PATIENT SPECIFIC CARCINOGENIC RISKS IN CT

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PATIENT RADIATION

“DOSE PROBLEM”
$\text{CTDI}_{\text{vol}}$ 15 mGy

DLP 500 mGy-cm
Effective dose $\sim 10$ mSv

Impact Phantom’s “Dose” [not Lennon’s]
10 mSv + ICRP risk factors

~ 0.04% cancer fatality

~ 0.06% detriment

~ 0.1% cancer induction

[not Lennon’s]
Don’t “Need” or “Use” Risks

My father was a radiologist and assures me that radiation is NOT hazardous

[not (even) Lennon’s]
PURPOSE

Patient Specific Doses Possible

Can Get Patient Specific Risks

Do Need Patient Risks
PATIENT SPECIFIC DOSES
At constant CT output, what determines organ doses?
GE 120kV

Slice #
2 4 6 8 10 12 14 16 18 20 22

Mean TAR
0.6
0.8
1.0
1.2

[Graph showing mean TAR values for different slice numbers]
Liver 100%
Stomach 104%
Colon 93%
Bladder 108%
Adrenals 93%
Gonads 100%
Model John Lennon chest as mass equivalent water cylinder

\[ \text{Area} + \text{HU} \]
Theory & Practice
Figure F. Mean organ dose as a function of patient weight for identical scans (kV, mAs, pitch etc.).

Doses Corrected for Patient Weight
Radiation Doses → Patient Specific
PATIENT SPECIFIC RISKS
Simulate CT

Get Organ Doses
Calculate Organ Risks

HEALTH RISKS FROM EXPOSURE TO LOW LEVELS OF IONIZING RADIATION BEIR VII PHASE 2

NATIONAL RESEARCH COUNCIL OF THE NATIONAL ACADEMIES
Sum Organ Risks

Divide Risk by DLP
(i.e., Risk/DLP)
ESTIMATING CANCER RISKS TO ADULTS UNDERGOING BODY CT EXAMINATIONS

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Cancers Induced per mGy-cm per 100,000 Patients vs Age
Cancers Induced per mGy-cm per 100,000 patients vs Age
Cancers Induced per mGy-cm per 100,000 Patients vs Age
Correct For Patient Size

Organ Risk Directly Proportional to Organ Dose
John Lennon’s Risk

@ 40

~ 0.04%
WHY DO WE NEED RISKS?
IONIZING RADIATION EXPOSURE OF THE POPULATION OF THE UNITED STATES

1987
3.6 mSv/year
US Medical Per Caput Dose
~ 0.6 mSv in 1980
IONIZING RADIATION EXPOSURE OF THE POPULATION OF THE UNITED STATES

Recommendations of the NATIONAL COUNCIL ON RADIATION PROTECTION AND MEASUREMENTS

March 3, 2009

National Council on Radiation Protection and Measurements
7910 Woodmont Avenue, Suite 400 / Bethesda, MD 20814-3095
~ 6 mSv/year
US Medical *Per Caput* Dose
~ 3 mSv in 2006
Protecting Individual Patients

Justified

Optimized
Is examination indicated?

Benefits > radiation risks
Radiation-Related Cancer Risks in a Clinical Patient Population Undergoing Cardiac CT

OBJECTIVE. The purpose of our study was to estimate cancer induction risk and generate risk conversion factors in cardiac CT angiography.
Educational Tool
Optimize: Use no more radiation than needed for a diagnosis
X-RAY TUBE CURRENT MODULATION AND PATIENT DOSES IN CHEST CT

Wenjun He¹,*, Walter Huda², Dennise Magill², Emily Tavrides³ and Hai Yao¹
CONCLUSIONS
"Judging by your X-rays, I'd say you've been exposed to too much radiation."
Patient Specific Risk OBTAINABLE

“Still, let’s do an x-ray just to be sure.”
Patient Specific Risks REQUIRED

"We've considered every potential risk except the risks of avoiding all risks."
RADIATION RISK CAVEATS

Latent period

Differences in life expectancy of “patients” and normal population

Risk Uncertainties
Thank You

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