INDIANA UNIVERSITY
SCHOOL OF MEDICINE

Matt Cooper, Meryvn Cohen, Kelly Piersall, Bruce Apgar

INDIANA UNIVERSITY
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- Excellent Image Quality
- Patient Safety
  - ALARA
- Reliable Quality Assurance Tools

Objectives

- To present our study implementing a new Quality Assurance tool, the "Exposure Index" into clinical practice
  - performed at IU-Riley Children's Hospital in Indianapolis from Sept-Dec 2009
  - Focus on portable neonatal chest radiographs

Presentation

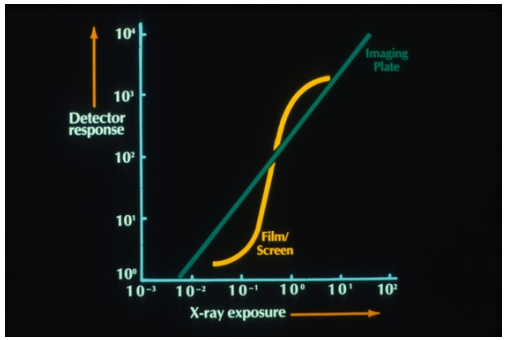
- Background
  - ➢ What is Dose Creep? Why is it so difficult to monitor?
  - ➢ What is the Exposure Index?
- Purpose of our Study

Dose Creep is the inadvertent increase in radiation exposure while obtaining radiographs

- Dose Creep is a problem associated with digital computed radiography (CR) systems as opposed to plain film
- Dose Creep is of concern because the majority of plain film radiographic studies performed today are performed with these digital imaging systems

Background – Historical Film Systems

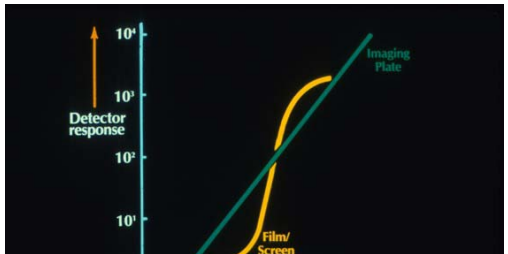
- Provided a well established standard
- Fixed Speed Classes 100, 200, 400, 800
- Limited Dynamic Range + or - 2X
- Clear indication of over or under exposure (light or dark films)



Background – Digital Imaging Systems

Digital Imaging Systems

- Effectively no speed class
- Wide Dynamic range > 10X
- Underexposure can be compensated for but at the risk of losing information (noise)

