Efecto de las imágenes utilizadas en la planificación de la radioterapia

(dosis recibida por TAC de simulación y por IGRT)

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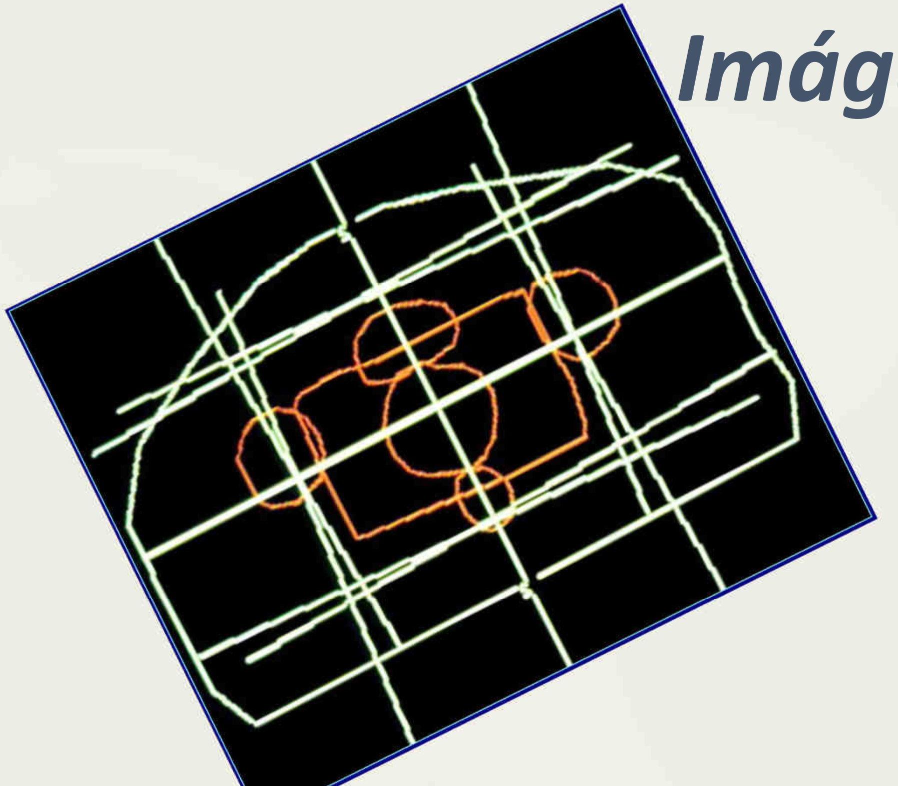
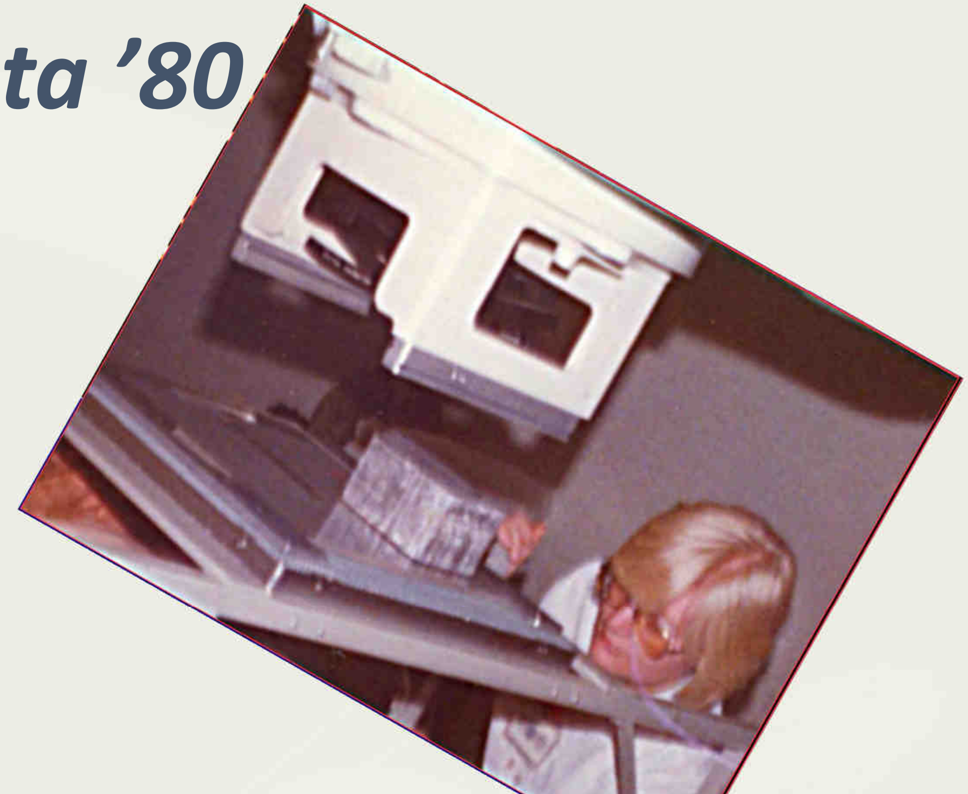
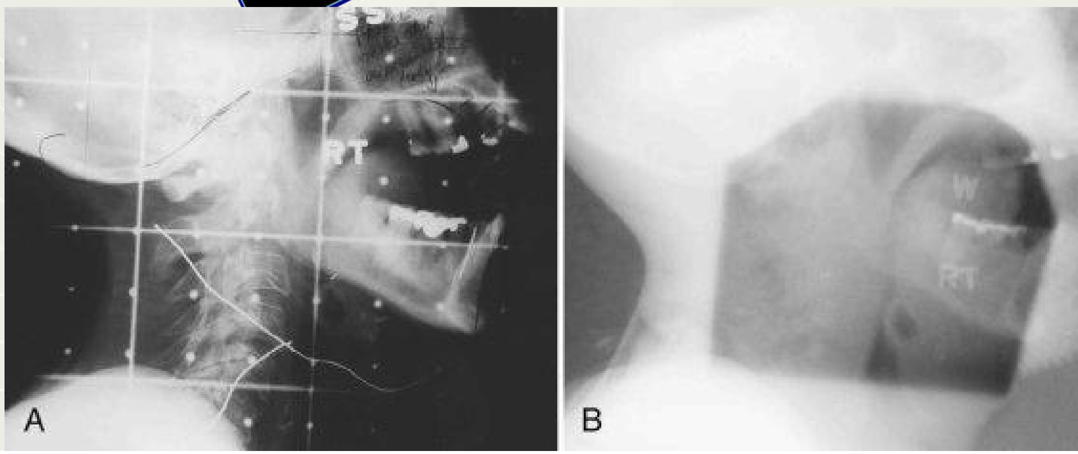
PROGRAMA DE EDUCACION CONTINUA
FUNDACIÓN MARIE CURIE 2013 - 2014

