Cesium: Cardiac Toxin and Radiological Threat

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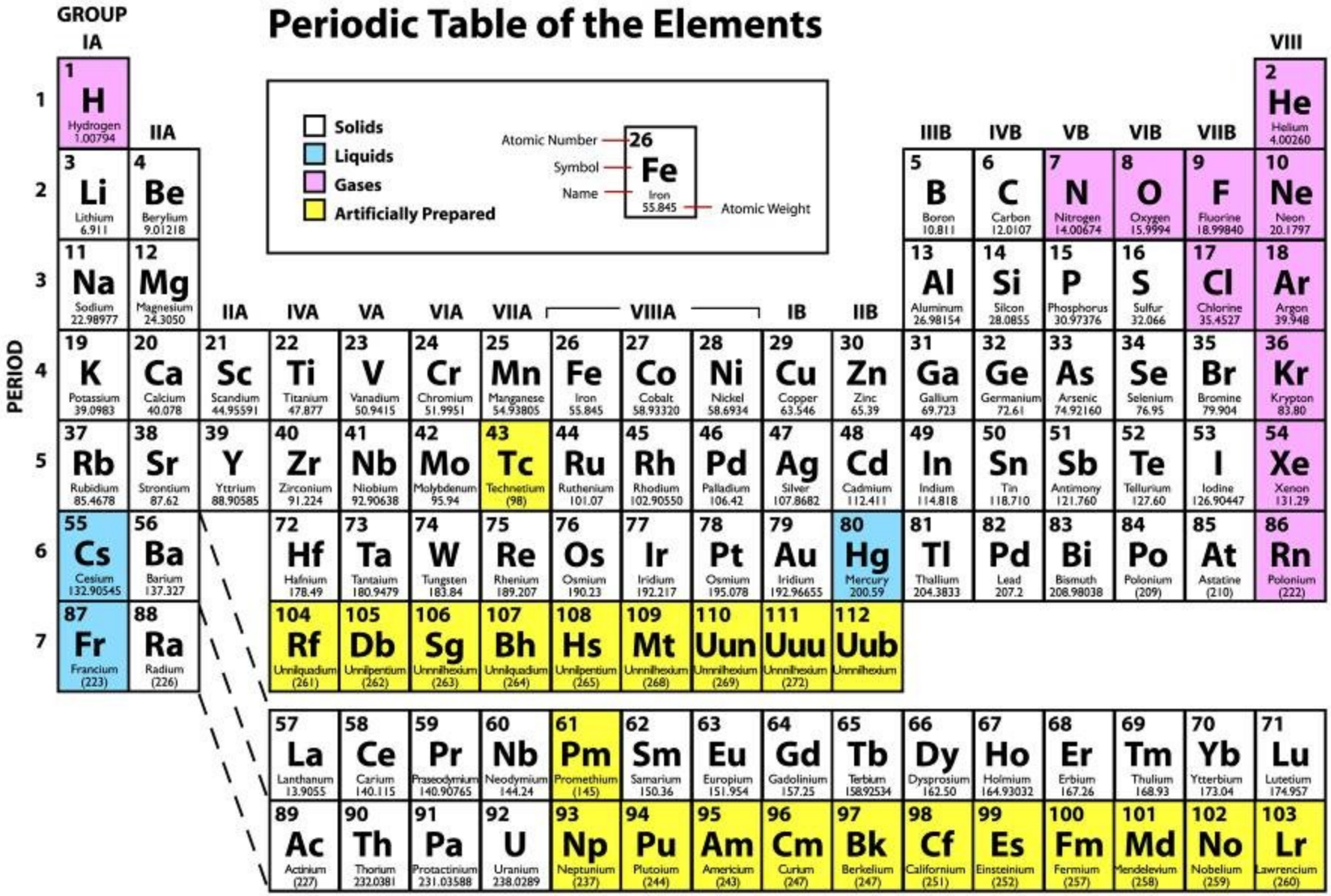
New York City Poison Center, NY, USA

Overview

- Chemistry
  - Elemental
  - Inorganic salts
  - Radiological
- Toxicity
- Diagnosis
- Treatment

Periodic Table of the Elements



Elemental Cesium

- Solid at 298K
- Liquid slightly above that
- Highly reactive with water

Chemistry

- Alkali Metal
  - Similar to potassium
  - Very strong base – dissolves glass
- Period 6
  - Similar to thallium
- Most Important Radioisotope
  - ^{137}Cs (also ^{134}Cs)
  - γ and β^- to ^{137}Ba
  - Radiological half-life about 30 years

Toxicity

- Popularized by alternative medicine groups
- Reported to be effective against a variety of cancers
- Mechanism:
  - Altering intracelluar pH of cancer cells???
- Also promoted for general detoxification

Can't Decide or Confused about a product?

Cesium 500

1 capsule contains: Cesium Chloride 500mg

Natural Medicine Use: Cesium may be used to support your immune system.

Typical Daily Dose: 1 capsule per day.

100 capsules per bottle

AVAILABILITY: In Stock

Price: $53.00

add to cart

Review this product

Wellness Products for Body, Mind & Soul

Cesium

Nature's most alkaline mineral.

The key to understanding how cesium works lies in the chemistry of a cancer cell. In 1925, German Nobel Laureate Dr. Otto Warburg published his ground-breaking paper establishing that cancer cells use a different form of chemistry to produce energy than normal cells do. In a healthy cell, oxygen can move freely across the cell membrane as can glucose. Oxygen is used in a healthy cell to "burn" glucose and create energy.

A few individuals have read that radioactive Cesium is used by radiologists in conventional cancer treatment and asked whether this is the same as Cesium - High pH Therapy.

ELSEVIER

Cardiovascular Research 39 (1998) 178–193

Cardiovascular Research

Review

Experimental models of torsade de pointes[1]