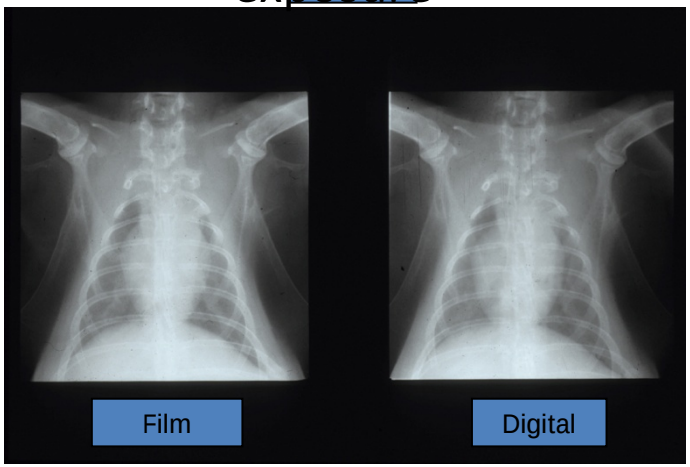


Dose creep – rabbit study

60kVp

Plain Film v. CR - Appropriate exposure

1.0 mAs

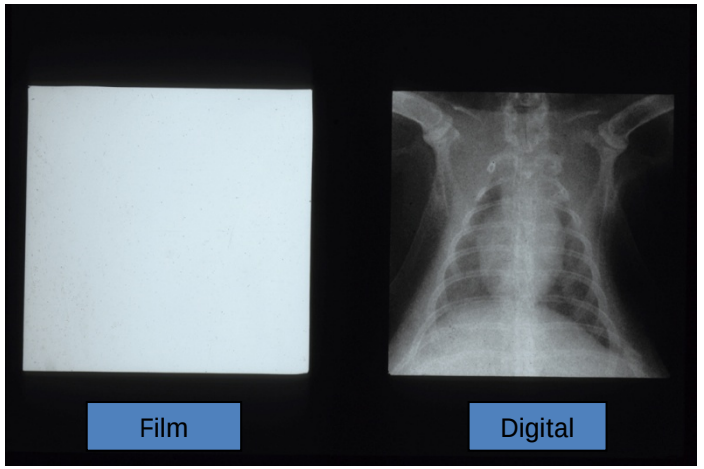


Dose creep – rabbit study

60 kVp

Plain Film v. CR – under exposure

0.1 mAs

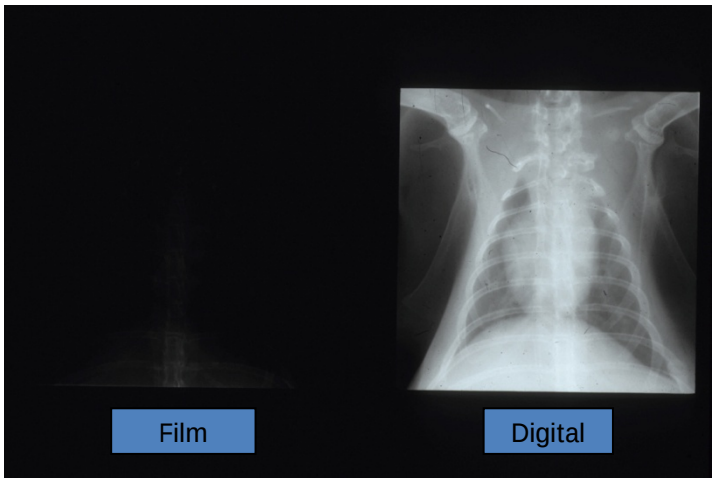


Dose creep – rabbit study

60 kVp

Plain Film v. CR - Overexposed image

4.0 mAs

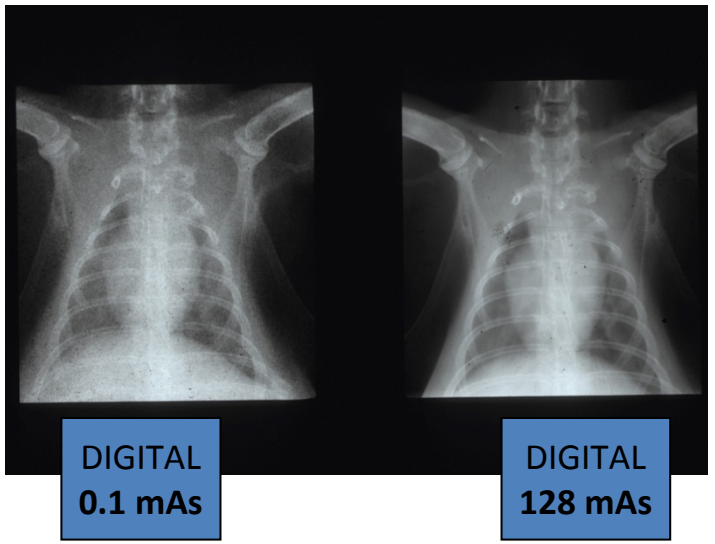


Dose creep – rabbit study

60 kVp

Dose Creep!!!!!!!!!!!

Dose increase is over 1,000 times



- How do we measure Exposure to keep track of Dose Creep?
- Naturally, each Manufacturer had their own way of indicating exposure to the detector; this caused problems
  - Some values increase when the exposure is increased, some decrease
  - Some values change in a linear fashion (Fuji, Canon)
  - Some values change in a logarithmic fashion (Agfa, Kodak)
  - Some change in an unusual fashion
- Results are very confusing for the user
  - Multiple systems in one department with no relationship between systems

Historical Exposure Monitoring.

Four Systems with four ways of measuring exposure

Exposure in Microgray	Fuji	Canon	Agfa	Kodak
2.5	710	30	1.96	1451
5	355	60	2.26	1751
10	177	120	2.56	2051

Physicists in Medicine (AAPM) separately developed the “Exposure Index” (EI) to set an international standard to measure the radiation exposure to a digital detector.

- The Exposure Index is a standard way to measure the exposure to a Digital detector.
- The Exposure Index is designed to monitor exposure consistency within an exam type.