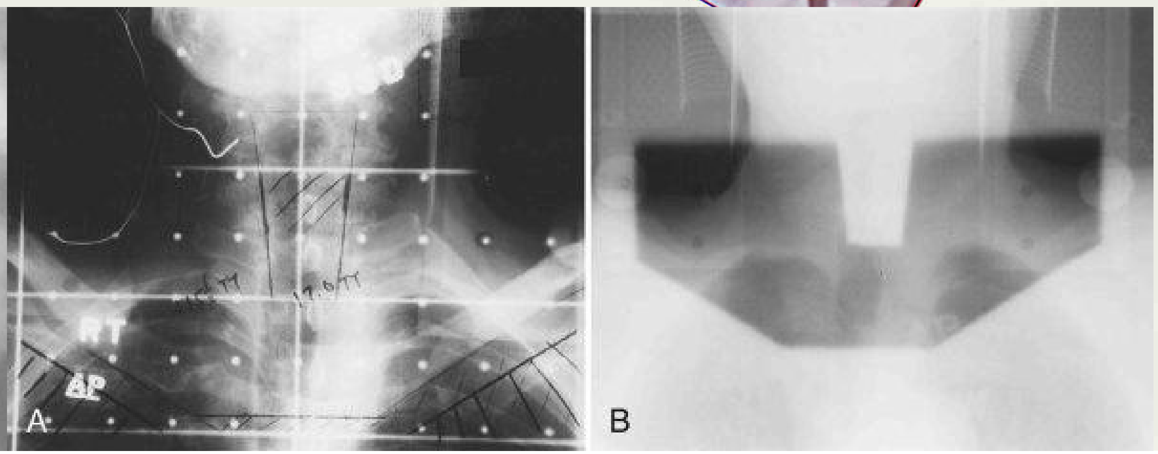
CURSO DE ACTUALIZACIÓN EN PROTECCIÓN RADIOLÓGICA

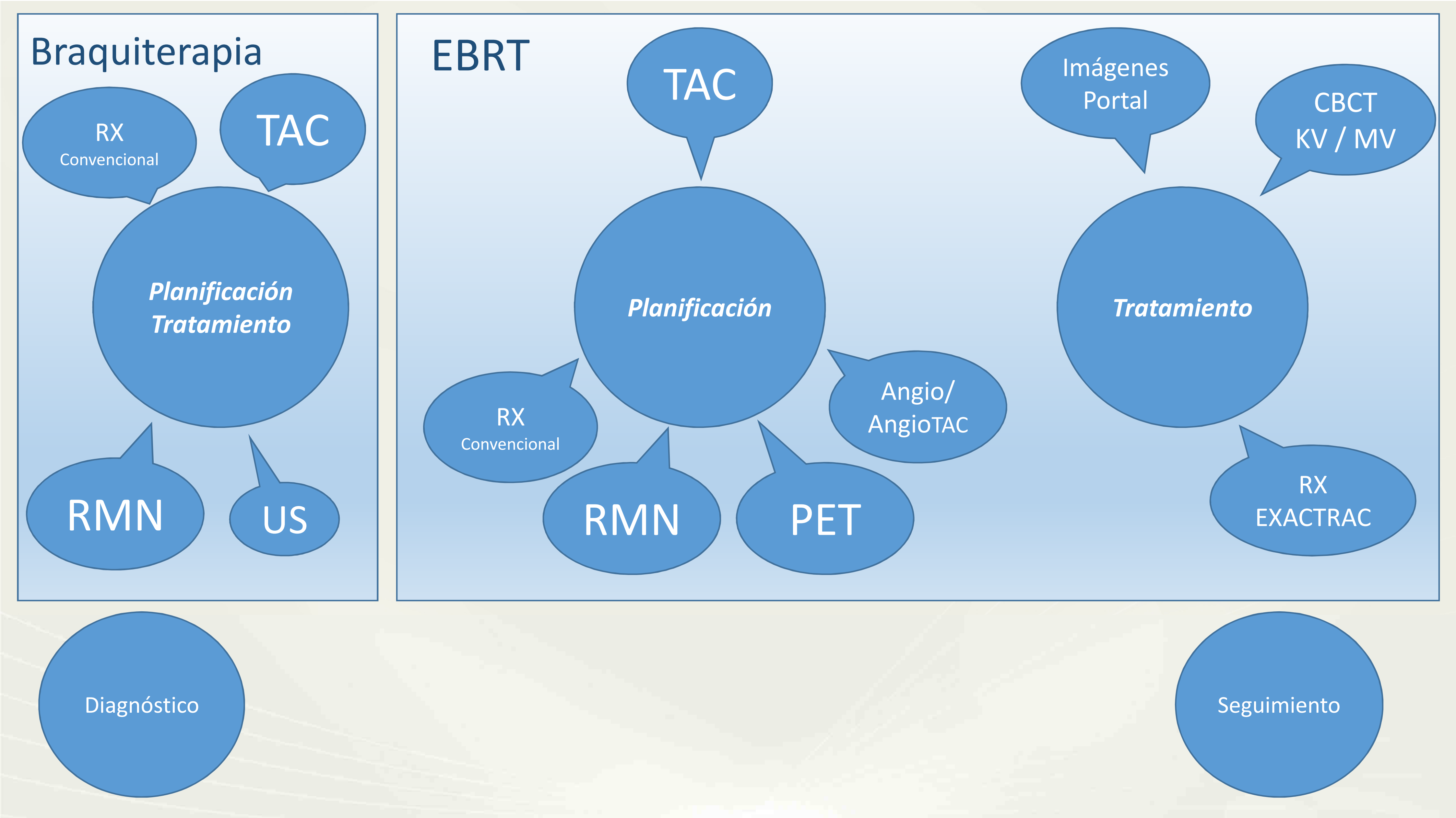
Imágenes hasta ’80











Braquiterapia
RX Convencional
TAC
Planificación Tratamiento
RMN
US
EBRT
TAC
Imágenes Portal
CBCT KV / MV
Planificación
Tratamiento
RX Convencional
Angio/ AngioTAC
RMN
PET
RX EXACTRAC
Diagnóstico
Seguimiento

Cancer Statistics, 2012

Rebecca Siegel, MPH[1]; Deepa Naishadham, MA, MS[2]; Ahmedin Jemal, DVM, PhD[3]

Abstract

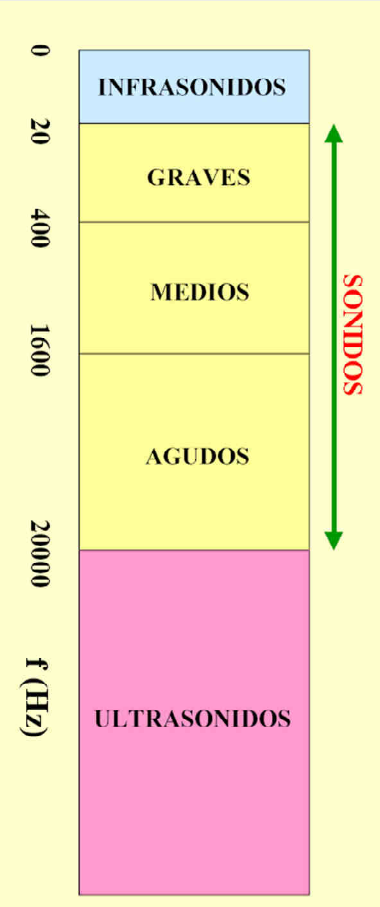
Each year, the American Cancer Society estimates the numbers of new cancer cases and deaths expected in the United States in the current year a… based on incidence data from the … the North American Association of … Statistics. A total of 1,638,910 new … United States in 2012. During the most recent 5 years for which there are data (2004-2008), overall cancer inci- … n women, while cancer death rates … ast 10 years of available data (1999- … women of every racial/ethnic group … ave remained stable. The most rapid … .4% and 2.3% per year, respectively). Death rates continue to decline for all 4 major cancer sites (lung, colorectum, breast, and prostate), with lung cancer accounting for almost 40% of the total decline in men and breast cancer accounting for 34% of the total decline in women. The reduction in overall cancer death rates since 1990 in men and 1991 in women translates to the avoidance of about 1,024,400 deaths from cancer. Further progress can be accelerated by applying existing cancer control knowledge across all segmen… nomic bracket. CA Cancer J Clin 20…

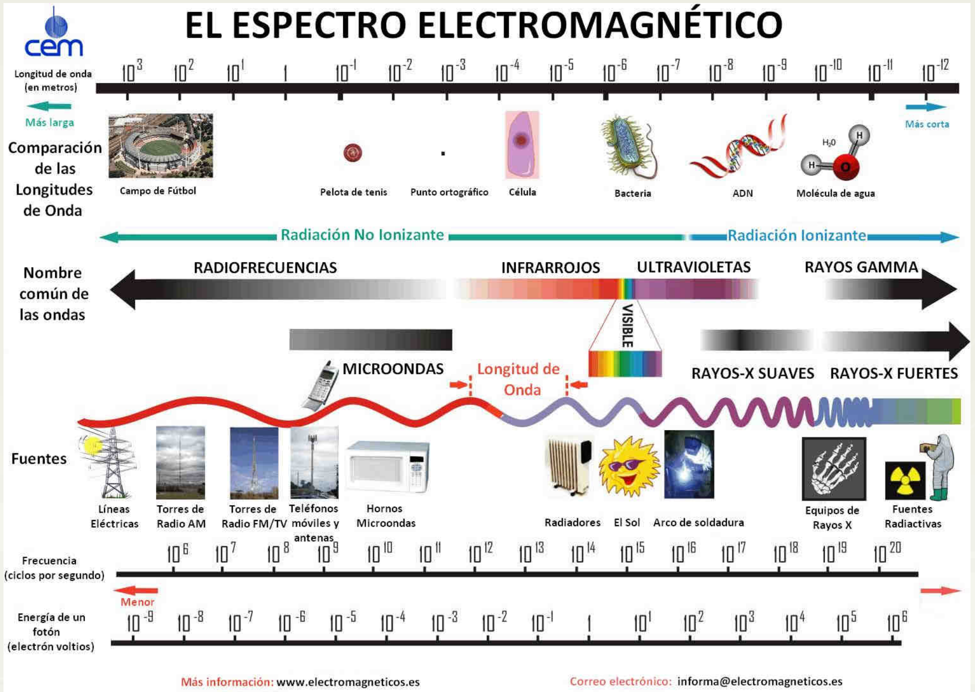
…1.638.910 nuevos casos de cáncer y 577.190 muertes son proyectadas en 2012 (USA)…

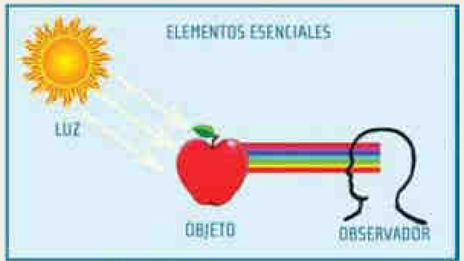
… durante (2004-2008) la incidencia de cáncer disminuyo levemente, mientras la tasa de muerte por cáncer disminuyo 1.8% en hombres y 1.6% en mujeres…

