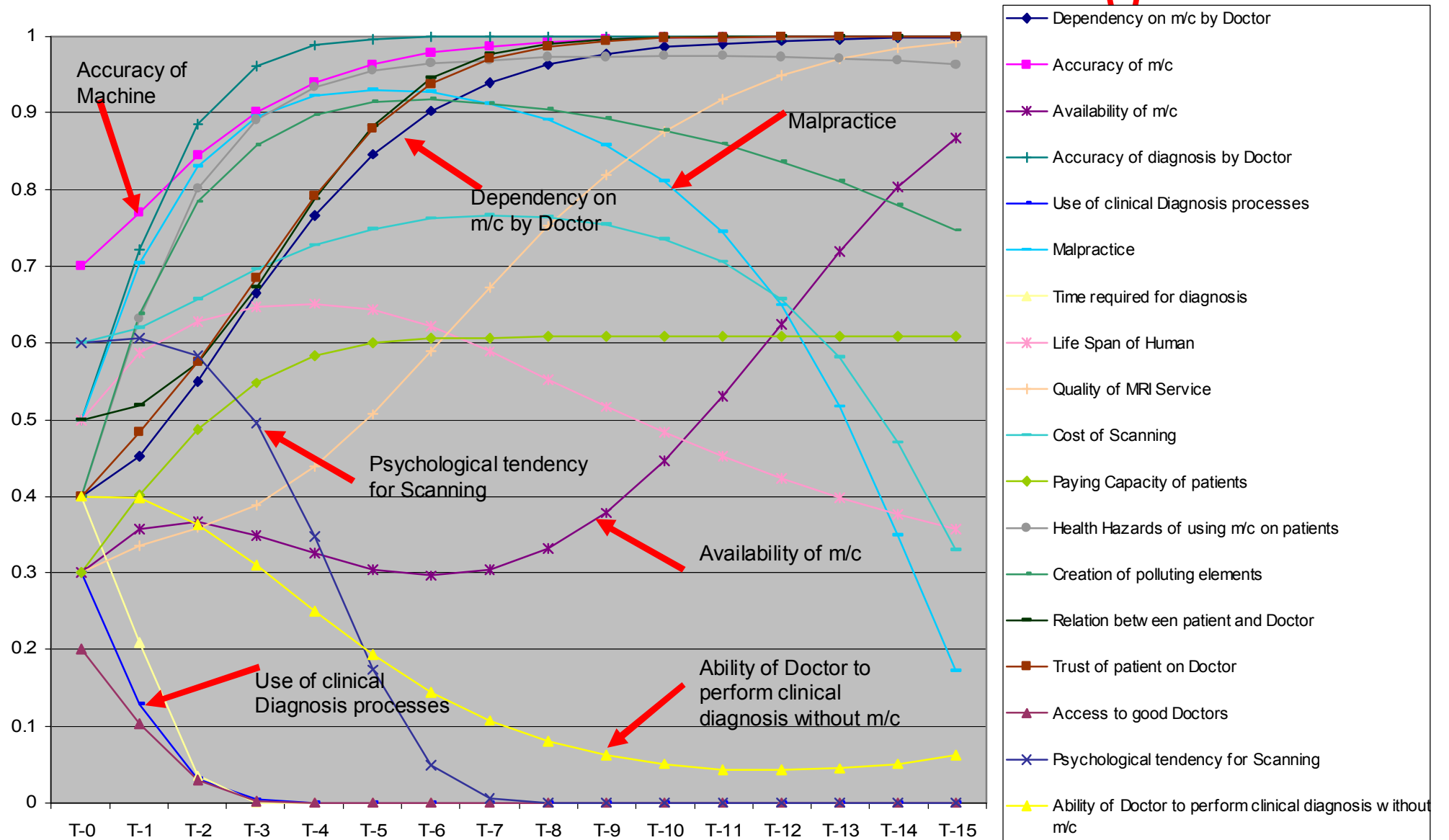
MEDICAL

1. ACCURACY OF DIAGNOSIS BY DOCTOR
2. USE OF CLINICAL DIAGNOSIS PROCESSES
3. MALPRACTICE
4. TREND OF FOLLOWING GUIDELINES
5. EXPERIENCE OF A DOCTOR
6. TIME REQUIRED FOR DIAGNOSIS
7. EFFICIENCY OF TREATMENT
8. LIFE SPAN OF HUMAN
9. ADVANCEMENT IN TECHNOLOGY OF M/C'S
10. QUALITY OF MRI SERVICE
11. EFFECTIVENESS IN CRUCIAL TIME
12. ABILITY OF DOCTOR TO PERFORM CLINICAL DIAGNOSIS WITHOUT M/C

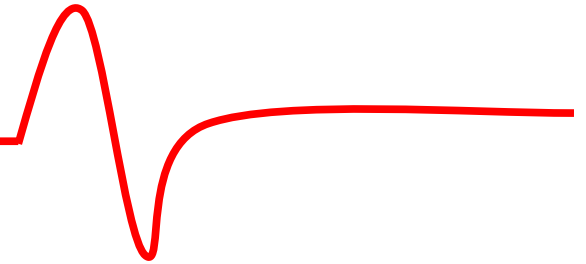
SOCIAL

1. RELATION BETWEEN PATIENT AND DOCTOR
2. NEED OF OTHER MEDICAL STAFF
3. TRUST OF PATIENT ON DOCTOR
4. ACCESS TO GOOD DOCTORS
5. PSYCHOLOGICAL TENDENCY FOR SCANNING
6. PATIENTS AWARENESS ABOUT GUIDELINES

