ICMP 2011
April 17-20 · Porto Alegre · RS · Brazil

HTTG Workshop:

Equipment characteristics:

technical specifications and complexity issues –

WHO recommendations for X-ray equipment (for healthcare stations)

+ Associated Basic Training

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Main issues:

-Electrical energy supply

-X-ray equipment parameters

-Type of film/detector

-Detector stability

-Environment/room

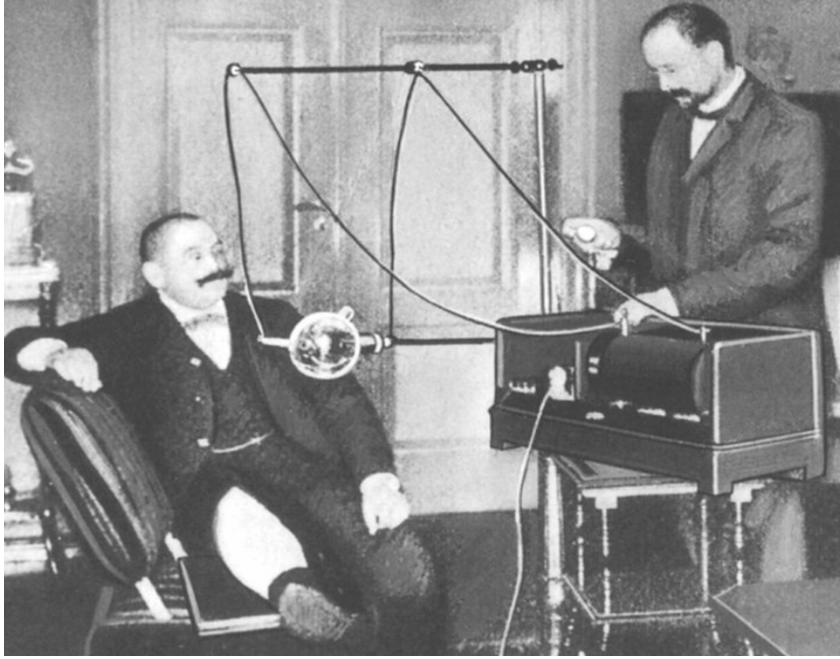
-Patient(s) safety

-Operator’s training

-Maintenance

-Technical staff

-Use of imaging information



WORLD HEALTH ORGANIZATION ORGANISATION MONDIALE DE LA SANTE

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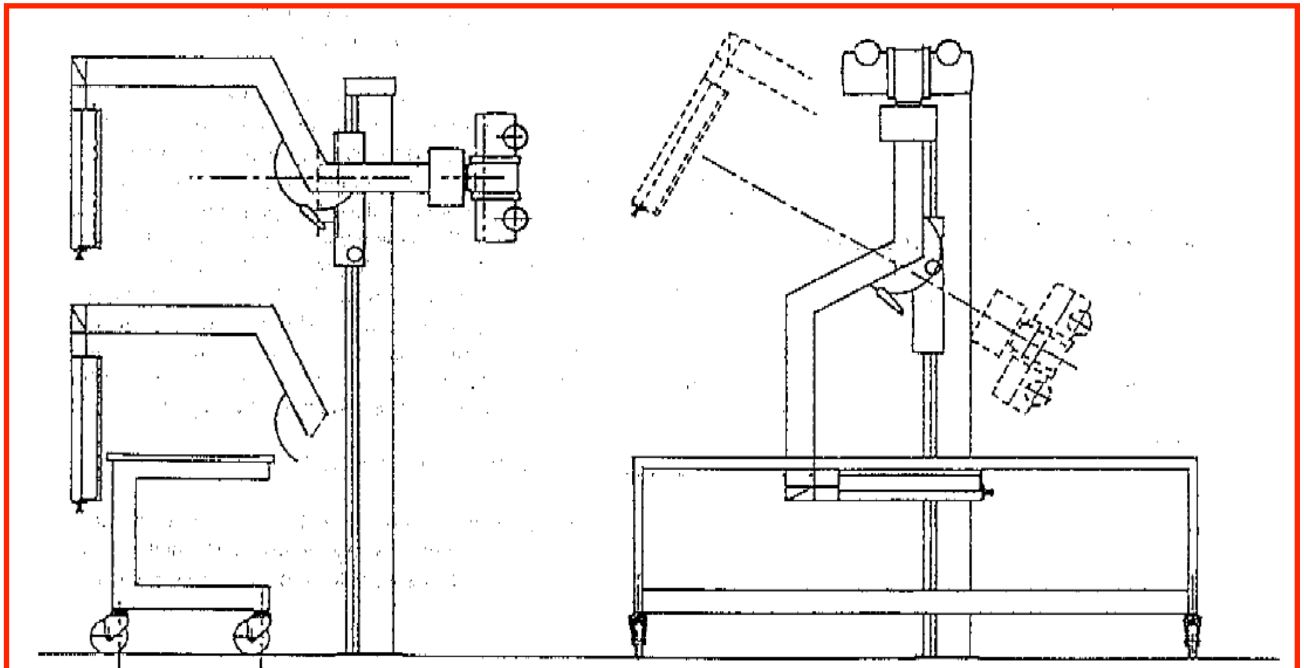
TECHNICAL SPECIFICATIONS FOR THE WORLD HEALTH IMAGING SYSTEM FOR RADIOGRAPHY - THE WHIS-RAD

This document is based on the *Report from the consultation meeting on the WHO Basic Radiological Systems*, Lund, Sweden, June 1993, and on subsequent comments from the partcipants and other professionals and experts.