Instead of Multiple Confusing Systems

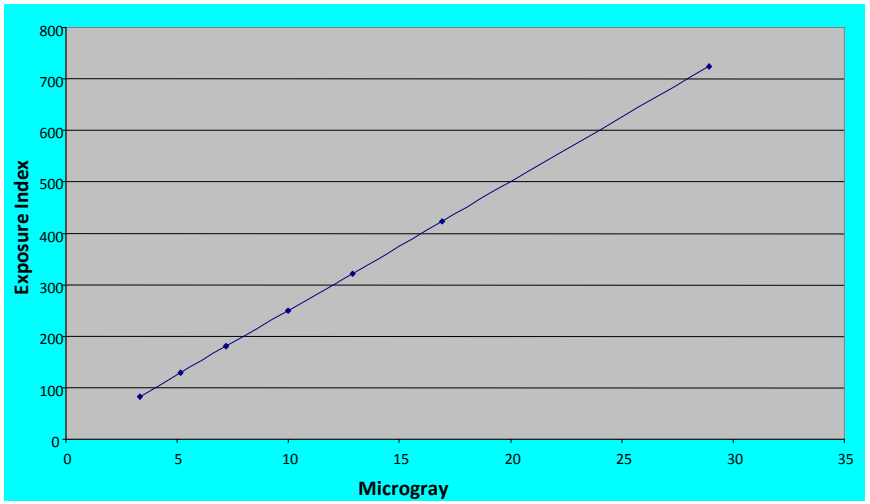
Exposure in Microgray	Fuji	Canon	Agfa	Kodak	IEC Exposure Index
2.5	710	30	1.96	1451	250
5	355	60	2.26	1751	500
10	177	120	2.56	2051	1000
20	89	240	2.86	2351	2000

One Simple Standard for all Systems

Exposure in Microgray	Fuji	Canon	Agfa	Kodak	IEC Exposure Index
2.5	250	250	250	250	250
5	500	500	500	500	500

- Universal
- Linear relationship to dose - mAs
- Can set target exposure index and track deviations from the target
- Can easily compare work of different technologists by shift and by individual.
- Can identify outliers
- Can detect equipment problems
- Can easily detect institution does creep
- Can easily be applied in routine clinical practice. It is a very powerful QA tool
- Can use it to educate hospitals using very high exposures; persuade them to change.

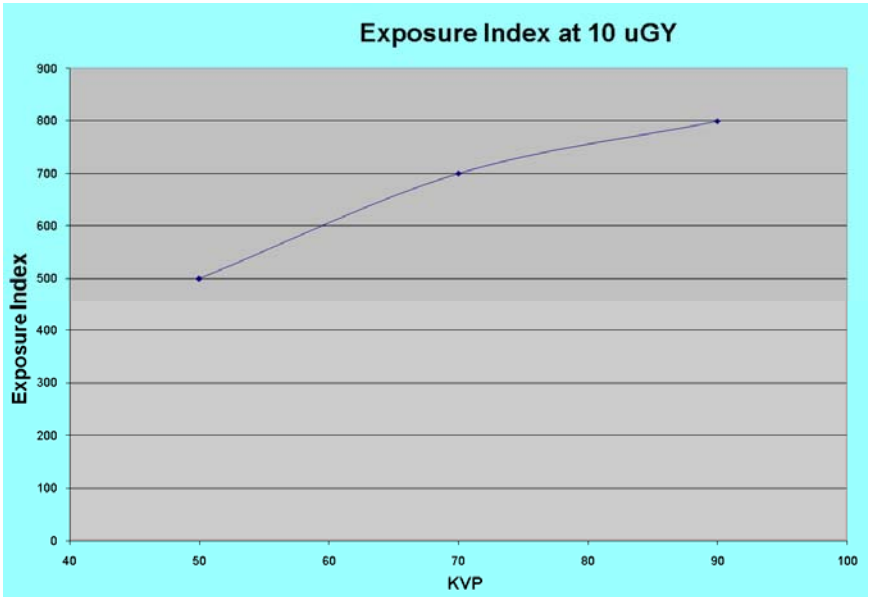
at a fixed beam quality (kVp and filtration)



Exposure Index - Limitations

- For a constant entry dose the Exposure Index will change with many factors. These include beam conditions (kVp and beam filtration), grids, the patient anatomy, and the screen phosphor/detector structure used.
- Thus Exposure Index for different body parts and patient sizes will vary.
- The Exposure Index for a specific study cannot easily be compared between different institutions
- We can set targets for the EI and track deviations from the target, but the setting of a target exposure index for an institution is subjective

Exposure index increases in relation to kVp at a fixed detector dose



- To apply and evaluate the newly developed Exposure Index as a Quality Assurance tool in clinical practice .