VARIABLE TREND

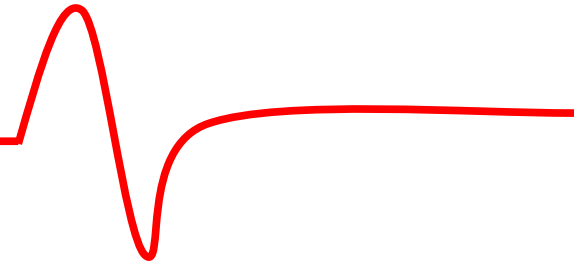


OBSERVATIONS



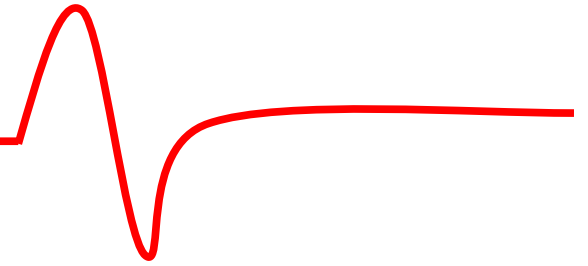
- ABILITY OF DOCTORS TO PERFORM CLINICAL DIAGNOSIS WITHOUT MACHINE WILL REDUCE
- DEPENDENCY ON MACHINES WILL EXTEND TO MAXIMUM
- COST OF SCANNING WILL INCREASE AND THEN TEND TO COME DOWN
- ACCURACY OF MACHINE WILL INCREASE TO GREAT EXTENT
- USE OF CLINICAL DIAGNOSIS METHODS WILL REDUCE TO MINIMUM
- AVAILABILITY OF M/CS WILL REDUCE FOR INITIAL FEW YEARS AND THEN IT WILL INCREASE
- DUE TO EXCESS USE OF THESE M/CS, POLLUTING ELEMENTS WILL INCREASE.
- MALPRACTICE WILL INCREASE WITH INCREASE IN USE. AS USE TEND TO GO DOWN, MALPRACTICE WILL REDUCE.
- IF PATIENTS AWARENESS ABOUT GUIDELINES HAS INCREASE THEN TENDENCY TO GO FOR SCANNING WILL REDUCE

RECOMMENDATIONS



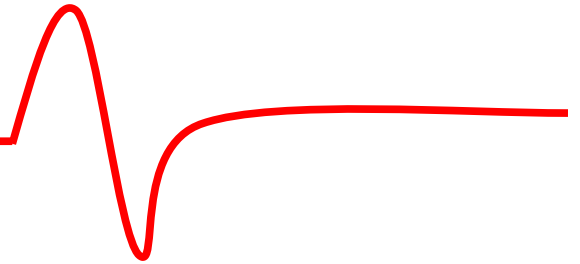
- PREFER TO USE GUIDELINES BEFORE GOING FOR SCANNING
- TRY TO USE CLINICAL METHODS WHENEVER POSSIBLE.
- TO REDUCE THE COST OF SCANNING FOR AFFORDABILITY, GOVERNMENT SHOULD TAKE INITIATIVE.

WORD OF THANX



- ❑ DR. SHARADA
- ❑ DOCTORS WITH WHOM INTERACTED THROUGH OUT MY STUDY.

REFERENCES



- ❑ [HTTP://WWW.SCIENCEDIRECT.COM/](http://www.sciencedirect.com/)
- ❑ [HTTP://WWW.OSHA.GOV/SLTC/RADIOFREQUENCYRADIATION/HEALTHEFFECTS.HTML](http://www.osha.gov/SLTC/RADIOFREQUENCYRADIATION/HEALTHEFFECTS.HTML)
- ❑ U.S. DEPARTMENT OF LABOR - OCCUPATIONAL SAFETY & HEALTH ADMINISTRATION
- ❑ [HTTP://WWW.RADMD.COM/MISC_PAGES/CLINICAL_GUIDELINES.HTM](http://www.radmd.com/misc_pages/clinical_guidelines.htm)
- ❑ HART, D.; WALL (2004). "UK POPULATION DOSE FROM MEDICAL X-RAY EXAMINATIONS". EUROPEAN JOURNAL OF RADIOLOGY 50 (3): 285-291.
- ❑ REFERRAL GUIDELINES FOR IMAGING- UK ROYAL COLLEGE OF RADIOLOGISTS
- ❑ INTERNATIONAL JOURNAL OF TECHNOLOGY ASSESSMENT IN HEALTH CARE, 21:1 (2005), 81-88.
- ❑ UTILIZATION OF MAGNETIC RESONANCE IMAGING IN ASIA
RAYMOND C. W. HUTUBESSY, PIYA HANVORAVONGCHAI AND TESSA TAN-TORRES EDEJER
- ❑ [HTTP://JOURNALS.CAMBRIDGE.ORG](http://journals.cambridge.org) (AJAY MAHAL, ANIL VARSHNEY AND SRINIVAS TAMAN)
- ❑ BOOK: HUTCHISON'S CLINICAL METHODS: R. BOMFORD, S. MASON, M. SWASH
- ❑ PERSONNEL INTERACTION WITH DOCTORS / USERS.

THANK YOU