Predecessor:

Basic Radiological System (BRS), PAHO, 1975

WHIS-RAD, WHO, 1985

Excellent technical document based on expert knowledge

Recommended:

-Main type of X-ray Generator

-Main parameters of the X-ray tube

-Construction issues

-Film/screen combinations/cassettes

-Protective and Operational accessories

The simplicity of the WHIS-RAD system lies in its set of fixed parameters

Many WHIS-RAD produced and shipped to developing countries

WHO: ESSENTIAL MEDICAL EQUIPMENT

- For hospitals, with larger numbers of beds, greater capacities of basically the same type of equipment can be used. For example: instead of using a 100 mA, 120kV X-ray unit for a 50-bed hospital, use a 200 mA, 120 kV unit for a 100-bed

GENERIC SPECIFICATIONS FOR X-RAY (WHO, 2002)

The major requirements for any stationary X-ray unit are as follows:

(i) Medium or high frequency converter with a tube generating potential (voltage) range of 45-120 kV.

Note: Some type of power storage may be required, e.g., a capacitor or battery (see below). A generator with falling tube current (mA) during exposure is preferable to one with constant tube current.

(ii) Minimum power, 11kW (at 0.1 s); minimum available energy, 25 kWs.

Note: If the relative speed of the screen-film system is 400, the energy requirement may be reduced to 12kWs. The power requirement remains the same.

(iii) Focal spot size, 1 mm or less.

(iv) Accurate, variable collimator, which cannot be removed.

(v) Minimum focus-film distance, 100 cm for vertical-beam radiography; 140 cm for chest radiography with horizontal beam.

It should be noted that single-phase two-pulse generators (not involving multi-pulse converter technology) and capacitor discharge units without constant voltage (kV) during exposure are not recommended

Good specs, provided Electrical power supply and Detector stability exist

Safe Spec X-ray equipment Specifications (2000 >>>…)

Hopeful

- “We require a general x-ray room”

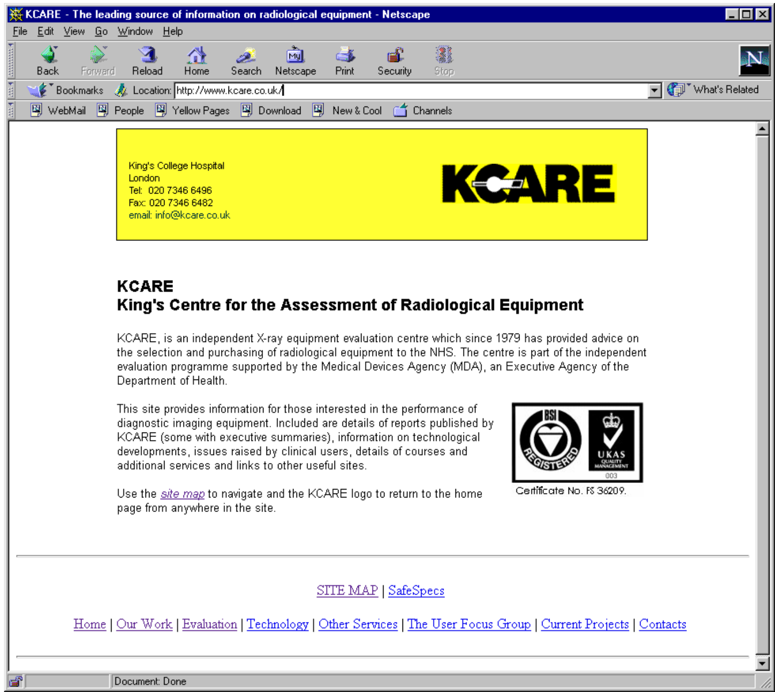
Directive

- Operating potentials between 45 and 125 kV
- Range of table heights from 80 - 120 mm