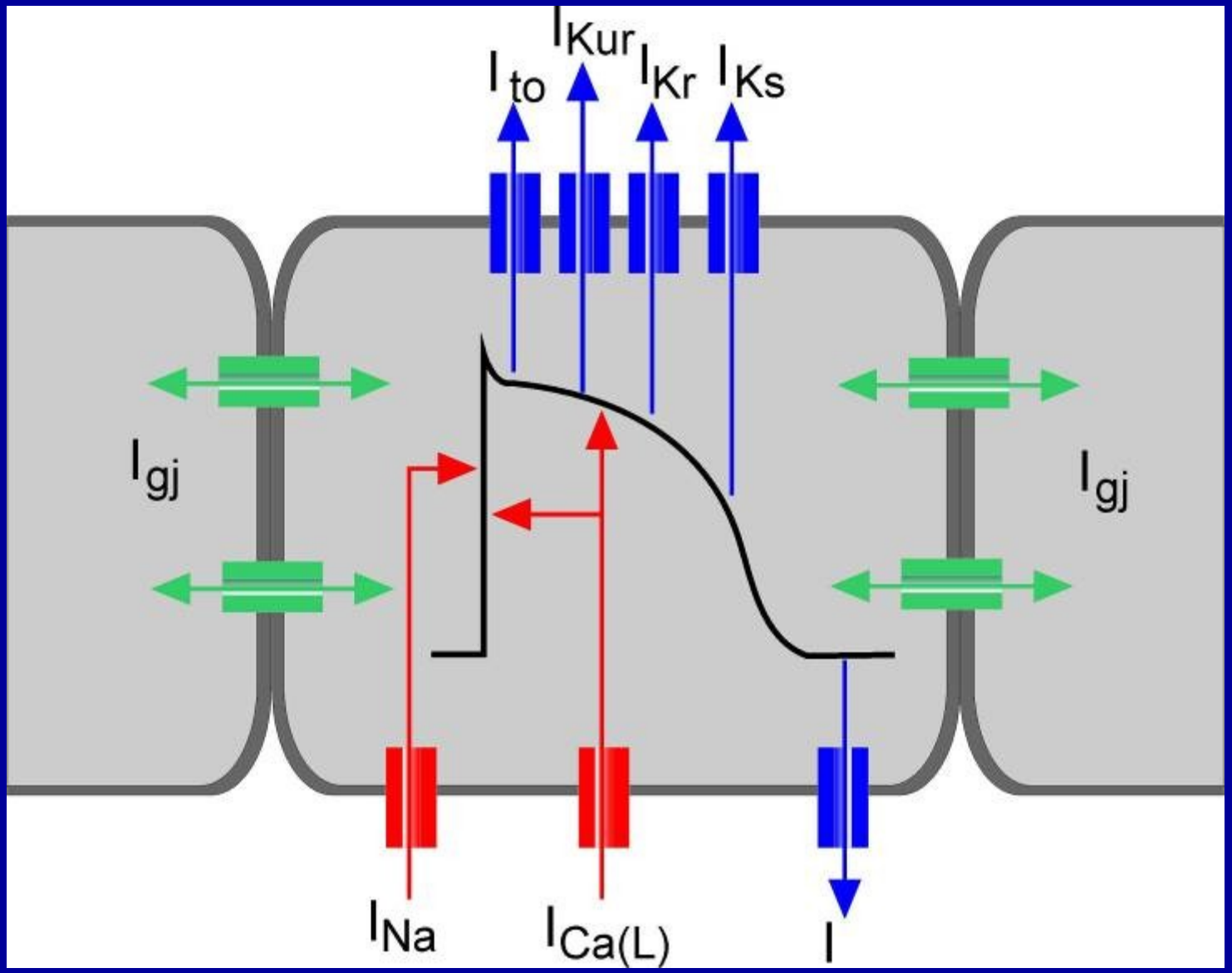
Lars Eckardt*, Wilhelm Haverkamp, Martin Borggrefe, Günter Breithardt

Hospital of the Westfälische Wilhelms-University, Department of Cardiology and Angiology and Institute for Arteriosclerosis Research, D-48129 Münster, Germany

Received 22 January 1997; accepted 12 January 1998

Mechanism

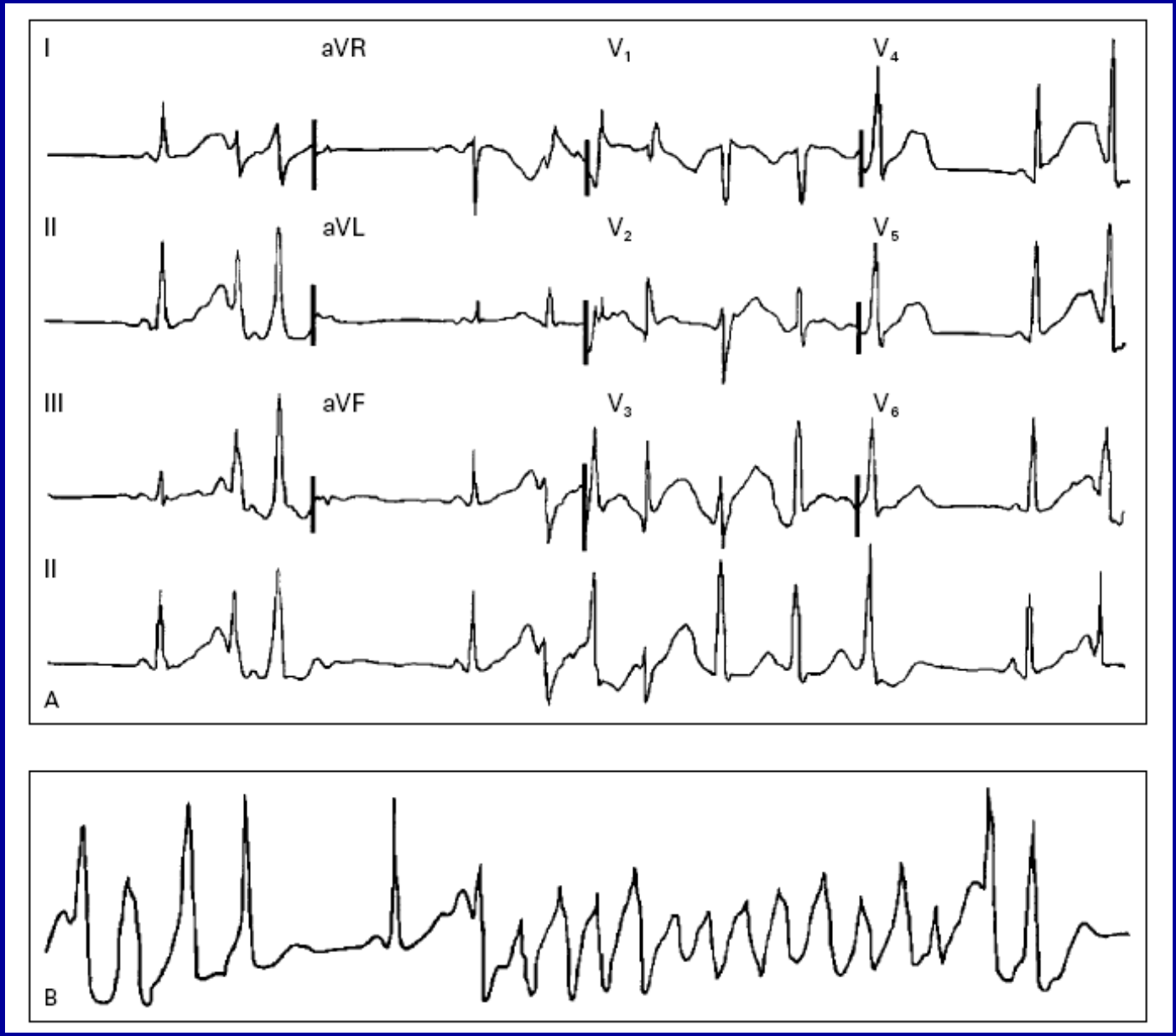
- Cesium delays repolarization
  - Reduces potassium rectifying currents (I_k)
- Produces two types of early after-depolarizations (EADs)
  - Prolonged phase 2 (-30mv)
  - During phase 3 (-60mv)
  - Suppressed by K channel openers
    - Pinacidil