- Our specific objectives were:
  - To determine the mean, range, and variation of the measured Exposure Index in chest radiographs in our newborn nursery
  - To evaluate the stability of the EI over time in both our radiographic studies and with a phantom control
  - Evaluate the overall ease of data collection and statistical analysis with a large number of patients

Methods

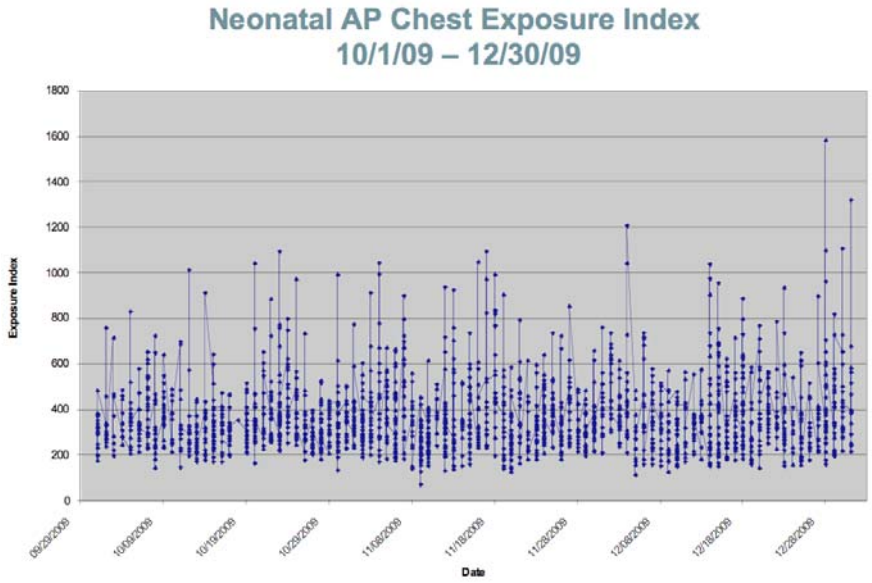
- 1,884 consecutive neonatal chest radiographs performed at Riley's Children's Hospital in Indianapolis from October 2009 to Dec 2009

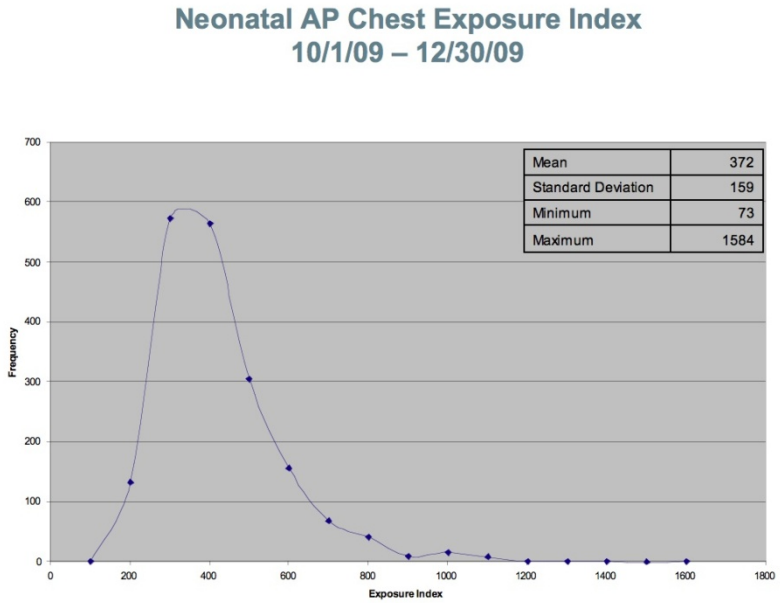
- Control: Gammex Neonatal Chest Phantom.
  One image was obtained weekly

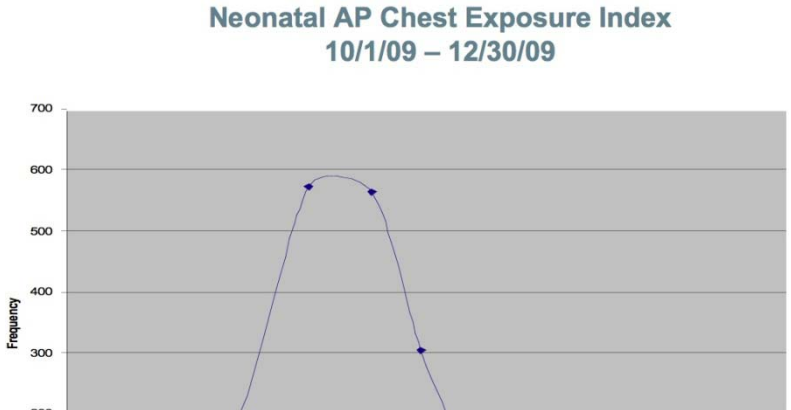
- Images were obtained and processed on Agfa Healthcare's DXS CR system. For every study, the NX technologist workstation and quality assurance software allows automatic storage of Exposure Index, date and time of acquisition, and technologist name.