Inquisitive

- Specify operating potentials
- State range of vertical table movement

www.kcare.co.uk

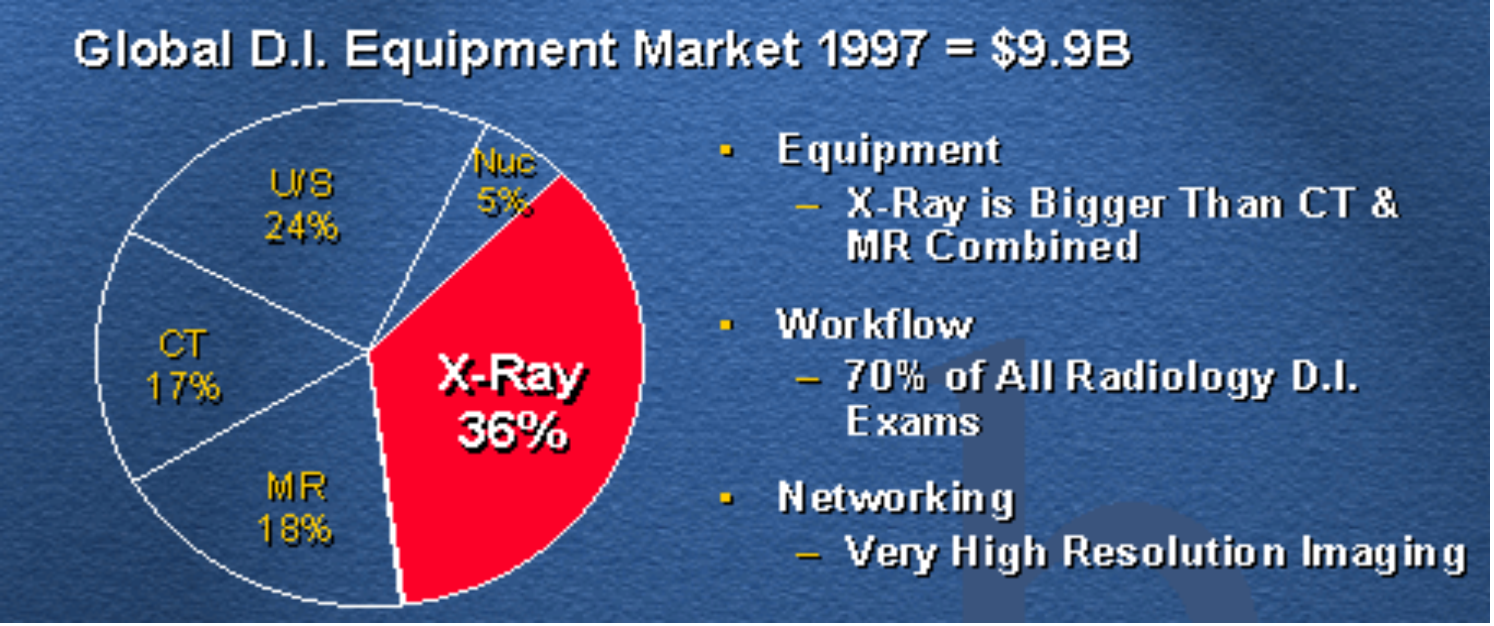


Two methods of **Safe Spec** use

Enter details of examinations ***or***

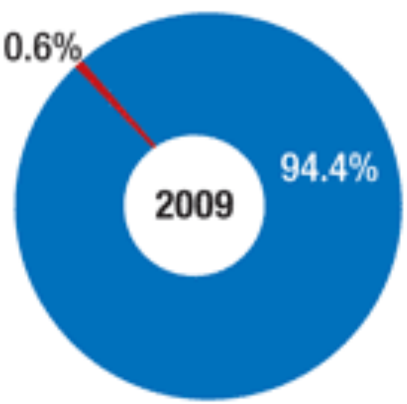
Ask for specific device

Password … Updates…



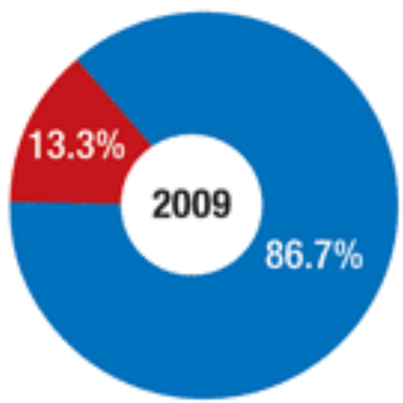
Medical Imaging Markets

Indian X-ray Equipment Market
Unit-wise
Total-5030 Units



Segment	Units
Analog and CR Equipment	5000
DR Equipment	30

Indian X-ray Equipment Market
Value-wise
Total Rs. 225 Crore



Segment	Value (Rs. Cr.)
Analog and CR Equipment	195
DR Equipment	30

The global trend of increase in Digital Medical Imaging has a strong drive in the number of conventional X-ray equipment , to be turned digital.

Some countries started late, but the trends are preserved

Integrated Digital X-Ray System for the WHIS-RAD
Africa Field Report, 2006

Limitations:
- A major limitation of the current screen-film (SF) WHIS-RAD system is the high cost of taking and processing an image. The film and chemicals required for a single exposure cost about $3.50.

- Shortage of medical professionals in the developing world

Solution:
- Eliminate film to lower recurring costs (CR system with OK resolution, not DR)
- Develop a suitable viewing system to view images
- Design a storage, archival, and retrieval system to manage the digital images
- Allow future teleradiology.

