“What’s Past is Prologue”

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Radiation Injuries to American Pioneer Users of X-rays

1895-1905

Hampton Symposium, Ether Dome, Oct 19, 2013
History of X-ray injuries
1895 - 1905

1. When and how soon did the injuries occur?
2. Who were the injured?
3. What, and how serious were the injuries?
4. Why did the injuries occur?
   - What were the facilitators?
   - Why did some of injured continue in their work?
5. US Army- HA Shaw, *History Base Hospital No. 6, MGH*, 1924
7. ERN Grigg, *Trail of Invisible Light*, 1965
8. RL Eisenberg: *Radiology: An Illustrated History* 1991
The Birth of our Specialty

Discovery: Fri Nov 8, 1895
Corroboration, Sat Nov 9, 1895

Glasser, 1945
1. When did injuries occur?
2. Who were the injured?

28 Martyrs, Died 1904-1936, P. Brown
3. What, and how serious were the injuries?  N=28

27 Dermatitis L>R, red, blisters, pain exfoliation, sores, necrosis, devitalization

24 Amputations (fingers, hands, arms, shoulders) grafts, some with 100 operations

22 Skin Cancers, 1 Sarcoma. 1 Visceral necrosis

1903 1908

Brown 1936
3. Who were the injured?

4. How did the injuries occur?

15 Physician
10 Employee
9 Manufacturer, Sales, Exhibitor
8 Solo practice MD
5 Engineer/physicist
4 Photographer
3 Solo non-MD

* Patient
* Volunteer
* Onlooker

Percy Brown 1936, 28 Martyrs

Electrical Engineering Exhibition 1896
Serious Early Injury

"7 years before Dally's hair begun to fall out and his face began to wrinkle... dermatitis...of the skin...sore on the back of his left hand...and arm due to placing it between the fluoroscope and the X-ray tube...to test it. It developed into cancer... amputation was about three inches below the shoulder. Also right hand and fingers... I took off four of Dally's fingers, so that now he has but one thumb on one hand with which to earn his livelihood. Wife and two children. [Supported by Edison]
Example of a seriously injured

- Schooling, Jobs
- Starts MGH Xray Jan ’96
- First radiograph Mar ‘96
- Success GE equip Oct ‘96
- Rx Xray burns Nov ’96
- Skin grafts 1897
  ~30 operations ’97-1916
- HMS, UVM MD ’00-’08
- HMS unit BEF 1915
- Interactions

R McNeil, Inexpensive Xray Apparatus, *Scien Amer*, 1896

*WJ Dodd 1869-1916*

16 cp, 50v
Example of who was spared?

- Well educated
- Busy TB practice at BCH
- Wm Rollins MIT team
- Lead tube housing, collimation, distance,
- No injuries in 250 pts
- Teacher of Geo Holmes
- Dark adaptation

FH Williams, 1852-1938

FH Williams, 1901
4. A model for X-ray injury

- Low kev unfiltered
- Hand ammeter
- No lead enclosure
- Tube proximity
- Prolonged exposure
- No personal protection
5. What Facilitated the Injuries?

- No radiobiology science
- Technical limitations
- Proximity to tube
- No leaded tube housing
- Low energy rays
- Use of hand as output indicator
- Prolonged handheld fluoro studies

- No personal protection
- Partial dark adaptation
- Psychology
  - Advancement, fame, adulation
  - Sacrifice, holy grail, contribution to science
  - Risky behavior
  - Job security
Biological Dark Adaptation

- Modern science unknown
- Slow Rhodopsin formation can adapt sensitivity to $1^8$
- 30 min darkness = $80\%_{\text{max}}$
- 10 min darkness $10^{1-2}$ less
- Full darkness impractical
- Light flash bleach forces restart
- Red goggles invented 1916

Williams 1901, Trendelenberg 1916
X-ray injuries in modern era (1992-3)

- Long flouro procedures
- FDA (PHA 1994)
  - Standardize procedures
  - Determine fluoro dose rate
  - Assess potential for injury
  - Modify for lower dose
- FDA 1995 Recomm
  Record skin absorb dose
  - Apply at threshold $>1$ Gy
Results re: X-ray injuries
1895 -1905

1. Was there prior knowledge of danger from X-rays?
2. When did the injuries first appear?
3. Who were the injured?
4. What were the injuries?
   How severe were they?
5. What facilitated the injuries?
   Why did some injured continue to use X-rays?