I Kur
I to
I Kr
I Ks
I gj
I gj
I Na
I Ca(L)
I

Net Result

- Variety of arrhythmias
  - Atrial fibrillation
  - Ventricular tachycardia
  - Torsades de pointes

- A 62-year-old man with recurrent syncope
- 2000 mg of CsCl QID IV x 2 weeks for prostate CA then 1000 mg PO TID
- ECG showed a QT of 700 msec
- Runs of TdP were recorded on telemetry
- Level: 830 µmol/L (0.0045- 0.0105)
- Stoped taking cesium chloride
- 6 months later QTc was normal

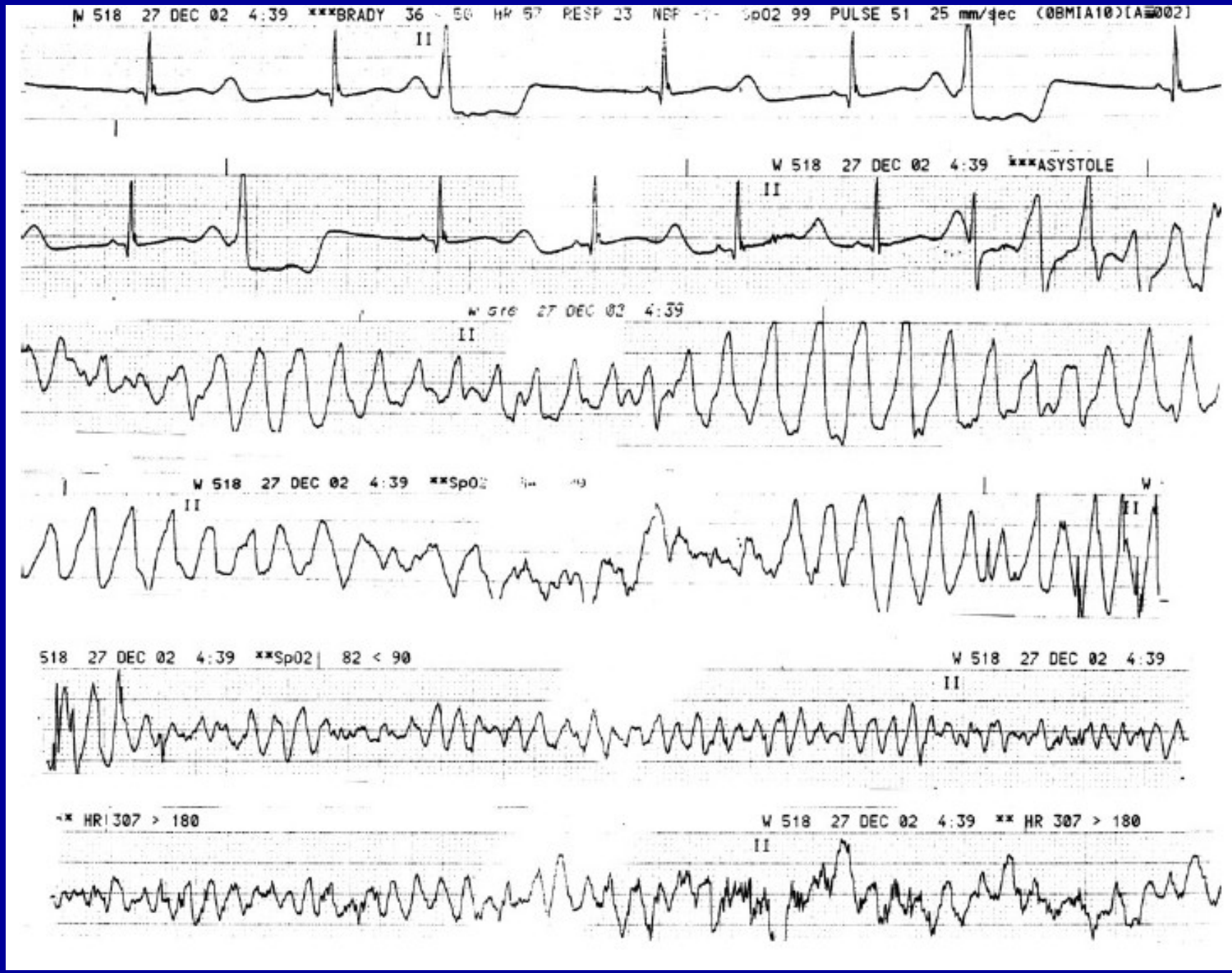


Pinter A: Cesium-induced torsades de pointes. N Engl J Med 2002;346:383-4.

Literature Review

- 6 papers documenting 6 case individual reports
- All patients used cesium salts as either alternative therapy for cancer, prevention of cancer, or detoxification
- Typical doses around 1-3 gram/day
  - As much as 9 gram/day
- Tendency for hypokalemia

- Vyas H: Acquired long QT syndrome secondary to cesium chloride supplement. J Altern Complement Med 2006;12:1011
- Curry TB: Acquired long QT syndrome and elective anesthesia in children. Paediatr Anaesth 2006;16:471
- Dalal AK: Acquired long QT syndrome and monomorphic ventricular tachycardia afteralternative treatment with cesium chloride for brain cancer. Mayo Clin Proc. 2004;79:1065
- Lyon AW: Cesium toxicity: a case of self-treatment by alternate therapy gone awry. Ther Drug Monit 2003;25:114
- Pinter A: Cesium-induced torsades de pointes. N Engl J Med 2002;346:383
- Saliba W: Polymorphic ventricular tachycardia in a woman taking cesium chloride. Pacing Clin Electrophysiol 2001;24(4 Pt 1):515