- Pilot project initiated

- Good Decision Matrix – can be used a background for further studies

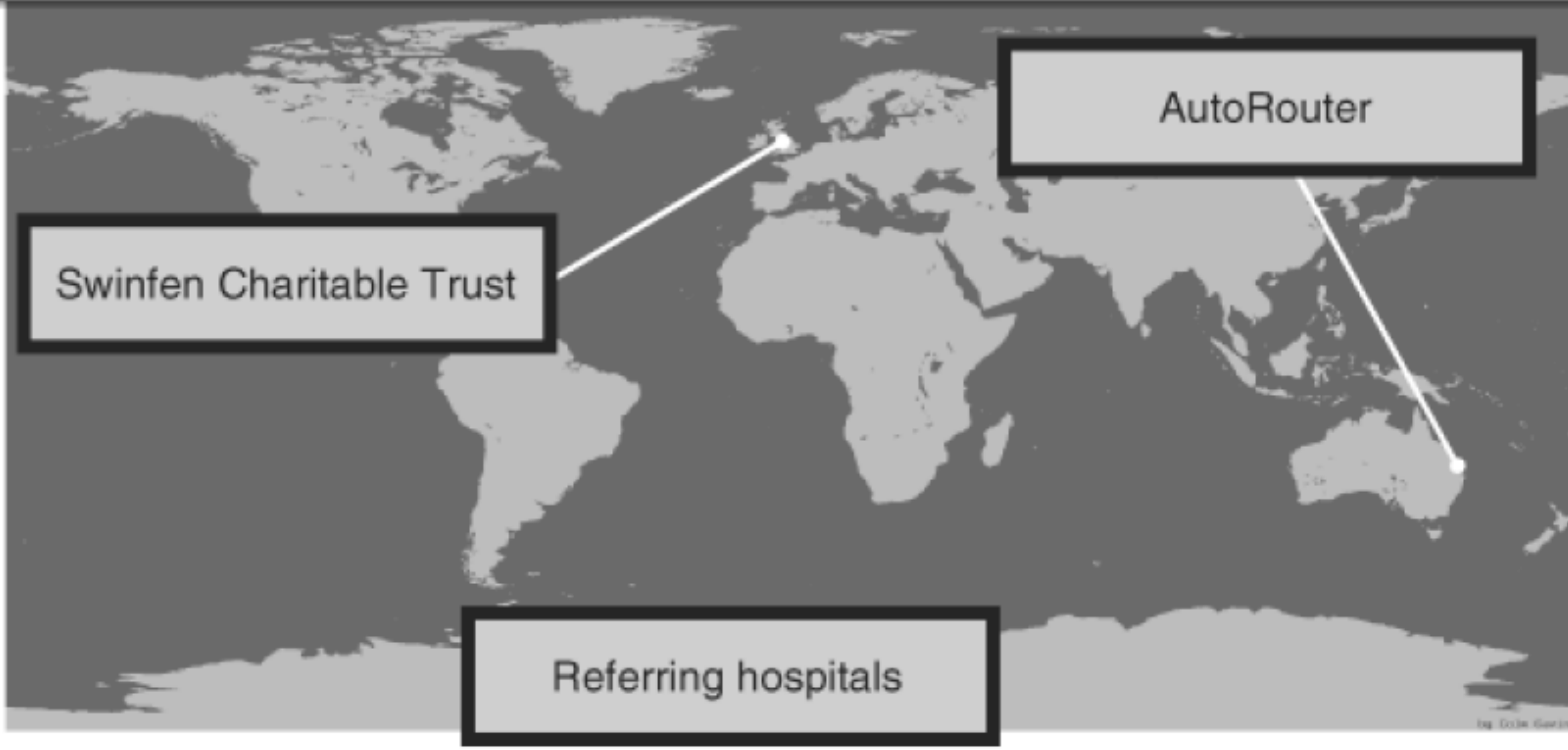
5.0 Decision Matrix

In the following Pugh Matrix, we show our decision progress between the main technology categories. We have begun to assign weights to the important criteria in this project.

Factors	Importance	CR	Double Sided CR	DR	Film
Initial Cost	10	1	-1	-5	4
Recurring Cost	5	1	-1	6	-2
Image Quality	6	1	6	7	8
Image Capture Time	3	1	1	7	-2
Simplicity of Operation	2	1	1	1	-1
Ease of Capturing High Quality Image	4	1	1	0	-1
X-Ray Dose	2	1	1	3	0
Retrofit Feasibility	10	1	1	-1	1
Teleradiology Potential	5	1	1	0	-1
Productivity	1	1	1	1	-2
Weighted Total		**42**	**47**	**41**	**31**

Table 1 - Pugh Decision Matrix

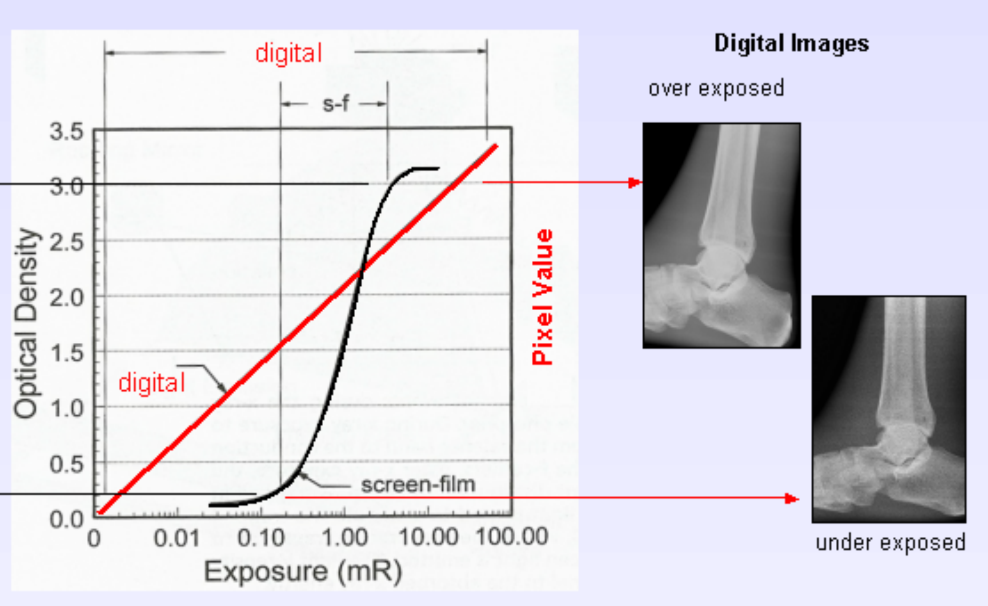
Source:
Integrated Digital X-Ray System for the WHIS-RAD
Mike Hoaglin, Aaron Eifler, Andrew McDermott, Emre Motan, Paul Beithon
Africa Field Report, June 7, 2006, Rev. September 19, 2006
Client: Mr. John Vanden Brink, Rotary International