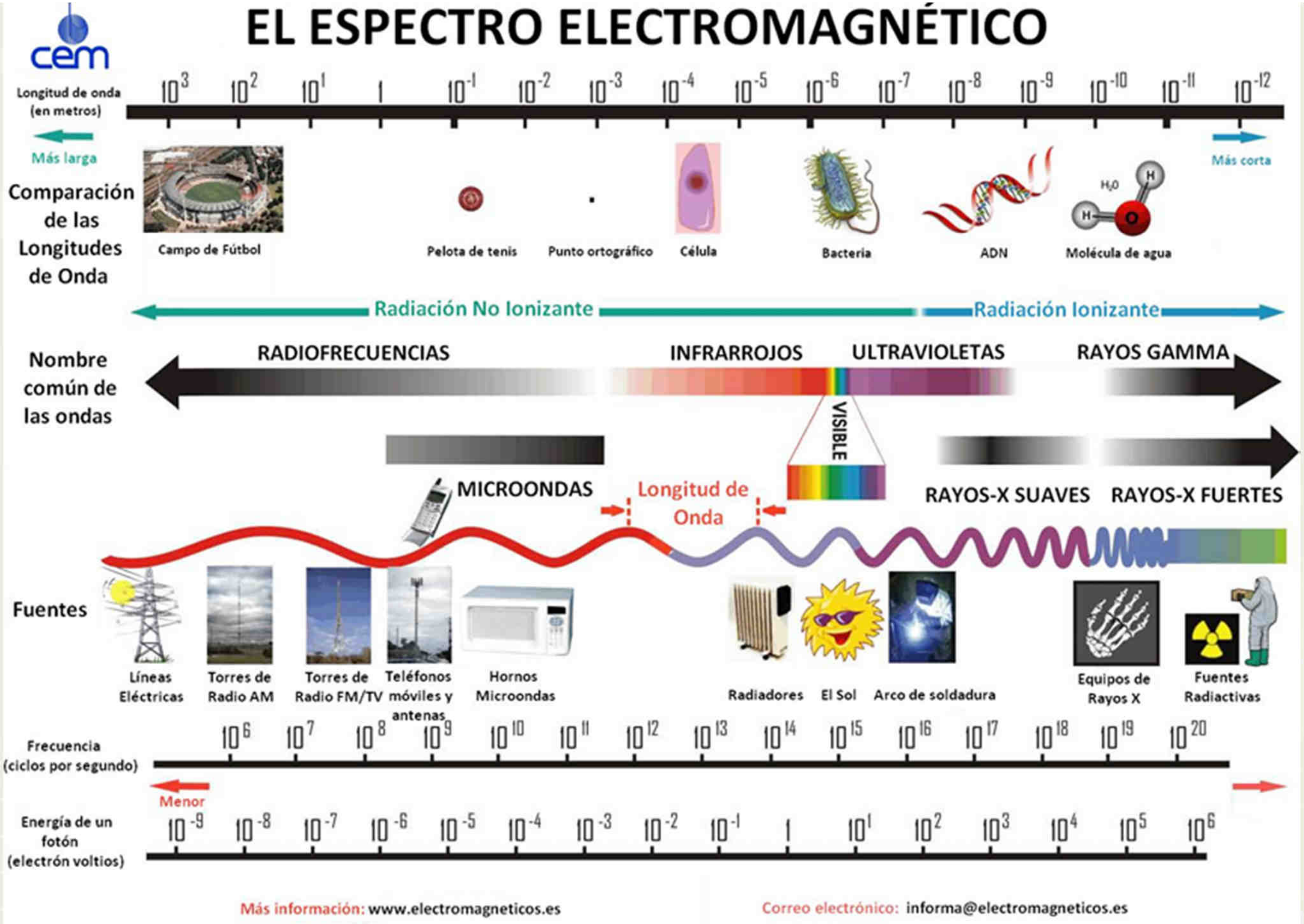
… la reducción en la mortalidad desde 1990 evitó **1.024.400** muertes por cáncer…progresos pueden ser acelerados…

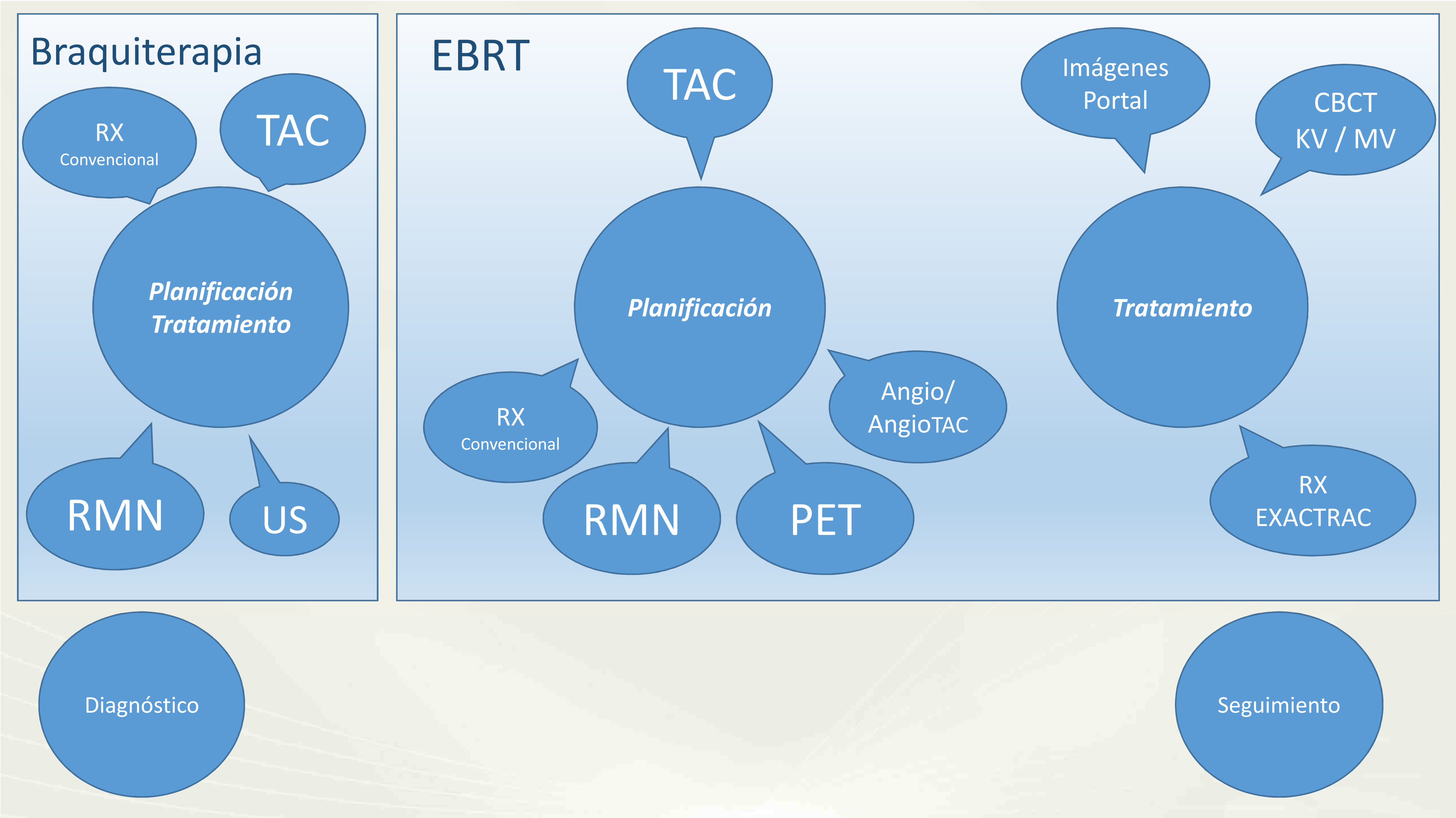
GENERACION DE LA IMAGEN








EL ESPECTRO ELECTROMAGNÉTICO
cem
Longitud de onda (en metros)
10^{3} 10^{2} 10^{1} 1 10^{-1} 10^{-2} 10^{-3} 10^{-4} 10^{-5} 10^{-6} 10^{-7} 10^{-8} 10^{-9} 10^{-10} 10^{-11} 10^{-12}
Más larga
Más corta
Comparación de las Longitudes de Onda
Campo de Fútbol
Pelota de tenis
Punto ortográfico
Célula
Bacteria
ADN
H_2O
Molécula de agua
Radiación No Ionizante
Radiación Ionizante
Nombre común de las ondas
RADIOFRECUENCIAS
INFRARROJOS
ULTRAVIOLETAS
RAYOS GAMMA
VISIBLE
MICROONDAS
Longitud de Onda
RAYOS-X SUAVES
RAYOS-X FUERTES
Fuentes
Líneas Eléctricas
Torres de Radio AM
Torres de Radio FM/TV
Teléfonos móviles y antenas
Hornos Microondas
Radiadores
El Sol
Arco de soldadura
Equipos de Rayos X
Fuentes Radiactivas
Frecuencia (ciclos por segundo)
10^{6} 10^{7} 10^{8} 10^{9} 10^{10} 10^{11} 10^{12} 10^{13} 10^{14} 10^{15} 10^{16} 10^{17} 10^{18} 10^{19} 10^{20}
Menor
Energía de un fotón (electrón voltios)
10^{-9} 10^{-8} 10^{-7} 10^{-6} 10^{-5} 10^{-4} 10^{-3} 10^{-2} 10^{-1} 1 10^{1} 10^{2} 10^{3} 10^{4} 10^{5} 10^{6}
Más información: www.electromagneticos.es
Correo electrónico: informa@electromagneticos.es