W 518 27 DEC 02 4:39 ***BRADY 36 HR 57 RESP 23 SpO2 99 PULSE 51 25 mm/sec
II
I
W 518 27 DEC 02 4:39 ***ASYSTOLE
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W 518 27 DEC 02 4:39 **SpO2
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W 518 27 DEC 02 4:39 ** HR 307 > 180
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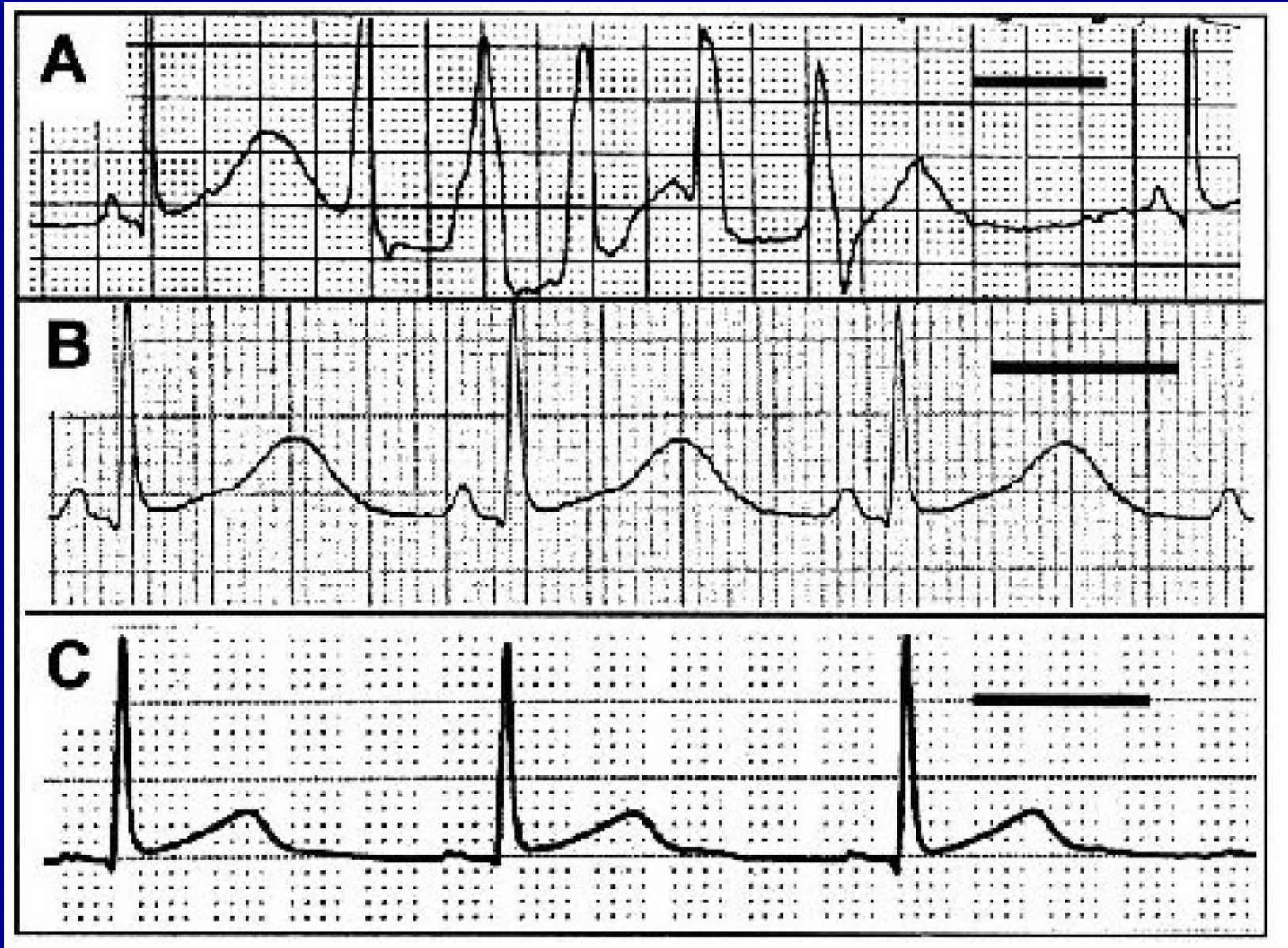

A
B
C

Treatment (experimental)

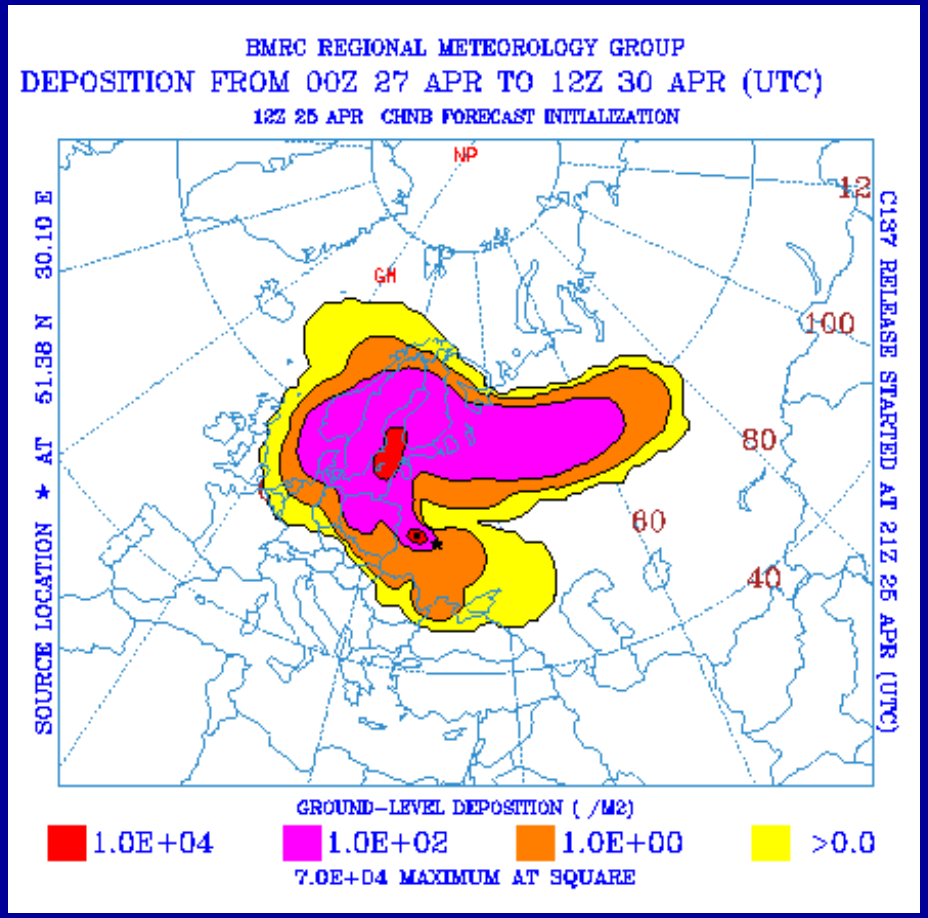
- Good response to magnesium
  - Kaseda S: Am Heart J 1989;118:458
  - Bailie DS: Circulation 1988;77:1395
- May not respond to overdrive pacing
  - Nayebpour M: Cardiovascular and metabolic effects of caesium chloride injection in dogs--limitations as a model for the long QT syndrome. Cardiovasc Res 1989;23:756.