Afghanistan, 5	Colombia, 1	Guyana, 1	Madagascar, 1	Russia, 1	Tibet, 1
Albania, 1	DR Congo, 1	Iraq, 40	Malawi, 4	Sierra Leone, 1	Tristan da Cunha (UK), 1
Antarctica, 1	East Timor, 2	Kenya, 1	Mozambique, 1	Solomon Islands, 5	Uganda, 2
Bangladesh, 6	Ethiopia, 5	Kuwait, 3	Nepal, 10	Somalia, 1	Uzbekistan, 2
Bolivia, 1	Gambia, 5	Laos, 2	Pakistan, 9	Sri Lanka, 5	Yemen, 1
Cambodia, 2	Ghana, 1	Liberia, 1	Papua New Guinea, 3	St Helena (UK), 1	Zambia, 2
China, 1	Guinea, 1	Lithuania, 1	Philippines, 1	Sudan, 1	

Figure 19.3 Swinfen Charitable Trust Network (July 2008)

Source: A low-cost international e-referral network, Richard Wootton, Pat Swinfen, Roger Swinfen, and Peter Brooks



Digital X-ray Imaging;

-Excellent latitude (less exposure errors);

-High dependence of image processing

A very high % of the equipment in developing countries (50%+) is dysfunctional…

Training of technical staff and operators is crucial

EQUIPMENT ?

-ROBUST AND EASY TO OPERATE

-STABLE   AND EASY TO MAINTAIN

-TRAINED STAFF FOR EACH EQUIPMENT

-PROVIDE A PACKAGE: EQUIPMENT + TRAINING FOR 2 PEOPLE + MAINTENANCE/TEST EQUIPMENT

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A total of 16 X-ray equipment operators were found at their posts in the 15 institutions visited. Only 3 (19%) of these 16 operators had completed a 3-year technician training diploma programme. The remaining 13 (81%) were either X-ray assistants (4) with a 6-month certificate in basic imaging and darkroom technique or X-ray attendants (9) who were trained on the job. One X-ray technician had received formal training in the United Kingdom; the remaining X-ray technicians and the X-ray assistants had received their training locally at one of Ghana's two teaching hospitals.

Three features of the WHO-BRS provide considerable assistance in improving basic X-ray services at rural first-referral level hospitals in many developing countries.

First, operators need only a short training period (2 weeks to 3 months) to produce high-quality radiographs of all parts of the body. This allows busy X-ray departments in larger urban hospitals to use highly trained X-ray technicians and expensive equipment for more complex examinations.

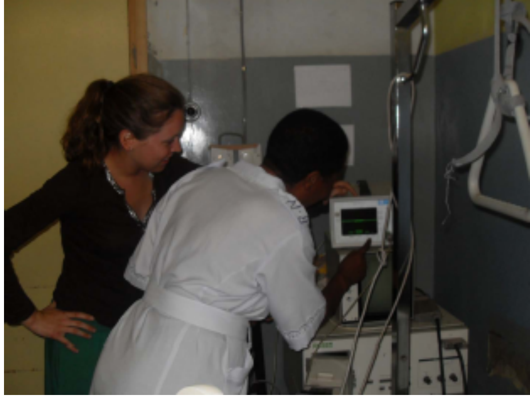
Second, because of its lower purchase price and maintenance costs the WHO-BRS is more cost-effective than standard X-ray equipment.

Third, the beam limitation of the WHO-BRS reduces the risk of harmful irradiation of patients and operators

Source: Radiological services in rural mission hospitals in Ghana
J. Sekiguchi & S.R. Collens, 1992

At least two levels of training:

1. Technical (above basic):



Source: Access to Medical Equipment Operation and Maintenance Manuals: AN ONLINE DEPOSITORY
Michael Eppley, Clinical Engineer, USA resident Kyrgyzstan

2. Basic (at school level)

Source: AN EVIDENCE-BASED CURRICULUM FOR BIOMEDICAL TECHNICIAN'S ASSISTANTS IN RESOURCE-POOR SETTINGS
Robert Malkin, Michelle Garst (trial in Rwanda)

We have developed a Biomedical Technician's Assistant (BTA) curriculum to train secondary school graduates in resource-poor settings to accomplish these repairs. The BTA curriculum aims to provide a sustainable method for local technicians' assistants to repair and maintain medical equipment. The first trial of the curriculum is currently underway in Rwanda….

Our data suggests that a graduate of the BTA curriculum could return 66% of the broken medical equipment in their hospital to service independently.

From the evidence we gathered, we prepared a curriculum sufficient to teach the identified skills. The BTA curriculum includes a set of 115 basic skills required frequently in the repair of medical equipment. The skills were classified into 5 knowledge domains: Plumbing, Mechanical, Electrical, Power Supply and Motors. Each general knowledge domain was further specified into Units, of which there are 25. Each skill is classified by its general Knowledge Domain, and further by its Unit. For example, the skill of Descaling is in the Blockages Unit, which is in the Plumbing knowledge domain.