Braquiterapia
RX Convencional
TAC
Planificación Tratamiento
RMN
US
EBRT
TAC
Planificación
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PET
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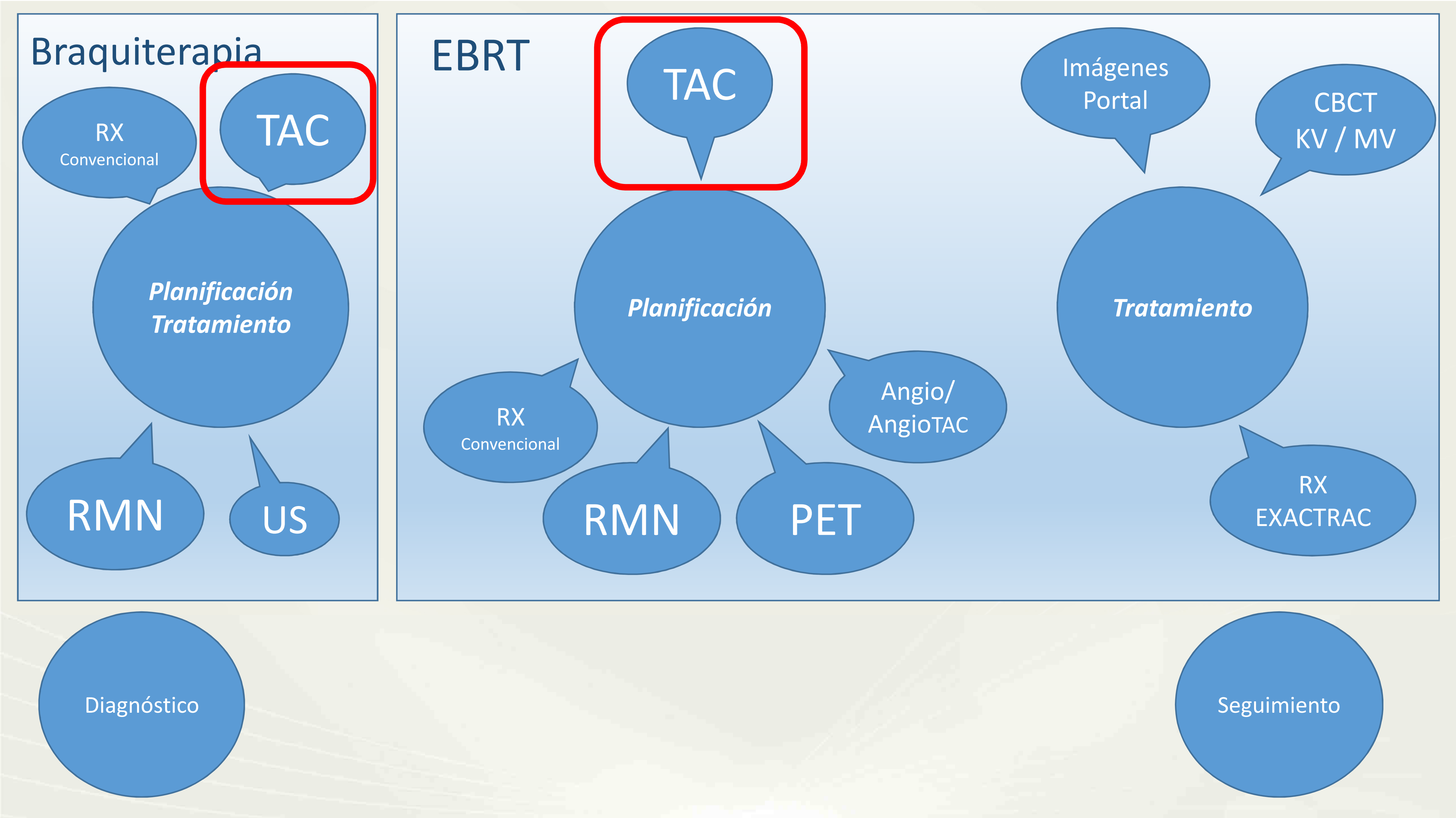
Braquiterapia
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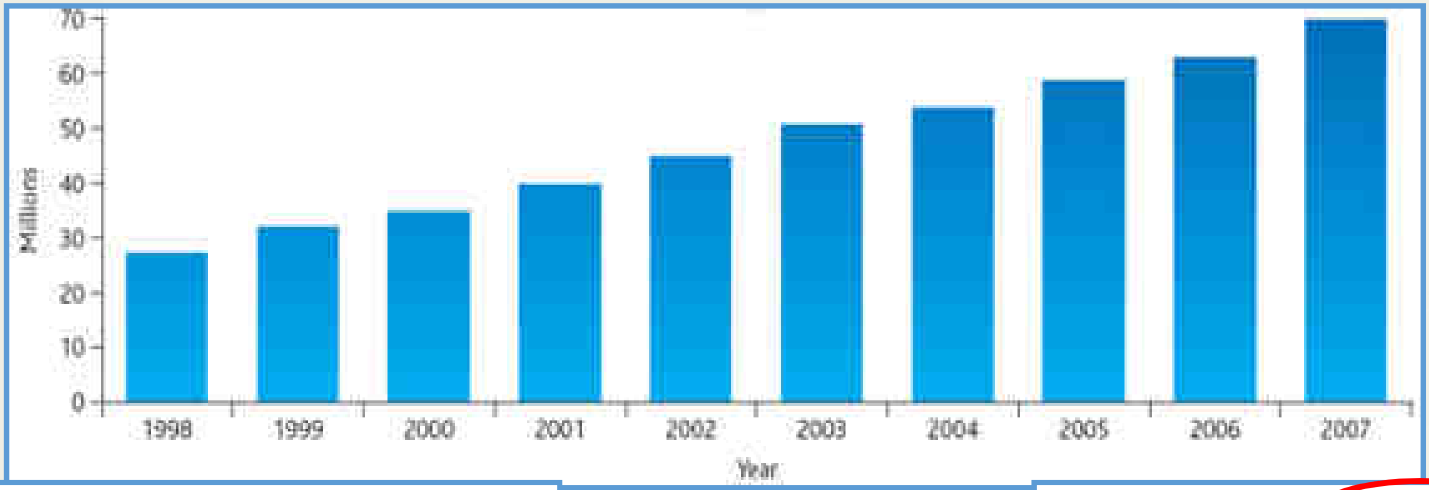
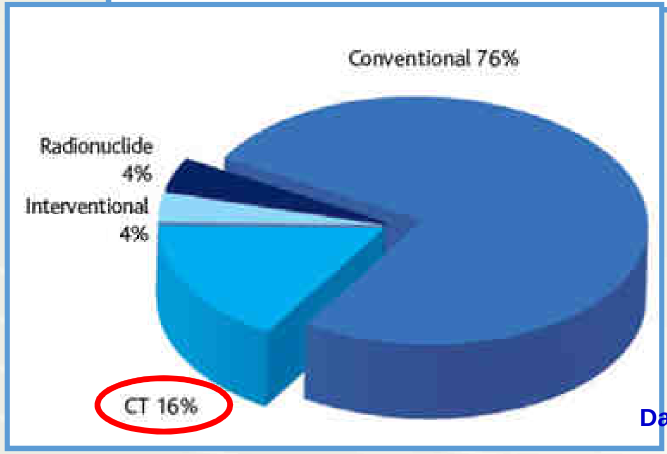
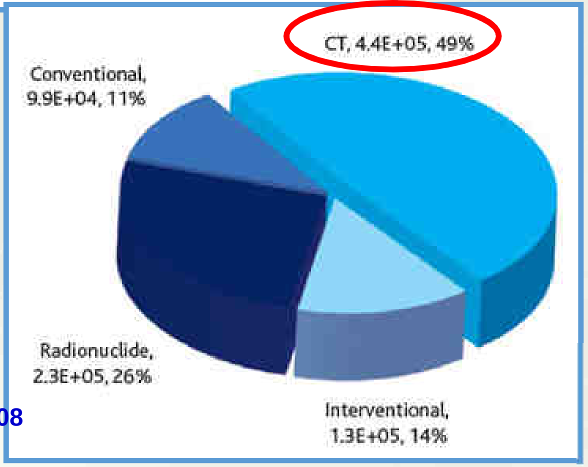
AngioTAC
RMN
PET
RX
EXACTRAC
Diagnóstico
Seguimiento