Treatment (clinical)

- Supplemental potassium: 4/6
- Supplemental magnesium: 4/6
- Lidocaine: 2/6
- Electrical cardioversion/defibrillation: 1/6

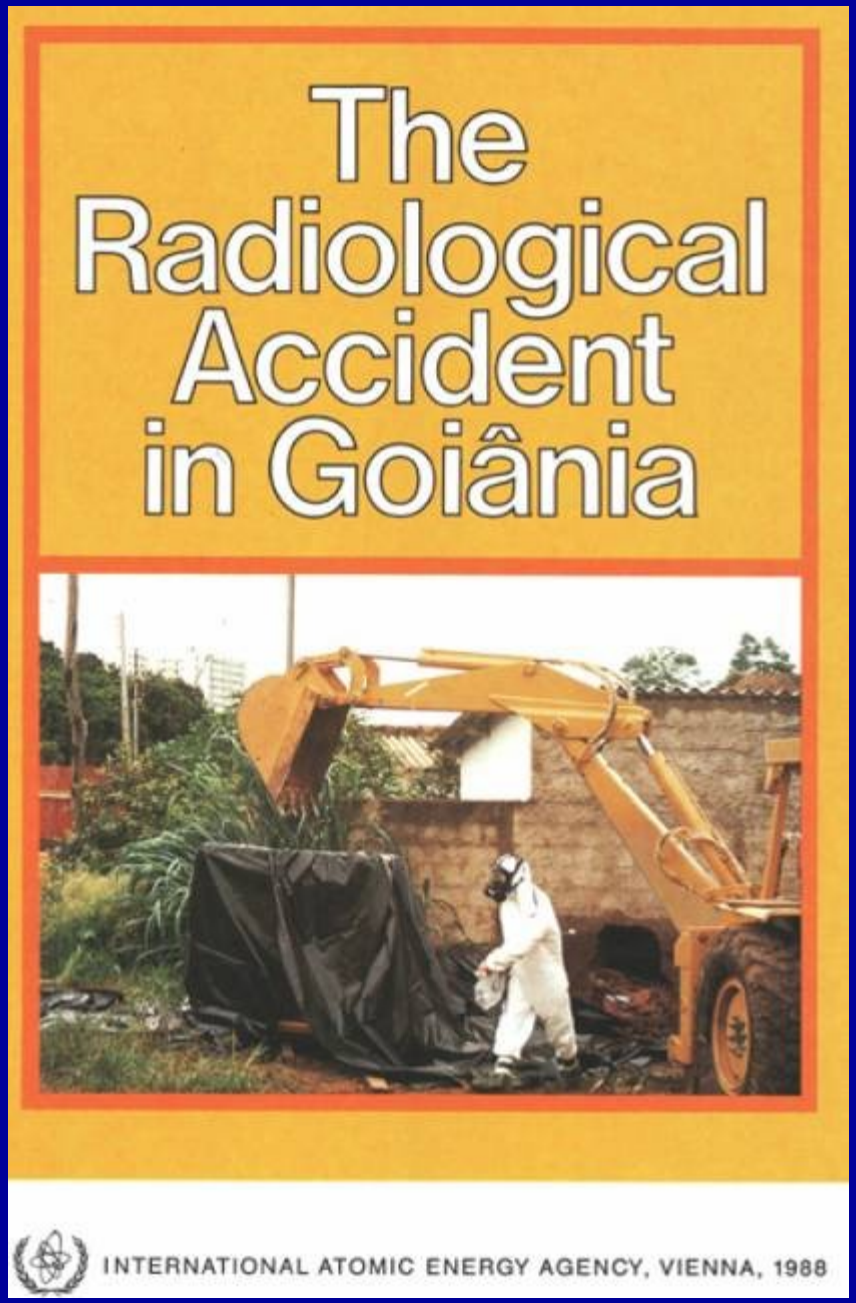
Radioactive Cesium

Chernobyl - 1986



The Brazilian Event

- In 1985, the Goiania Institute of Radiotherapy discarded an obsolete ^{137}Cs teletherapy unit
- In September of 1987, scavengers dismantled the machine and sent it to a junk yard
- 5 days later a junkyard worker pried open the lead canister to reveal a pretty blue, glowing dust: radioactive ^{137}Cs (~90 gm)
- The material was widely distributed



www.pub.iaea.org/MTCD/publications/PDF/Pub815_web.pdf

www.pub.iaea.org/MTCD/publications/PDF/eprmedt/Day_4/Day_4-18.pps

Medical Monitoring

- 112,000 people (10% of the population)

Consequences

- 250 were identified as contaminated
  - 50 were isolated inside the Olympic Stadium
  - 20 were hospitalized or transferred to special housing with medical and nursing assistance
  - 8 were transferred to the Navy Hospital in Rio de Janeiro
  - 4 died

Dose assessment by cytogenetics

Dose (Gy)	Number of individuals
< 0.1 - 0.49	105
0.50 - 0.99	8
1.00 - 1.99	8
2.00 - 2.99	3
3.00 - 3.99	2
4.00 - 4.99	2
5.00 - 5.99	1
Total	129

Consequences

- Radiation induced skin injuries observed in 28 patients

FIG. 9.2. 17 days after exposure. Large and tense blisters. Significant swelling limits fingers movement.

FIG. 9.3. 3–30 days after exposure. The skin was excised. A raw reddish surface is covered with a delicate layer of fibrinous exsudate. Note the centripetal character of the healing process and the attempt of re-epithelialization.

FIG. 9.5. 75 days after exposure. The wound, now limited to a superficial ulceration, is covered with a dense and firm fibrinous exsudate.