Each module consists of an introduction as to why the skill is necessary, an example of when the skill is used, an exercise to demonstrate essential aspects of the skill, and methods to identify when the skill must be used.

Step 1: Place the cuff snugly around the upper arm of the patient.

Step 2: Place the cuff at approximately the same height as the patient's heart. The cuff should be approximately an inch above the

Step 3: Push the button that displays the words "ON/OFF" or "START"

Step 4: Wait for the machine to turn on. When the digital display lights up, the sphygmomanometer is on.

Step 5: Push the "START" button to take the measurement.

Step 6: The cuff will automatically inflate. The cuff will automatically deflate. Do not remove the cuff until the display box displays numbers.

Above is an example of a the procedure section from the module Calibrating Sphygmomanometer.

Knowledge Domain	Unit	Skill
Mechanical		
Plumbing	Leaking	Finding holes
		Cutting tubes
		Electrical tape
		Epoxy
		Superglue
		Rubber patches
		Melting tube
	Connection	Clamps
		Hose barb with clamp
		Threaded pipe connector
	Seal	Caulk
		O-rings
	Filters	Cleaning
	Blockages	Routing
		Cleaning
		Descaling
Motors		
Power supply		
Electrical		

<u>What type of training:</u>

-What is the entry training level (and how to assess it)?

-Do we need specialised courses?

- How to assess trainees (do we need some certification)?

-What type of teachers (do we need experts as trainers)?

-Do we need to send students abroad for such training?

-Can we develop own training (if yes, it must include local people)?

-Can we use e-Learning or other simulations?

-Can we use distant learning (and what language will be used)?

-How long will this training last (dynamic of development)?

-When the trainee will need updates?

-Who will employ and keep the trainee?

-What will be his/her possibilities for advise about equipment?

-Will he/she has some input regarding hospital/patient safety?

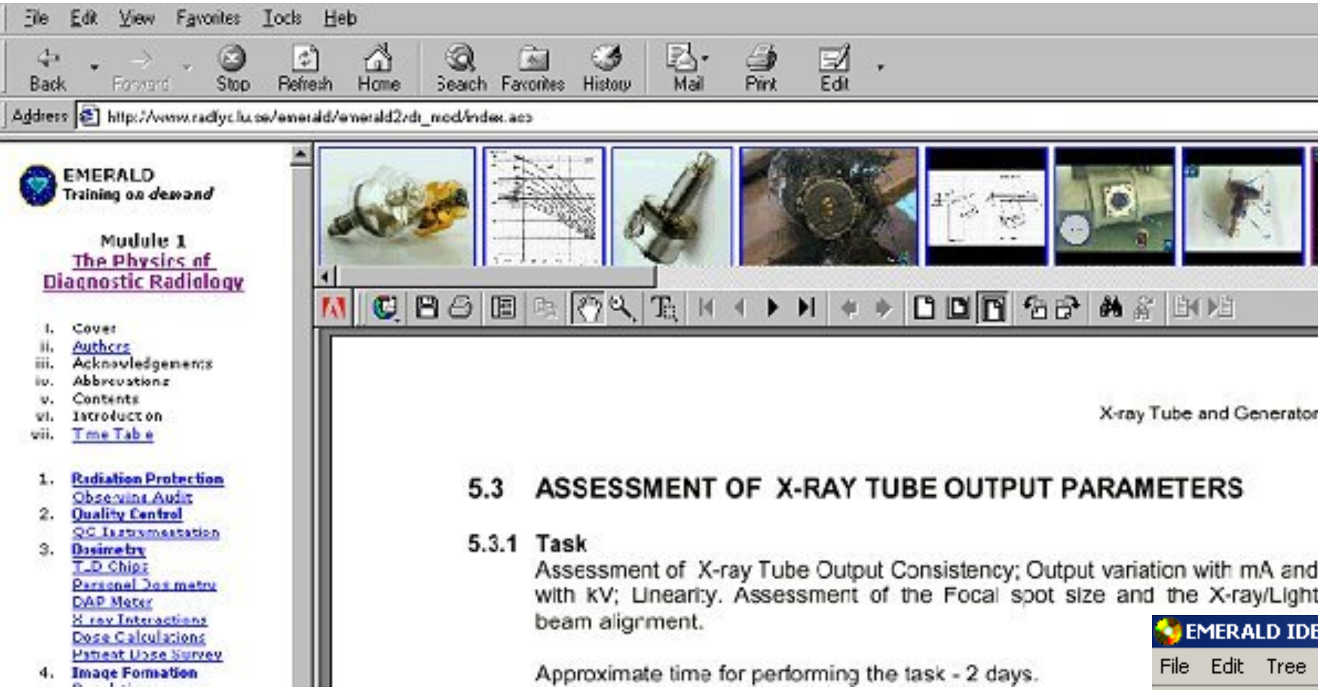
- The ICTP Medical Physics College trains students (graduates) to be future teachers in their countries – for 25 years proved to be very successful, but it takes only graduates with acceptable English and filed knowledge.

- Arranging practical tutorial is very difficult (and expensive).