Dosis entregada a la población debido a estudios de TAC
(2007 USA)





David Sutton, C2I2, Volume VI, Issue 2, 2008



- Nueva Generación de escaner
- TAC helicoidal, fan o cone beam (MDCT)
- Nuevas técnicas de perfusion (mesa fija o con mov combinado)

Dosis ➤➤ → Accidentes

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Parámetros de dosimetría

- **CTDI =** Computed Tomography Dose Index en mGy
- **MSAD =** Multiple scan Average Dose en mGy
- **DLP =** Dose Length Product en mGy.cm

CTDI y MSAD → Dosis a los órganos

DLP → Estimación del riesgo

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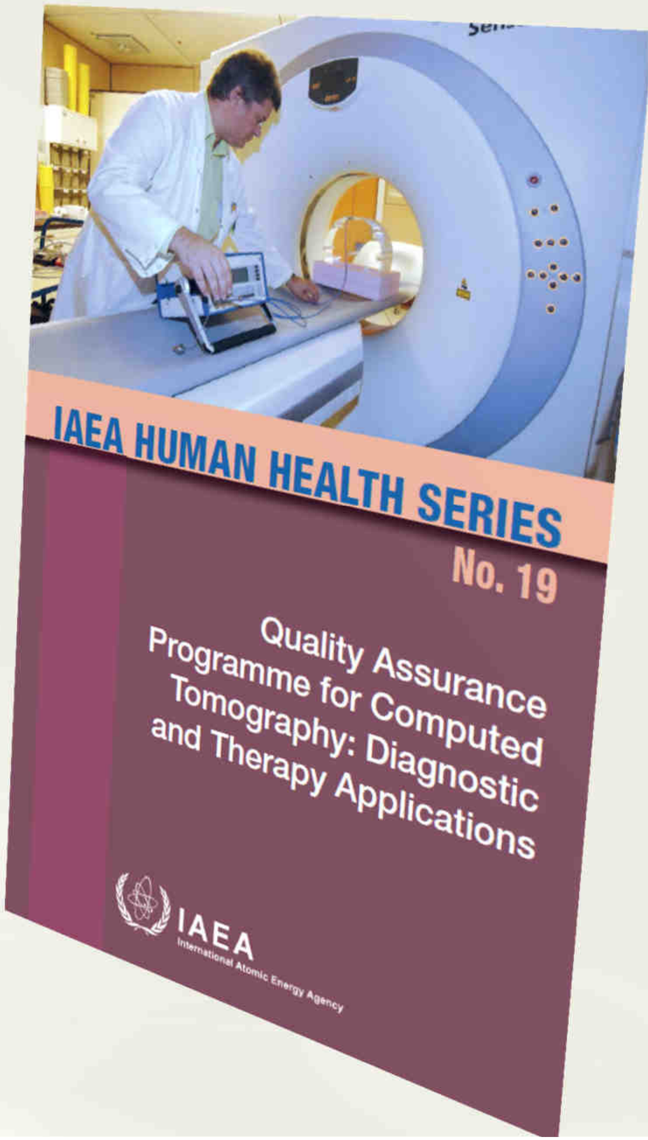
TABLE 1. COMPARISON OF IAEA AND IEC DOSIMETRY TERMINOLOGY USED IN CT

Quantity	IAEA	IEC
Measured free-in-air:		
CT air kerma index	$C_{a,100} = \frac{1}{NT}\int_{-50}^{+50} K(z)\,dz$	$CTDI_{air} = 1/NT \int_{-\infty}^{+\infty} K_a(z)\,dz$
Measured in standard phantom:		
Weighted CT air kerma index	$C_w = \frac{1}{3}\left(C_{PMMA,100,c} + 2\ C_{PMMA,100,p}\right)$	$CTDI_w = 1/3\ CTDI_{100,c} + 2/3\ CTDI_{100,p}$
Normalized weighted CT air kerma index	${}_nC_w$	${}_nCTDI_w$
Volume CT air kerma index	C_{VOL}	$CTDI_{VOL}$
CT air kerma–length product	$P_{KL,CT} = \sum_j {}_nC_{VOL_j} l_j P_{It_j}$	$DLP = CTDI_{VOL}\ L$



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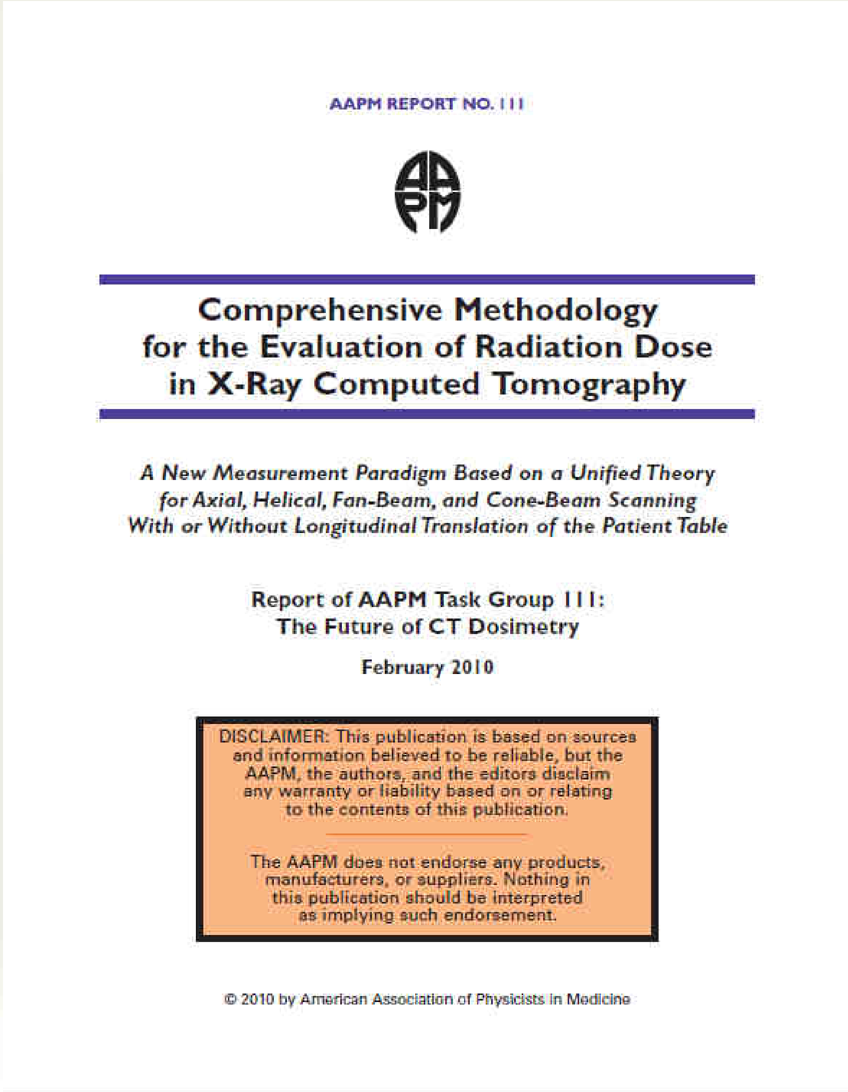
- Cámara de ionización de pequeño volumen
- Fantoma grande para asegurar equilibrio
- Aplicable a todas las técnicas actuales (axial, helicoidal, cone o fan beam, con o sin traslación de mesa



AAPM REPORT NO. 111

Comprehensive Methodology for the Evaluation of Radiation Dose in X-Ray Computed Tomography

A New Measurement Paradigm Based on a Unified Theory for Axial, Helical, Fan-Beam, and Cone-Beam Scanning With or Without Longitudinal Translation of the Patient Table

Report of AAPM Task Group 111: The Future of CT Dosimetry

February 2010

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JOURNAL OF APPLIED CLINICAL MEDICAL PHYSICS, VOLUME 13, NUMBER 6, 2012

Measurements of the dose delivered during CT exams using AAPM Task Group Report No. 111

C. Descamps,[1a] M. Gonzalez,[1] E. Garrigo,[1] A. Germanier,[2] D. Venencia[1]
Instituto de Radioterapia – Fundación Marie Curie,[1] Córdoba, Argentina; CEPROCOR,[2] Córdoba, Argentina
cdescamps@radioncologia-zunino.org