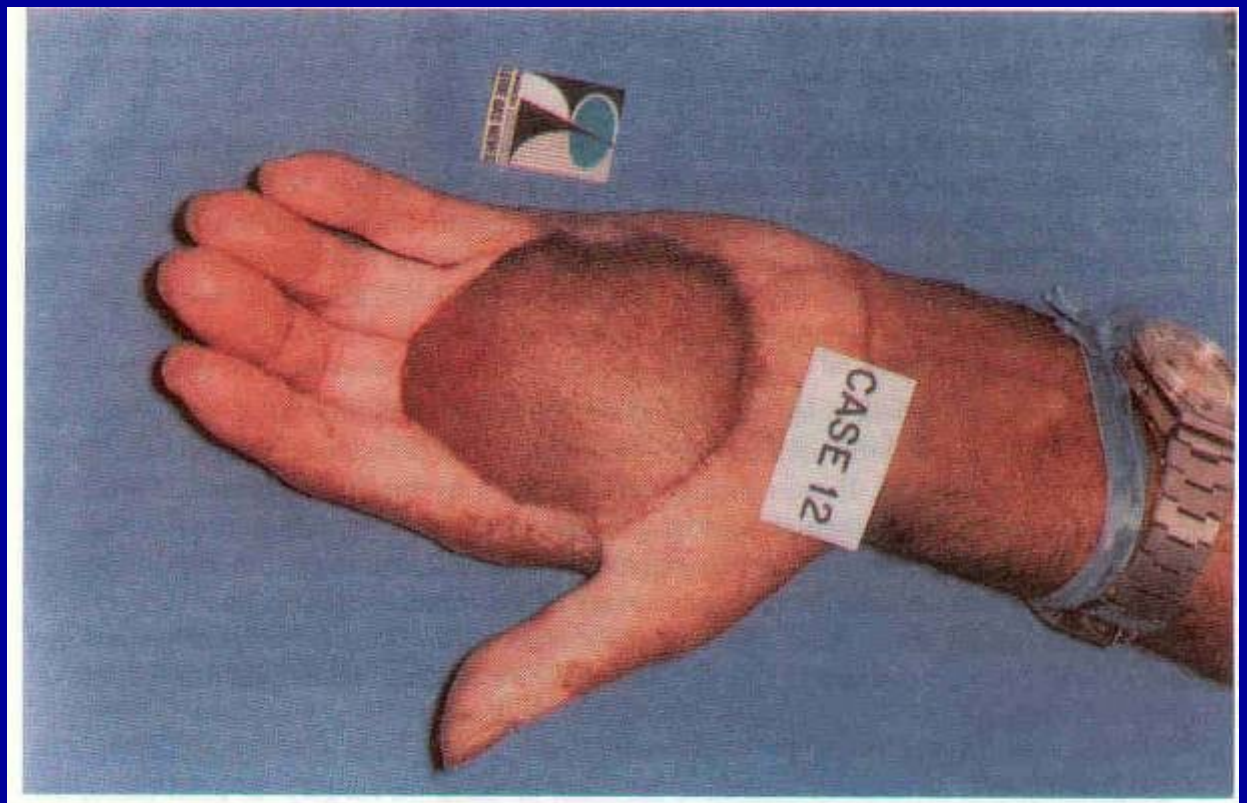


FIG. 9.9. The entire injury was excised and bed of ulcer covered with a full-thickness flap. Palm of hand shows a bulky appearance.

Consequences

- Widespread contamination of downtown Goiania
- External exposure to members of the public
- Four main foci of contamination identified:
  - 3 junkyard
  - 1 residence
  - Total 5000 m^3 of waste
- 85 residences found to have significant levels of contamination
  - 41 of these were evacuated and a few were completely or partially demolished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Nuclear Terrorism

- In 1995 a Chechen military commander arranged for a dispersal bomb containing ^{137}Cs to be found in a Moscow park

- Bomb never detonated – scare tactic
  - It was real device, though

NOXIOUS PLUME of hot fallout spreads over New York City's Manhattan Island after the simulated detonation of a radioactive cesium-based dirty bomb (assuming a wind from the southwest). The highlighted zones would be expected to have radiation levels comparable to those that caused the closing of contaminated regions around the damaged Chernobyl nuclear power plant.

Wednesday, 18 June 2003, 9:54 am

www.scoop.co.nz

Potential Radioactive "Dirty Bomb" Materials Seized In Thailand Sting

by Richard S. Ehrlich

BANGKOK, Thailand -- U.S. investigators said they want to send to America a sample of the illegal radioactive cesium-137 seized from a Thai smuggler in a hotel parking lot, amid fear that it may have been destined to create a "dirty bomb".

Cesium Kinetics

- Well absorbed in the small bowel
- Distributes like potassium
- Undergoes enteric recirculation
- Elimination
  - 80% in the urine
  - 20% in the feces

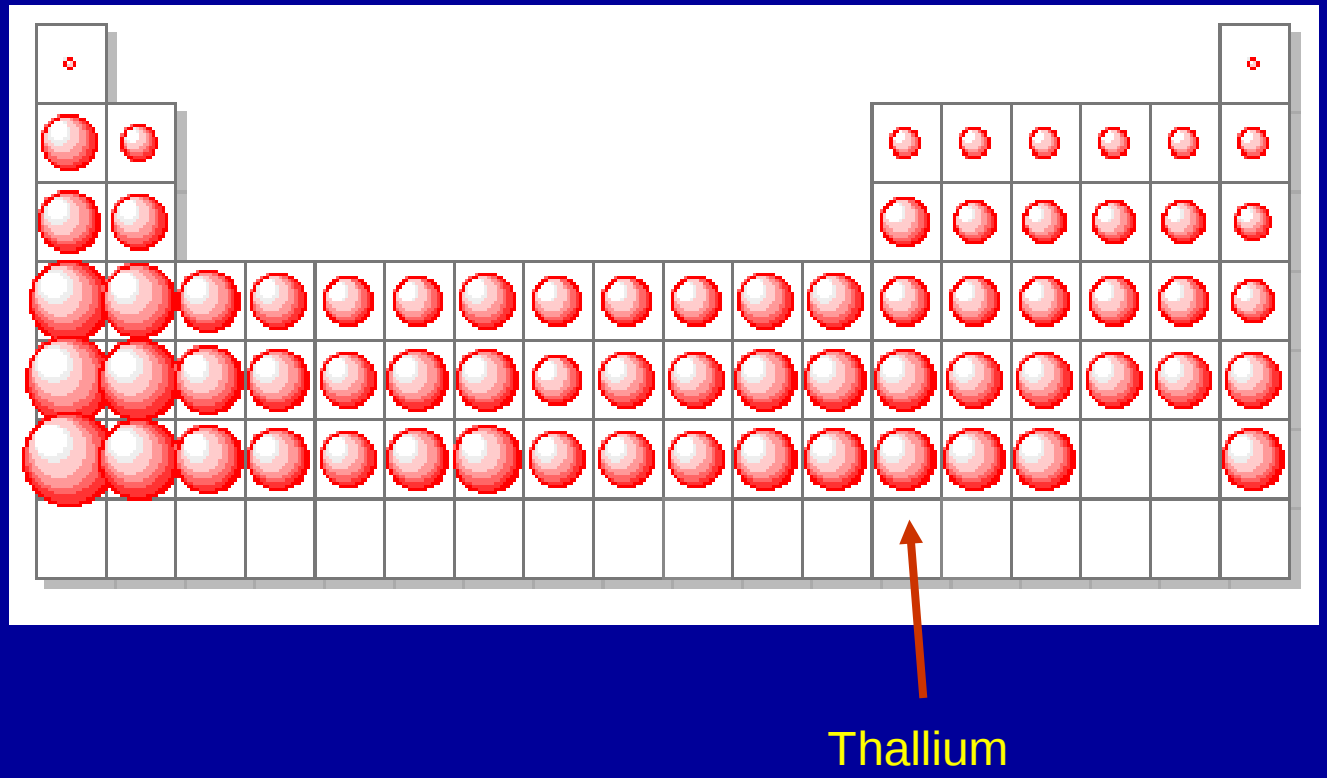
Treatment

(Also possible for non radioactive Cs)

Prussian Blue

- Crystal lattice
- Takes up cationic potassium ions from the surrounding environment
- Affinity increases as the ionic radius of the monovalent cation increases