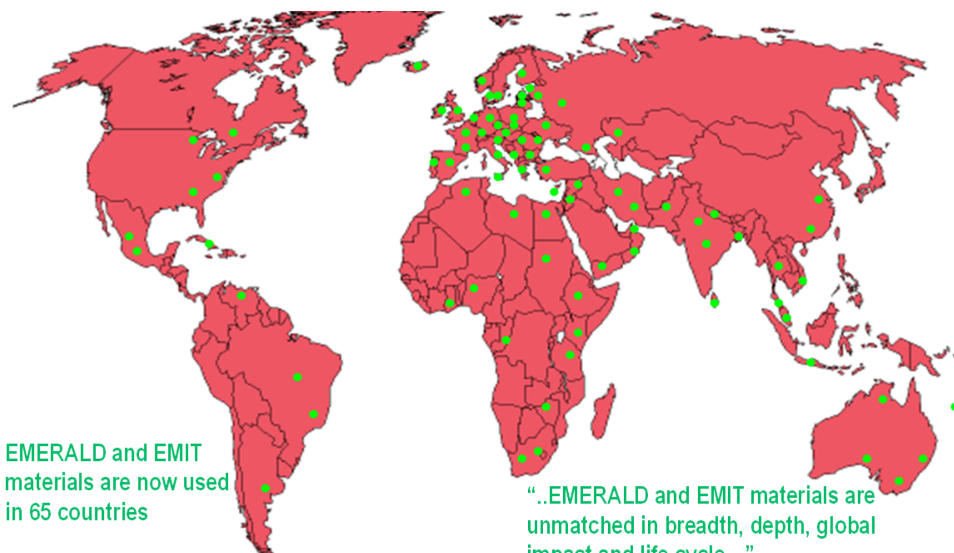
- The maximum possible length of training (financially and arrangements) is 3 months for about 10-15 students group (needs dedicated teacher)

- Extending the experience in other countries (College in India) – much better financially and cost per trainee significantly less.

Training – focussed, based on examples : EMERALD and EMIT

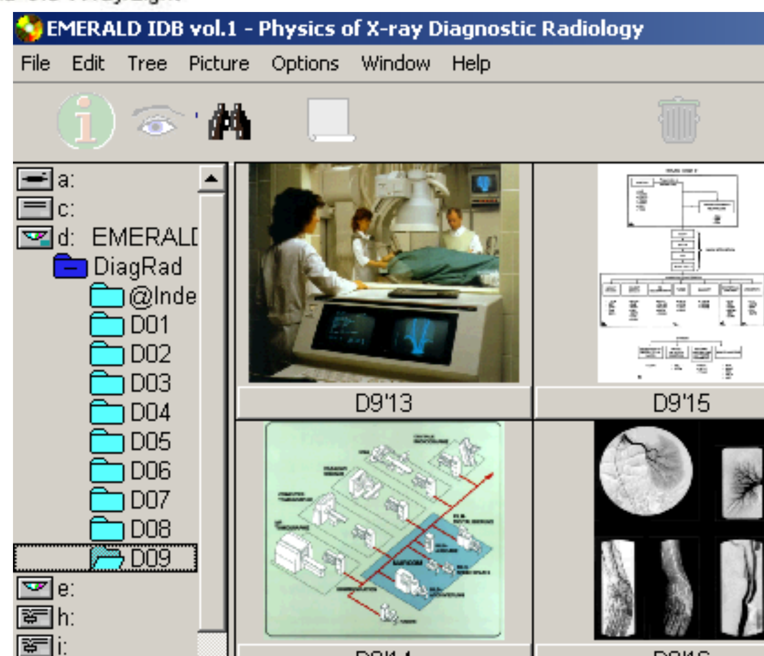


- Requires science background
- Requires tuition
- Expensive development
- Such training is difficult to develop for basic needs



EMERALD and EMIT materials are now used in 65 countries

"..EMERALD and EMIT materials are unmatched in breadth, depth, global impact and life cycle..."