Received 10 February, 2012; accepted 26 June, 2012

Se propuso seguir la recomendacion de AAPM para evaluar la dosis entregada durante los examenes de TAC mas comunmente utilizados y compararlos con lo informado por el TAC (CTDI)

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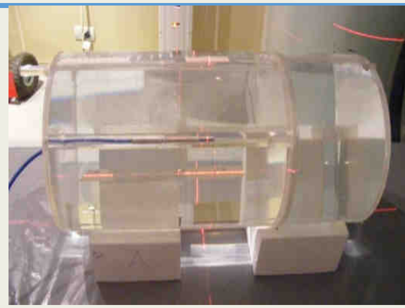
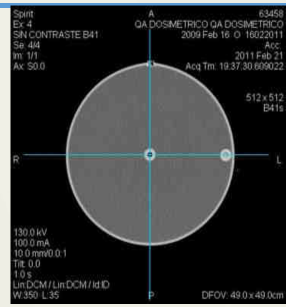
Materiales y Método

PTW 30013
(Farmer)

Electrometro PTW
Unidos E





Fantoma 60cm Long 30cm diam

Siemens SOMATOM Spirit Power
2-slice CT scanner

TLD100 (rods)
TLD Reader 4000 (Harshaw)
GCA-New v3.0

Materiales y Método

Protocolo	Mode	KV	mA	Rotacion de tubo [s]	Cortes	Corte reconstruido
Referencia	Axial	130	100	1	2 of 5mm	10 mm
Mama	Helical (pitch1)	130	100	1	2 of 5 mm	10 mm
Prostata	Axial	130	100	1	2 of 1.5mm	3mm
Axial 5 mm	Axial	130	100	1	2 of 2.5	5mm

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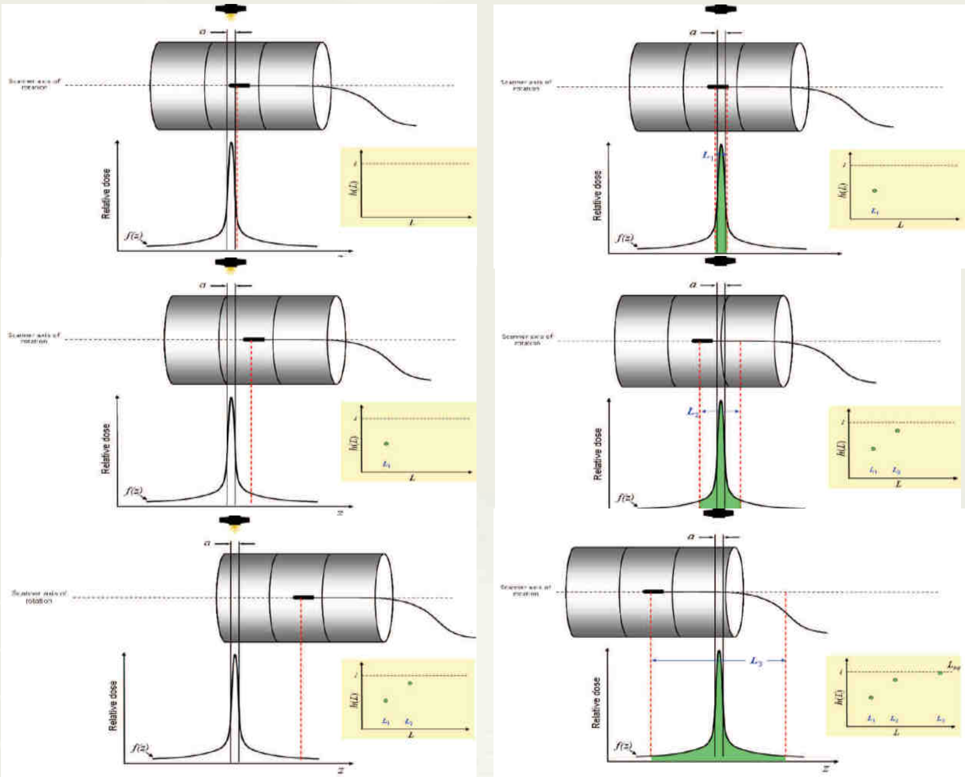
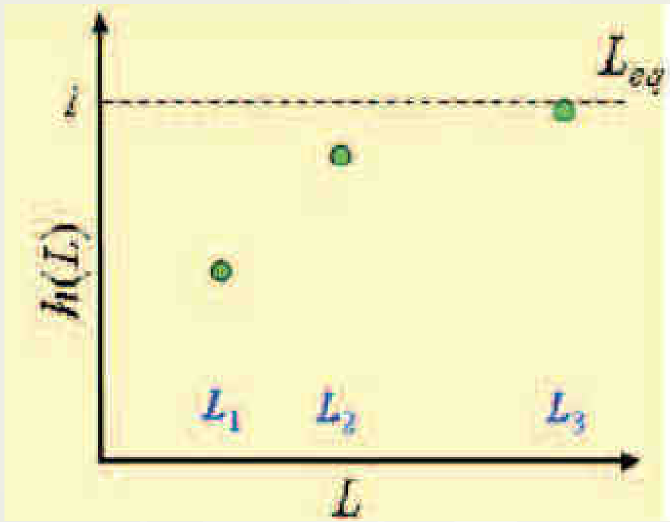
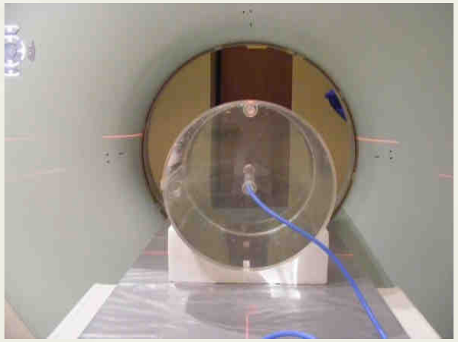
Materiales y Método





