

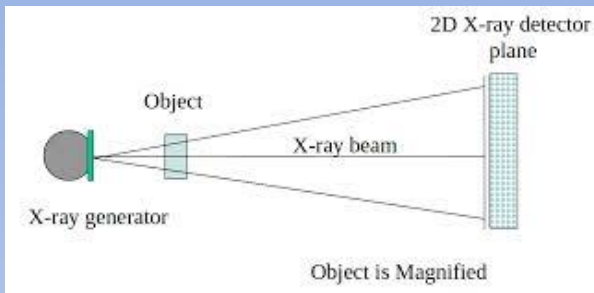
Comparative study of the X-ray diagnostic procedures safety using bacterial test-systems

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X-ray for medical imaging



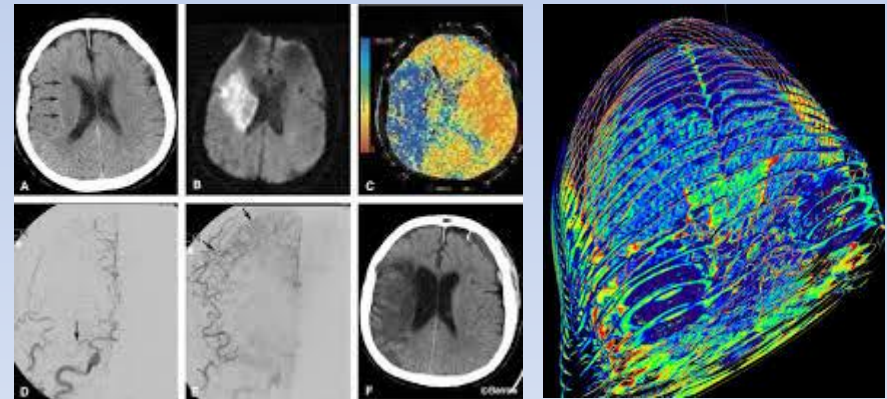
- **Radiography** : X-ray sources and film.



- **Fluoroscopy**: X-ray sources and fluorescent screen



- **Computed tomography**: X-ray and electronic sensors (flat panel detectors)



Other techniques for imaging:

Radioisotope scans

MRI scans (Magnetic resonance imaging)

(1980s)

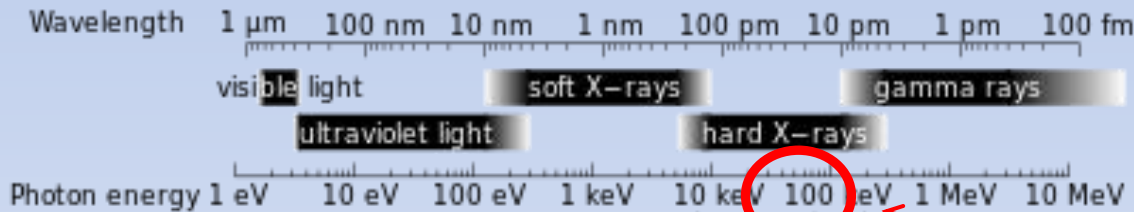
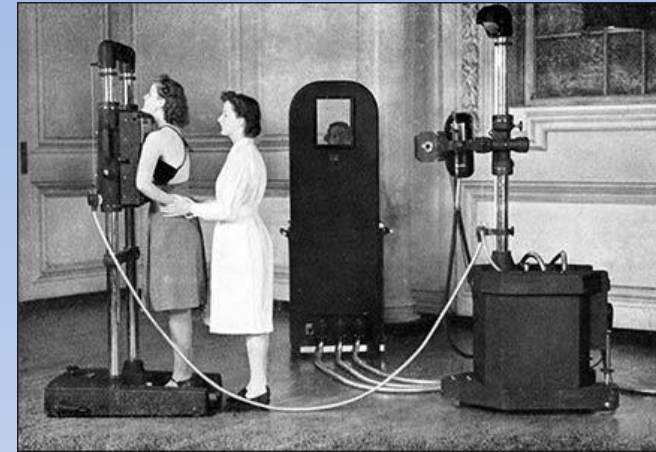
Ultrasound (1970s)

From 1960s, radiography, fluoroscopy, and CT, are all **digital imaging modes** with image analysis software and data storage and retrieval