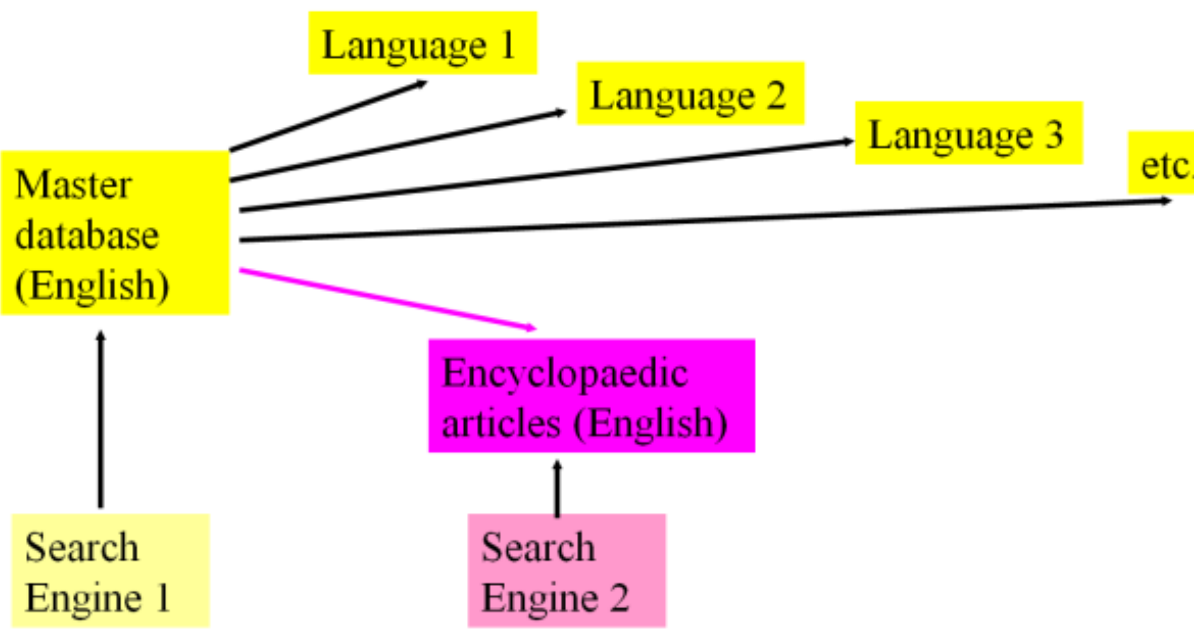


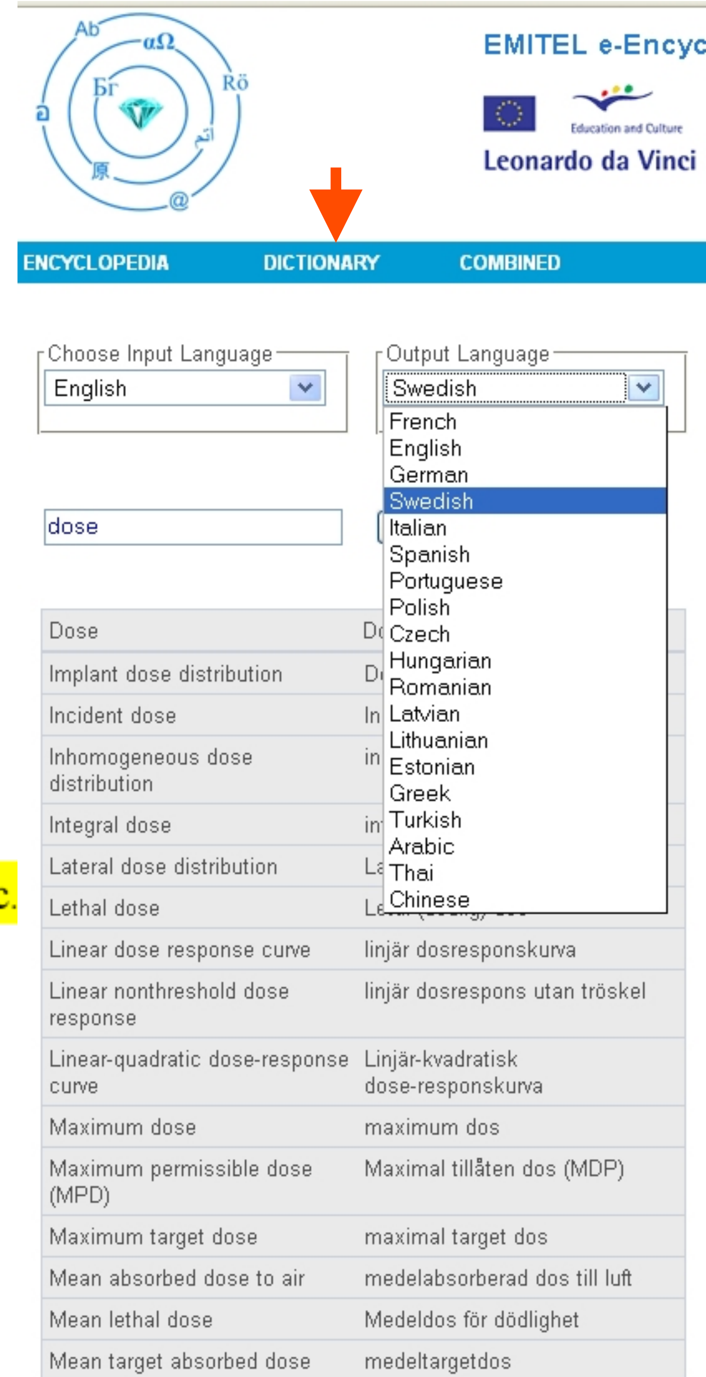
EMITEL DICTIONARY (WWW.EMITEL2.EU):

Dictionary – 29 languages (each with ~3400 terms):

English, French, German, Italian, Swedish, Spanish, Portuguese, Bulgarian, Czech, Greek, Hungarian, Lithuanian, Polish; Estonian, Romanian, Turkish, Latvian, Russian, Thai, Arabic, Persian, Bengal, Slovenian, Malay, Chinese, Croatian, Japanese, Finnish (Korean in final editing)

Future enlargement – others languages welcome





Do we have a solution?

An idea:

-Local/Regional Training Centres can be developed, using existing teaching/University facilities

-This approach will be less expensive, can be funded by specific international programme

-It will need about 3 years train-the-trainer courses up-front

-The Centre will need long time support (c. 10 years before it becomes self-sustainable)

-The Centre (and profession) will have to be attractive for local people

-PROVIDE A PACKAGE: EQUIPMENT + TRAINING FOR 2 PEOPLE + MAINTENANCE/TEST EQUIPMENT

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