Desde L=50 mm to L=Longitud del fantoma menos nT

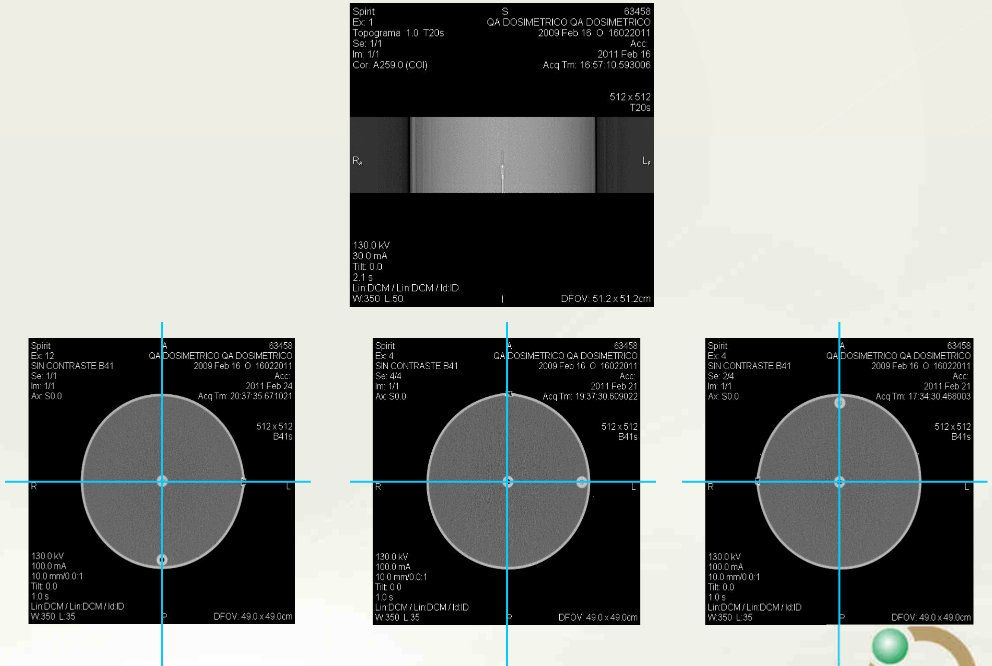
Resultados



Posición Central

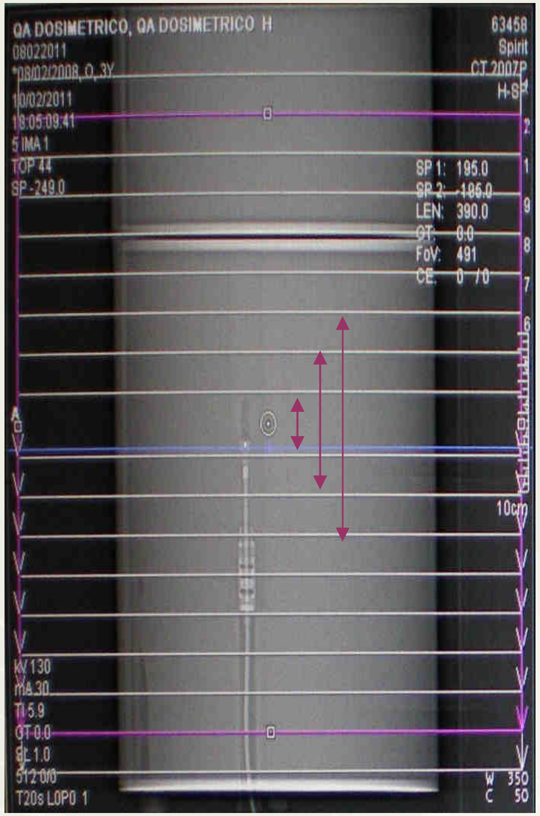
Posición Periferica

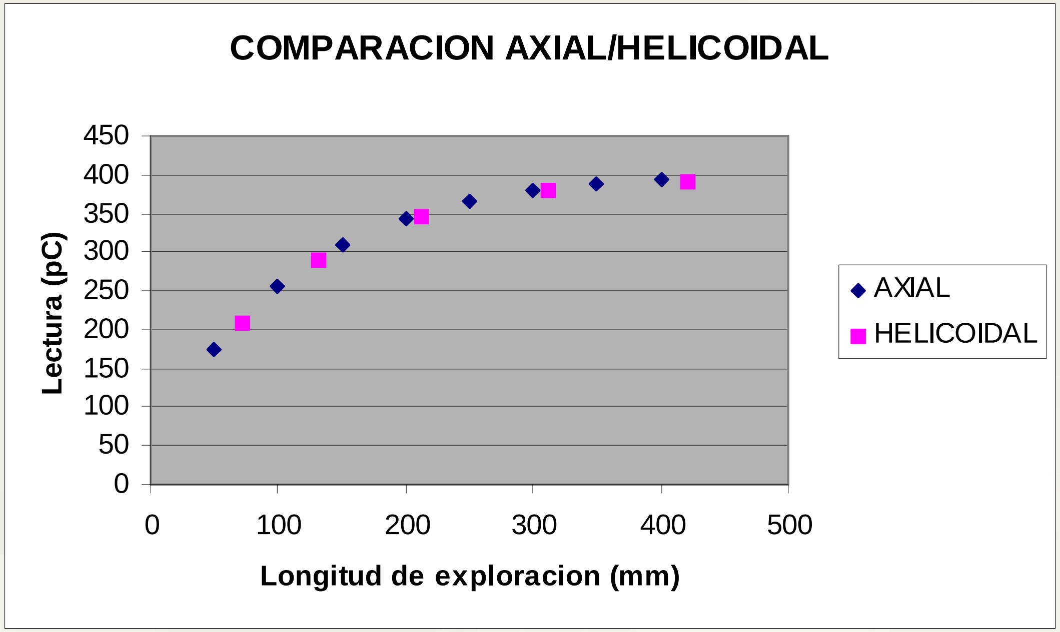
Repetibilidad : 0.44%



Resultados

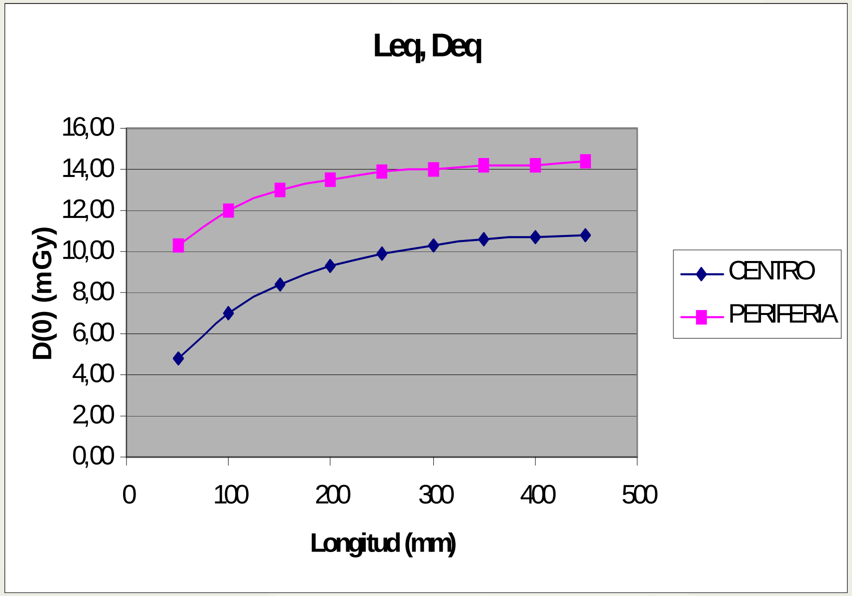
Comparación de modos de escaneo





Resultados

Dosis de equilibrio, periferica y central



$$D_L(z=0) = h(L)D_{eq}$$

$$h(L) \approx (1-\alpha) + \alpha\left[1-\exp\left(-4L/L_{eq}\right)\right] = 1-\alpha\exp\left(-4L/L_{eq}\right).$$

Primaria | Dispersa

Centro

D_{eq}=11.0 mGy

α =0,88

L_{eq}=450 mm

PERIFERIA

D_{eq}=14,4 mGy

α =0,47

L_{eq}=380 mm

Resultados

Calibración TLDs (TRS277)

Cámara Farmer N_k= 47,90 mGy/nC HVL = 0,23 mm Cu $(\mu en/\rho)_{w,air}$= 1,032

$D_{eq,c}$: TLDs vs Farmer Chamber

Dosímetro	Dosis [mGy]
TLD	12.4
Chamber	12.3
Dif[%]	*0.89*

D(0): comparación TLDs y cámara Farmer

Protocolo	Mama	Prostata	Axial 5 mm
Camara Farmer [mGy]	10.8	10.8	10.9
TLD [mGy]	10.4	10.7	10.9
Dif[%]	*3.4*	*0.6*	*0.3*

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Resultados

Dosis de equilibrio(mGy) acumulada en la posicion z =0

$$D(0)= ½\, D_c + ½\, D_p \qquad (D_{eq} \propto r^2)$$

Comparación con CTDIvol reportado por el TAC

Protocolo	Mama	Prostata	Axial 5 mm
CTDI vol [mGy]	9.1	9.3	9.3
Deq [mGy]	12.3	12.3	12.5
Dif[%]	***29.9***	***27.9***	***29.0***

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Programa de cálculo

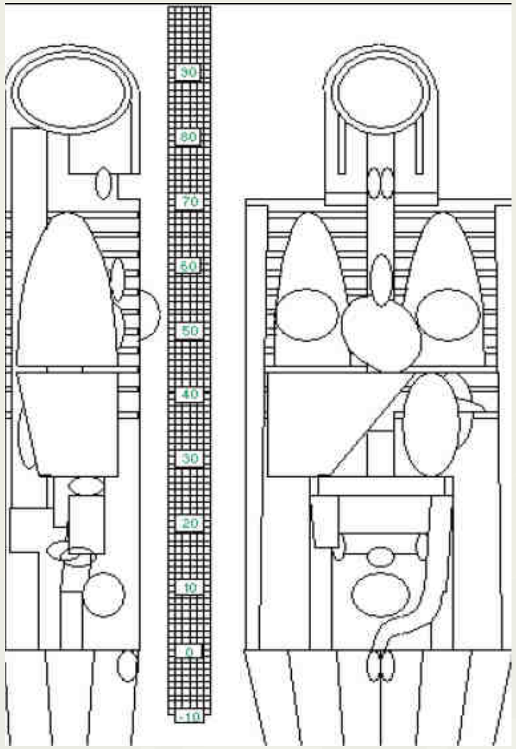
Freeware

CT Dose 1.0.1
http://www.mta.au.dk/ctdose/index.htm (2008-04-26)
Dose calculations for CT-exams (last update 2003-11-11)

Omni mAs
http://omnimas.arwen.se/ (2008-04-26)
Calculation of mAs settings for different patient diameters
Effective dose via conversion factors for DLP

D2ED (Palm)
http://www.mh-hannover.de/1604.html
Estimation of patient exposure using conversion factors (DAP, CTDI and DLP)

QuickDose (Windows Mobile 6)
http://www.mh-hannover.de/1604.html
Estimation of patient exposure using conversion factors (DAP, CTDI and DLP)



- Fantoma antropomórfico
- Párametros de entrada
- Ej. : CTDose, WinDose
- ***Monte-Carlo***