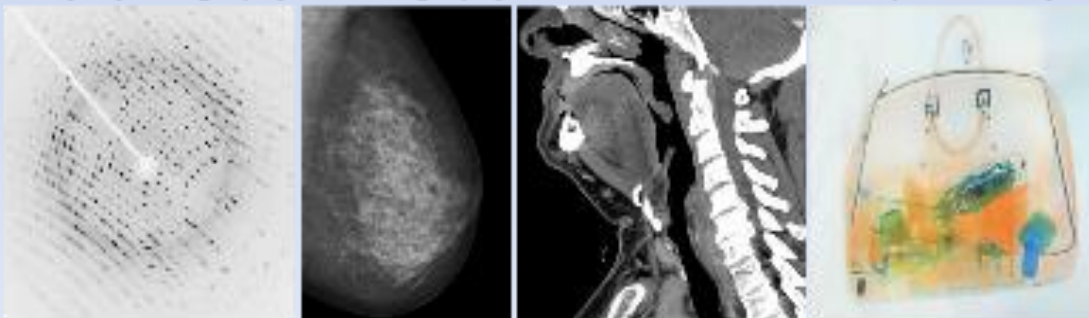
Medical application of X-ray



Radiography was put to diagnostic use very early, before the dangers of ionizing radiation were discovered



X-ray crystallography Mammography Medical CT Airport security



We are here!

Gamma rays for cancer treatment and gamma rays emission for radioisotope scan are not the subject of the report

We have tested:

Low-doses digital fluorographic device “Electron-01” (industrial series № 05325, Sankt-Petersburg, Russia)



Diagnostic stationary complex Vision (industrial series № 6070546, Villa Sistemi Medicali, Italy) with a workplace for roentgenographic studies



Computed tomograph «LightSpeed Pro32» (General Electric Medical Systems Healthcare, Germany)



I. Fluoroscopy

Table 1

Exposure mode of the biological material in the simulation study of digital fluorography of the chest in the frontal view on the device “Electron-01”

Settings			Measured parameters					ΔU , %	Radiation output, $mGy \times m^2 / mAs$
Electric potential (U), kV	Electric charge flowing for 1 sec (Q), mAs	Time (t), sec	U, kV	Dose on the sample location, (D), mGy	D', mGy/sec	t, sec	Al - layer reducing a half of radiation, mm		
100	8,1	0,016	101,4	0,672	33,06	0,02	3,77	1,4	0,085

Table 2

Estimation of effective doses for conditional patient of 19 years using the mode from Table 1

Distance “source-receiver”, m	Settings		Field size, $cm \times cm$	Radiation output, $mGy \times m^2 / mAs$	K_e , $mZv / mGy \times m_2$	Calculated effective dose, mZv
	U, kV	Q, mAs				
1,0	100	8,1	35×35	0,085	220	0,151

II. Radiography

Table 3

Mode exposure of the biological material in the simulation study of digital roentgenography of the chest in the **frontal back view** on the stationary complex “Vision” (mode 1)

Settings		Measured parameters					Dose to sample, mGy
U, kV	Q, mAs	U, kV	D, mGy	D', mGy/s	t, sec	Al-layer, mm	
77	125	78,57	7,108	22,72	0,313	3,14	7,108

Table 4

Mode exposure of the biological material in the simulation study of digital roentgenography of the chest in the **side view** on the stationary complex “Vision” (mode 2)

Settings		Measured parameters					Dose to sample, mGy
U, kV	Q, mAs	U, kV	D, mGy	D', mGy/s	t, sec	Al-layer, mm	
76	32	77,96	1,785	22,24	0,08	3,10	1,785

Toxicity of X-ray produced by tested devices

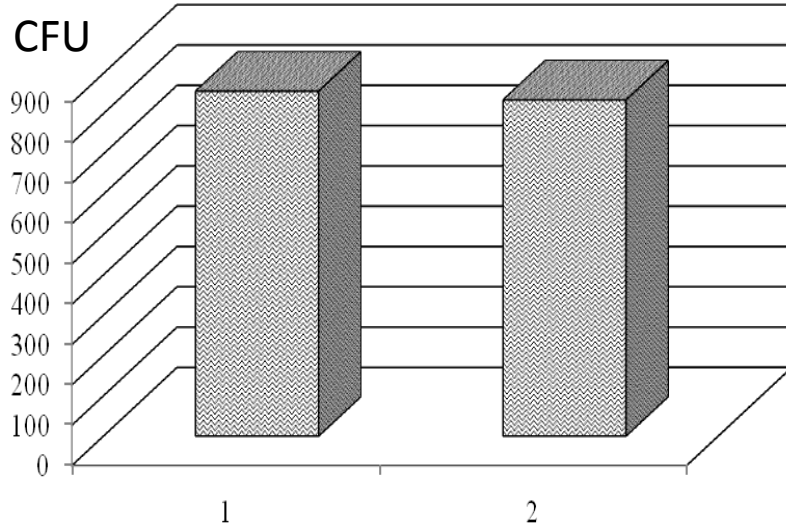


Fig.1.