Ionic Radii

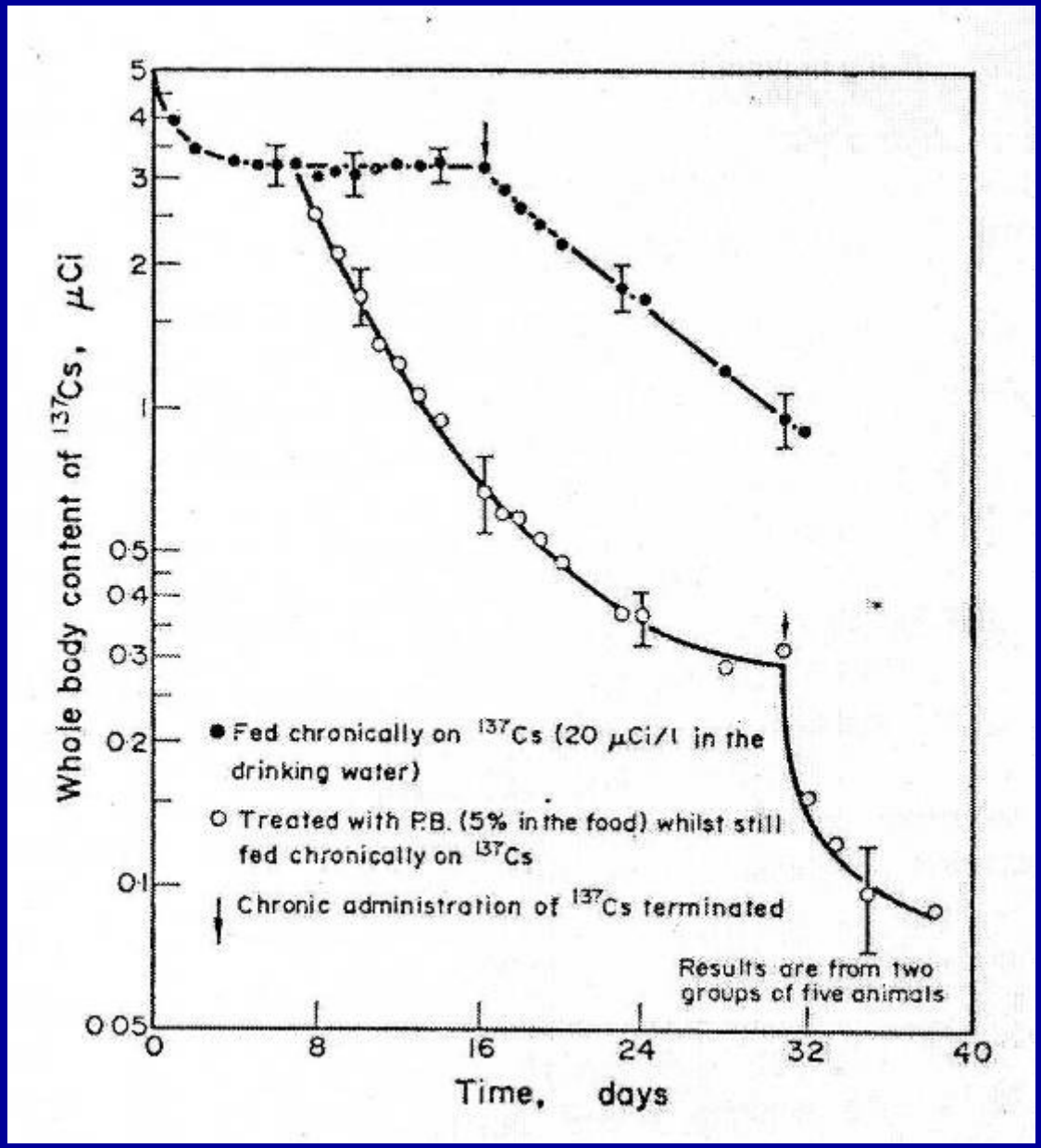


Binding

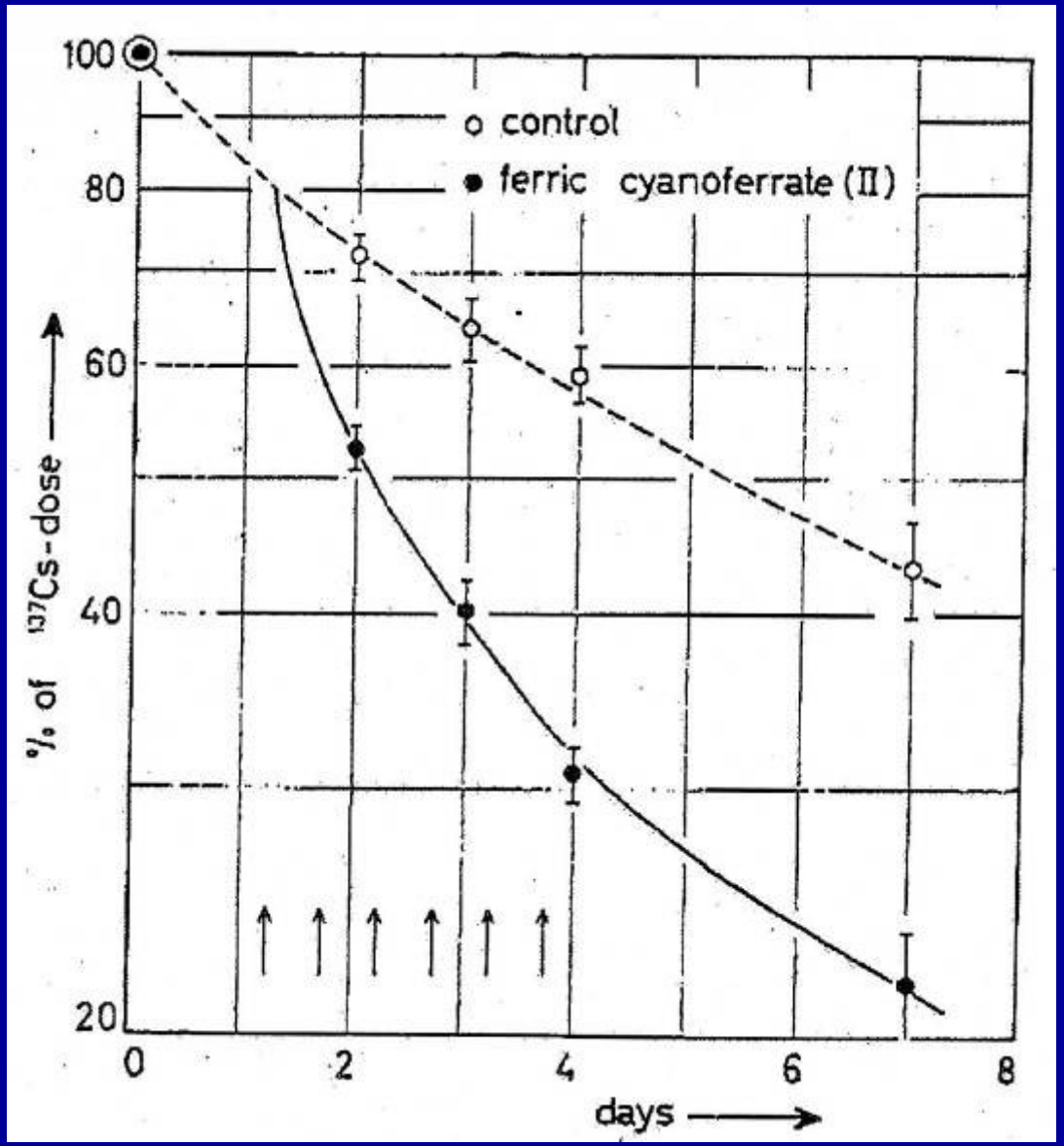
- Prussian blue preferentially binds:
  - Cesium (ionic radius 0.169 nm)
  - Thallium (ionic radius 0.147 nm)
  - Rubidium (ionic radius 0.148 nm)
- Over potassium (ionic radius 0.133 nm)
  - Kravzov J: J Appl Toxicol 1993;13:213-216
- In vitro MAC 238 mg ^{137}Cs/gm Prussian blue