Medical Physics

The International Journal of Medical Physics Research and Practice

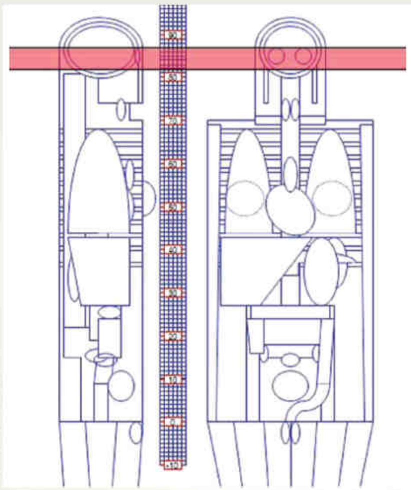
Estimating peak skin and eye lens dose from neuroperfusion examinations: Use of Monte Carlo based simulations and comparisons to CTDIvol, AAPM Report No. 111, and ImPACT dosimetry tool values

Di Zhang, Chris H. Cagnon, J. Pablo Villablanca, Cynthia H. McCollough, Dianna D. Cody, Maria Zankl, John Demarco, and Michael F. McNitt-Gray

Citation: Medical Physics **40**, 091901 (2013); doi: 10.1118/1.4816652
View online: http://dx.doi.org/10.1118/1.4816652
View Table of Contents: http://scitation.aip.org/content/aapm/journal/medphys/40/9?ver=pdfcov
Published by the American Association of Physicists in Medicine

M Y M

- 4 MDCT
- Estudios de Perfusión cerebral
- 4 Fantomas cerebro
- Varios KV – 100 mAs
- Dosis en piel y cristalino
  - MC
  - CTDI
  - AAPM 111
  - ImPACT



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Medical Physics
The International Journal of Medical Physics Research and Practice

Estimating peak skin and eye lens dose from neuroperfusion examinations: Use of Monte Carlo based simulations and comparisons to CTDIvol, AAPM Report No. 111, and ImPACT dosimetry tool values

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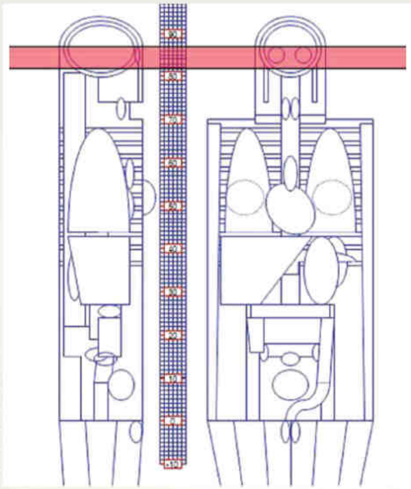
View Table of Contents: http://scitation.aip.org/content/aapm/journal/medphys/40/9?ver=pdfcov
Published by the American Association of Physicists in Medicine

Conclusion

CTDI e ImPACT, sobreestiman 40-60%
AAPM 111 mejor predictor

CTDI, Software, AAPM 111. Solo índices predictores (no dosis real)



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AAPM Report No. 204

Size-Specific Dose Estimates (SSDE) in Pediatric and Adult Body CT Examinations

Report of AAPM Task Group 204, developed in collaboration with the International Commission on Radiation Units and Measurements (ICRU) and the Image Gently campaign of the Alliance for Radiation Safety in Pediatric Imaging

ICRU

image gently℠

Fantoma 16cm o 32cm

$$CTDI_w = \frac{1}{3} CTDI_{100}^{center} + \frac{2}{3} CTDI_{100}^{periphery} .$$

$$CTDI_{vol} = \frac{CTDI_w}{pitch} ,$$

Fantoma llevado a “paciente”

$$size\ specific\ dose\ estimate = SSDE = f_{size}^{32X} \times CTDI_{vol}^{32} ,$$

for the 32 cm diameter $CTDI_{vol}$ reference phantom, and

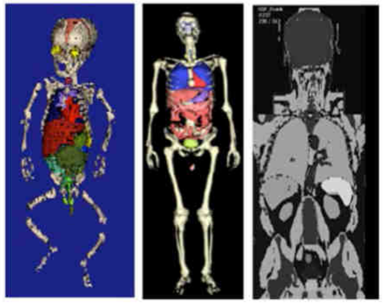
$$size\ specific\ dose\ estimate = SSDE = f_{size}^{16X} \times CTDI_{vol}^{16}$$

for the 16 cm diameter $CTDI_{vol}$ reference phantom.

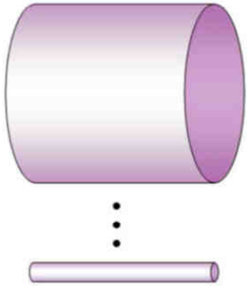
The various tools used by the four independent research groups are illustrated Figure 3.

A. Physical Anthropomorphic Phantoms
(McCollough and collaborators, Mc)

B. Cylindrical PMMA phantoms
(Toth and Strauss, TS)



C. Monte Carlo Voxelized Phantoms
(McNitt-Gray and collaborators, MG)



D. Monte Carlo Mathematical Cylinders
(Boone and collaborators, ZB)

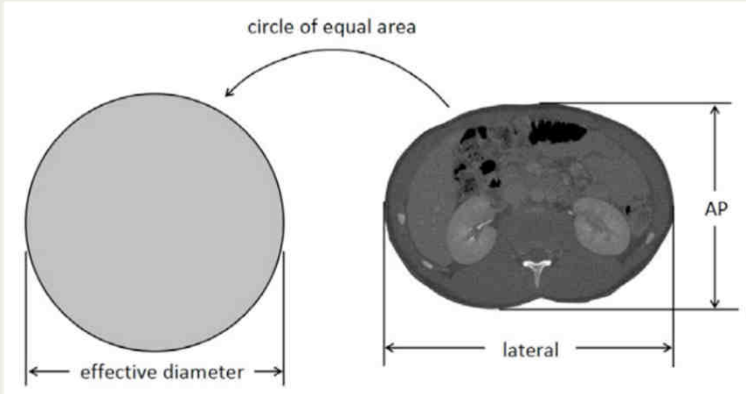


Table 1A

Lat+AP Dim (cm)	Effective Dia (cm)	Conversion Factor
16	7.7	2.79
18	8.7	2.69
20	9.7	2.59
22	10.7	2.50
24	11.7	2.41
26	12.7	2.32
28	13.7	2.24
30	14.7	2.16
32	15.7	2.08
34	16.7	2.01
36	17.6	1.94
38	18.6	1.87
40	19.6	1.80
42	20.6	1.74
44	21.6	1.67
46	22.6	1.62
48	23.6	1.56
50	24.6	1.50
52	25.6	1.45
54	26.6	1.40
56	27.6	1.35
58	28.6	1.30
60	29.6	1.25
62	30.5	1.21
64	31.5	1.16
66	32.5	1.12
68	33.5	1.08

Table 1B

Lateral Dim (cm)	Effective Dia (cm)	Conversion Factor
8	9.2	2.65
9	9.7	2.60
10	10.2	2.55
11	10.7	2.50
12	11.3	2.45
13	11.8	2.40
14	12.4	2.35
15	13.1	2.29
16	13.7	2.24
17	14.3	2.19
18	15.0	2.13
19	15.7	2.08
20	16.4	2.03
21	17.2	1.97
22	17.9	1.92
23	18.7	1.86
24	19.5	1.81
25	20.3	1.76
26	21.1	1.70
27	22.0	1.65
28	22.9	1.60
29	23.8	1.55
30	24.7	1.50
31	25.6	1.45
32	26.6	1.40
33	27.6	1.35
34	28.6	1.30

Table 1C

AP Dim (cm)	Effective Dia (cm)	Conversion Factor
8	8.8	2.68
9	10.2	2.55
10	11.6	2.42
11	13.0	2.30
12	14.4	2.18
13	15.7	2.08
14	17.0	1.98
15	18.3	1.89
16	19.6	1.81
17	20.8	1.73
18	22.0	1.65
19	23.2	1.58
20	24.3	1.52
21	25.5	1.45
22	26.6	1.40
23	27.6	1.34
24	28.7	1.29
25	29.7	1.25
26	30.7	1.20
27	31.6	1.16
28	32.6	1.12
29	33.5	1.08
30	34.4	1.05
31	35.2	1.02
32	36.0	0.99
33	36.8	0.96
34	37.6	0.93

Table 1D

Effective Dia (cm)	Conversion Factor
8	2.76
9	2.66
10	2.57
11	2.47
12	2.38
13	2.30
14	2.22
15	2.14
16	2.06
17	1.98
18	1.91
19	1.84
20	1.78
21	1.71
22	1.65
23	1.59
24	1.53
25	1.48
26	1.43
27	1.37
28	1.32
29	1.28
30	1.23
31	1.19
32	1.14
33	1.10
34	1.06

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Conclusion

- Debemos conocer que dosis estamos entregando en para cada protocolo.
- Recordar: Justificación de la práctica, Optimización (ALARA), Límites de Dosis
- AAPM 111 parece ser mejor **índice predictor** que CTDI y programas
- CTDI "standard". AAPM 204 1er intento para dosis "real"
- MC el ideal
- Futuro TAC ->E?

MUCHAS GRACIAS