Bacterial colony forming units: 1 – without radiation; 2- exposed to X-ray produced by “Electron-01”

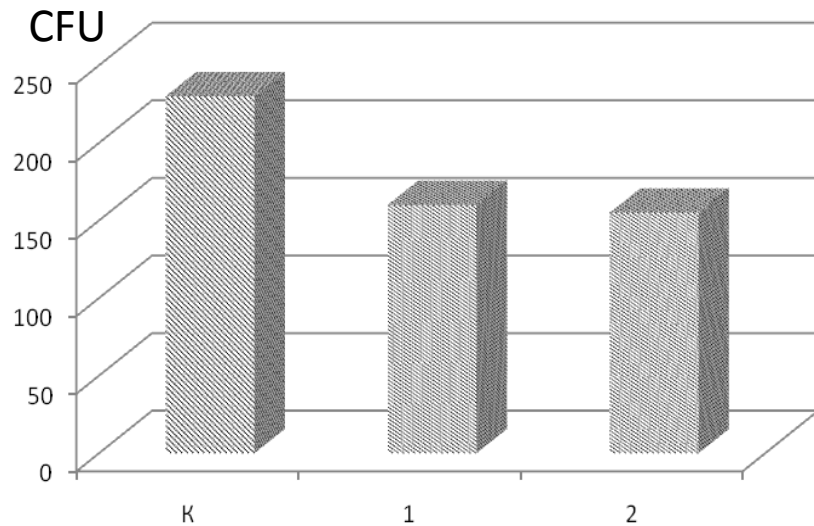


Fig.2.

Bacterial colony forming units: K – without radiation; 1- exposed to X-ray produced by stationary complex “Vision” at frontal view; 2 -by “Vision” at side view

Ames test

with *Salmonella thyphimurium* auxotrophs (his-) for detection of point mutations induced by X-ray from tested devices

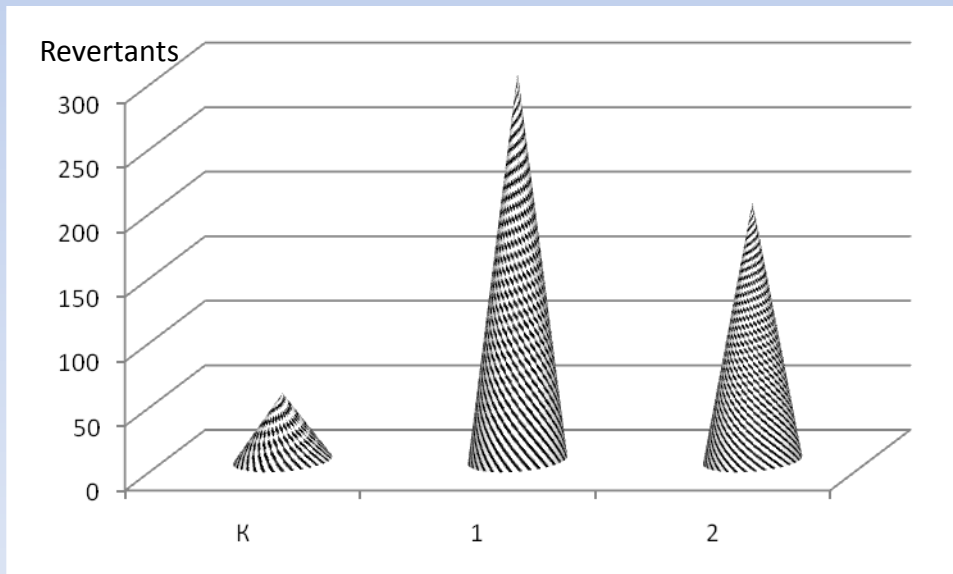
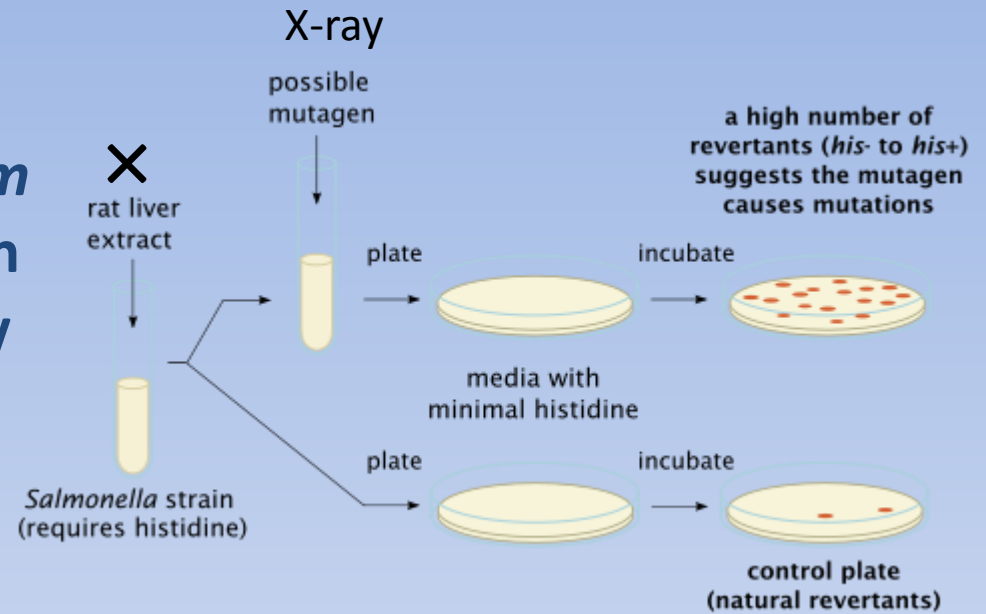