Small Animal Data

- Prussian blue therapy
  - Reverses the urine to stool elimination ratio from 8:1 to 0.3:1
  - Reduces the biological half-life
  - Reduces total body AUC by as much as 60%
  - Reduces retained cesium at a given endpoint



Stather JS: Health Physics 1972;22:1-8



Nigrovic V: Int J Radiat Biol Relat Stud Phys Chem Med 1963;96:307-9

Large Animal Data

- Daily Prussian blue therapy
  - Reduced radiocesium in sheep by as much as 42%
  - Reduced radiocesium transfer to milk in cows by 85%
  - Reduced the amount of radiocesium in meat from pigs fed contaminated whey

Human Volunteers

- Two human volunteers feed ^{134}Cs
- Control
  - At 14 days they retained 94.7% of the ingested dose
- Prussian blue
  - At 14 days they retained 5.1% and 4.9% of the ingested dose

Dresow B: J Toxicol Clin Toxicol 1993;31:563-569.

Human Volunteers

- Two volunteers given ^{134}Cs
- Prussian given 10 minutes before
  - Absorption decreased from 100% to 3-10%.
- Prussian given simultaneously
  - Absorption decreased from 100% to 38-63%
- Prussian blue given 0.5 g Q8H post absorption
  - Biological half-life of reduced from 106 to 44 days

  - Nielsen P: Arzneimittelforschung 1991;18:821-826.

Goiânia Victims

- 37 patients given Prussian blue
  - 3g/day in children up to 10g/day in adults
- Untreated, half-lives
  - 39 to 106 days in adults
    - Mean 65.5 days in women and 83 days in men
- Treatment
  - Reduced half-lives by a mean of 32%
  - Reduced the retained cesium dose 51-84%

Oliveira AR: Health Phys 1991;60:17-24.

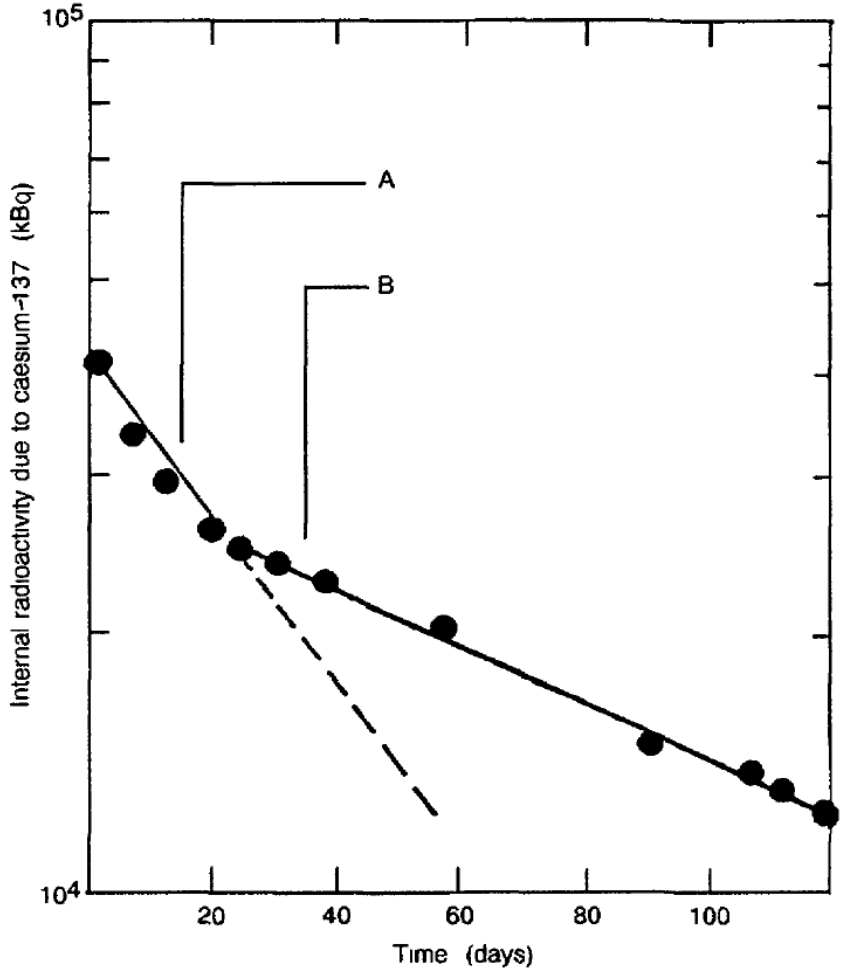


FIG. 11. The effect of the administration of Prussian Blue: plot of content of radioactive material in the body versus time. A: administration of 10 g of Prussian Blue per day. B: after cessation of administration of Prussian Blue.

Chernobyl Victims

- 3 Chinese victims of radiocesium incorporation treated many weeks after their exposure

Table 2. Biological half-life of ^{137}Cs and ^{134}Cs in man and the effect of oral administration of prussian blue (PB).

Subject	Biological half-life† (days)			
	^{137}Cs		^{134}Cs	
	Control	PB Admin.	Control	PB Admin.
YN	71	43	46	23
ZN	54	48	42	33
MU	60	29	51	‡

Ming-Hua T: J Radiol Protect 1988;8:25-28

Prussian Blue

- Dosing Recommendations
  - Adults: 9 grams daily (3 grams TID)
  - Children: 3 grams daily (1 gram TID)
- Duration
  - 30 day minimum (radiocesium)
  - Longer based on monitoring
  - No clear endpoint

From Olshansky (but for Zilker)

- *Cesium, ‘tis of thee.*
- *Thy ‘positivity, Of thee I sing.*
- *Thou whose hydroxide*
- *Dissolved my wife, when she died.*
- *Glorious too, for suicide*
- *Here . . death, is thy sting.—*