1884 Neonatal Chest Radiographs

- Exposure Index is stable over time- No dose creep
- Skewed distribution of the Exposure Index due to variations in patient size
- Logarithmic normal distribution of the Exposure Index

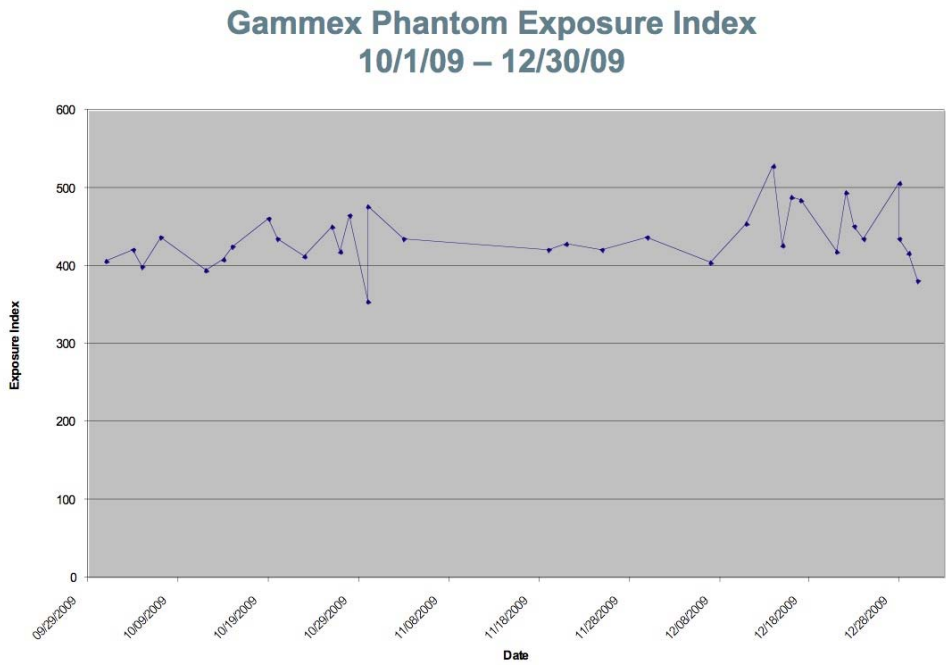


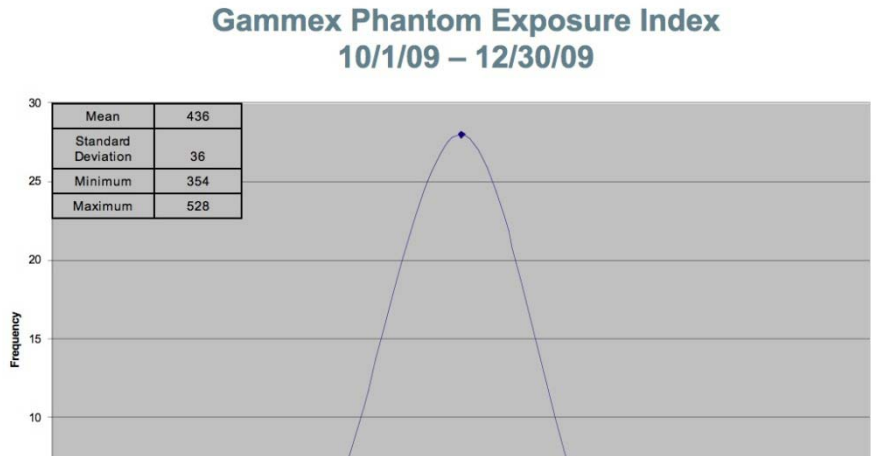




Phantom

- Exposure Index is stable over time- No dose creep. Slight variation is due to variation in tube output.
- Normal distribution of the Exposure Index





- Patients may have many exams
- Immature patients may have increased sensitivity to radiation
- Long life span after the NICU

2. For neonatal exposures a small amount of variation In Exposure Index occurs.
   - This is likely due to variation in size of patients.

Discussion

Exposure Index and the Gamma Phantom are an excellent quality assurance tools

- When combined with digital tracking software, the Exposure Index is a great improvement over previous tracking methods
- This new method is intuitive and easily implemented
- Action may be taken to correct dose creep before it becomes clinically significant

References

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