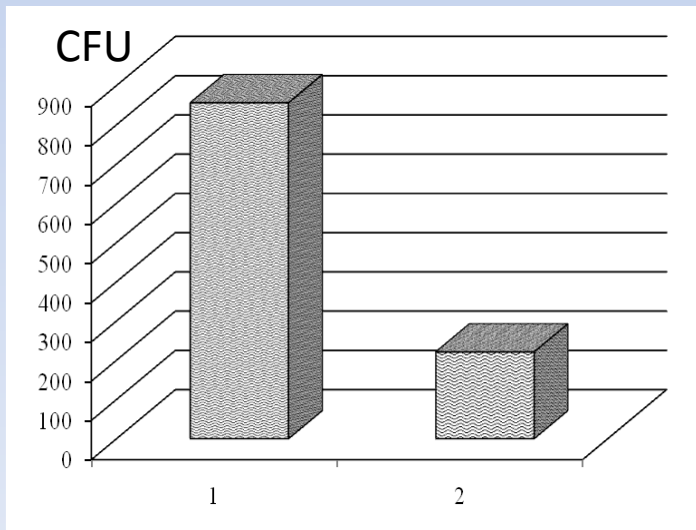
Fig.3. Revertant (his+) colonies: K – without radiation; 1- exposed to X-ray produced by stationary complex “Vision” at frontal view; 2 - by “Vision” at side view

III. Computed tomography

Table 5

Mode exposure of the biological material in the simulation study of computed tomography LightSpeed P32 (“Abdomen”)

Settings							P-f/s , mm	Detector location	Dose for 1 turn, mGy	Dose×length, mGy × cm	
Mode	U, kV	I, mA	ts, sec	t, sec	d, mm	n				calculated	total
Abdomen topogram	120	10	-	-	-	-	-	on the exposure place	0,04	0,04	
Abdomen helical	120	750	1,0	9,8	5,0	5	1,9		14,17	7,46	7,5



Toxicity of X-ray produced by LightSpeedPro32 (“Abdomen helical” mode)

Fig.4. Bacterial colony forming units: 1 – without irradiation; 2- exposed to X-ray produced by CT “LightSpeed Pro32 ” at “Abdomen helical” mode

Summary

Source of radiation	Procedure	Mode	Dose, mGy	Toxicity	Mutagenicity
“Electron-01”	Fluoroscopy	Frontal view	0,151	No	No
Stationary complex “Vision”	Radiography	Frontal back view	7,108	Yes, medium	Yes (weak)
		Side view	1,785	Yes, medium	Yes (weak)
CT “LightSpeed Pro32”	Computed tomography	Abdomen topogram	0,04	Not tested	
		Abdomen helical	14,17	Yes, high	Theoretically yes (medium)
Canadian nature	No	Life	1,8 - 4,1 in one year	No	???



Conclusion

- X-ray diagnostic procedures have toxic and mutagenic influence on bacteria, excluding procedures performed on low-dose machines for fluoroscopy
- Simple toxicity and genotoxicity tests are informative for estimation of radiological safety of different X-ray devices functioning at different modes
- Bacterial test-systems could be used for detection of some X-ray machines needed service
- Our results illustrate the need of microflora improvement by patients undergoing X-ray diagnostic, especially of abdominal organs and intestinal path

Thank you for the attention
Հնորհակալութիւնն ուշադրութեան համար
Спасибо за внимание!

