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Chest X-ray Taking Procedures Training for X-ray Technicians/ Radiographer

"Conventional Imaging"

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Content

Film – Screen Radiography

- In film-screen radiography, a sheet of film with a light-sensitive emulsion on both sides is sandwiched between two intensifying screens

- In order to overcome the thicker screen, sandwiching the double-sided film between two screens serves to add the optical densities of the two emulsions together

Reference: John Ball , Tony Price, Chesney's Radiographic

X-ray Film

Reference: John Ball , Tony Price, Chesney's Radiographic

X-ray Film

- A media that makes a permanent record of the image
- To record the image on the film
- Images are stored as a latent image

Reference: John Ball , Tony Price, Chesney's Radiographic

Film Construction

Reference: John Ball , Tony Price, Chesney's Radiographic

Film Construction

1) Polyester plastic base:

- Support layer for fragile emulsion
- Must be clear, strong and consistent thickness (0.18 mm)
- Tinted pale blue or blue-gray (reduces eye strain)
- Coated on one or two sides with emulsion
  *single emulsion film (better detail)
  *double emulsion film (less detail)

Reference: John Ball , Tony Price, Chesney's Radiographic

Film Construction – Cont.

2) Adhesive Layer

- To provide uniform surface over which the emulsion can be coated uniformly

3) Substratum layer

- To keep emulsion layer and base adhering to each other during the coating stage and processing

Reference: John Ball , Tony Price, Chesney's Radiographic

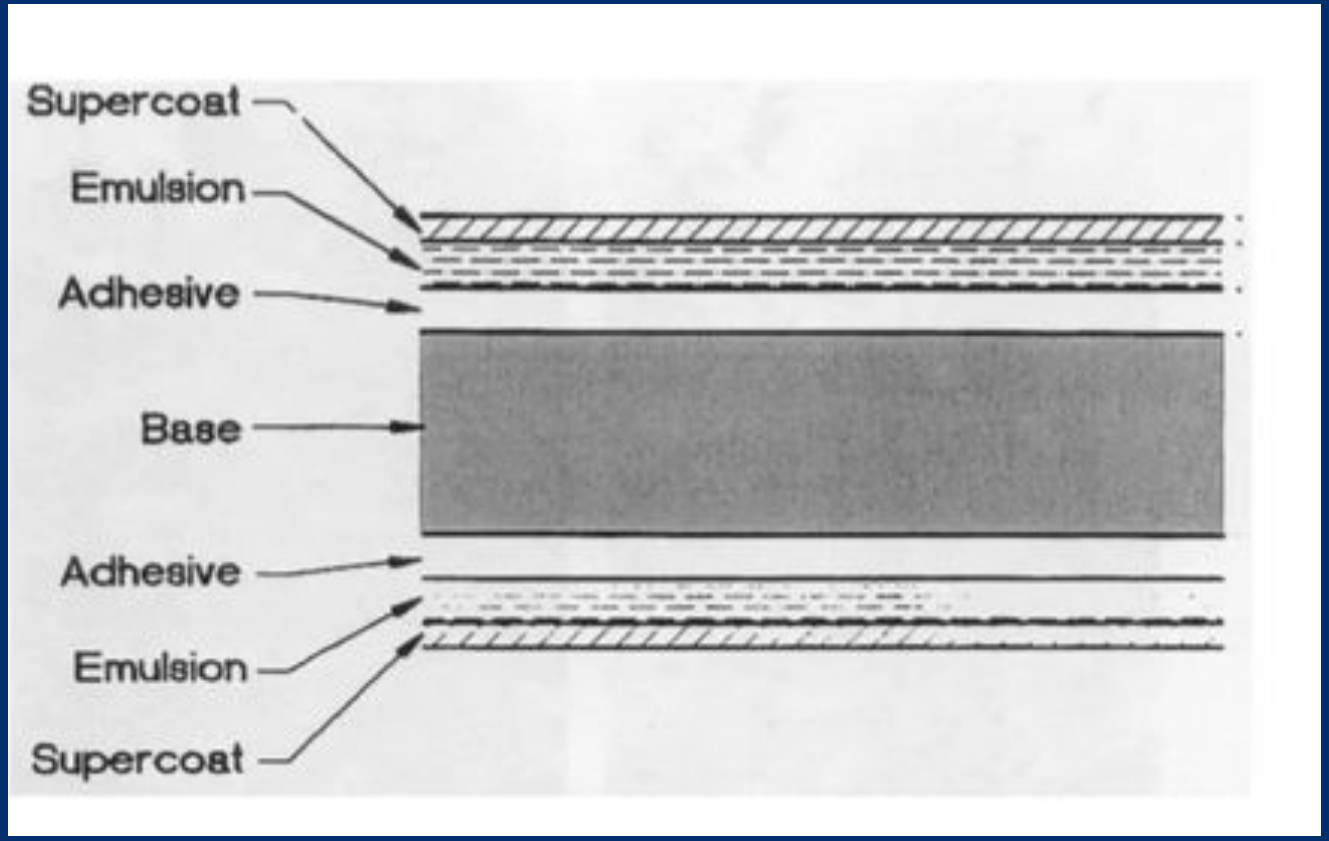
Film Construction – Cont.

4) Emulsion layer:

- Acts as photographic active layer
  *activated by light and radiation to create image
- Consists of a mixture of gelatin solution and silver halide crystal
  *typical emulsion consists of silver bromide (98%) and silver iodide (2%)
  *crystal size – 1.0 to 1.5 μ in diameter

Reference: John Ball , Tony Price, Chesney's Radiographic

Film Construction – Cont.



Film Construction

Reference: John Ball , Tony Price, Chesney's Radiographic

Film Construction – Cont.

"Latent Image Formation"

- Exposure of silver – iodo – bromide grains to light photons emitted by the screen
- Affects of grain size and distribution:
  - The bigger the average grain size, the higher the speed of the film
  - The more grain distribution, the lower the contrast
  - The bigger the crystal, the higher the graininess (clumping of the crystal)
  - Latent image is made visible by chemical processing

Reference: John Ball , Tony Price, Chesney's Radiographic

Film Construction – Cont.

"White and Dark Appearance on Film"

- **Dark** – silver halide crystals exposed to photons
  *after processing, it turns to black metallic silver
- **White** – no crystals exposed
  *silver halide is wash away by processing

Reference: John Ball , Tony Price, Chesney's Radiographic

Film Construction – Cont.

5) Supercoat

- To protect the layer of gelatin
- To reduce damage from scratches and pressure

Gelatin

- Used as a suspending medium and binding agent for the silver halide particles
- Can be easily spread on the film base when warm
- Firmly exists on the base as a gel when cool
- Flexible and does not crack easily on bending

Reference: John Ball , Tony Price, Chesney's Radiographic

Types of Film based on their Application

Reference: John Ball , Tony Price, Chesney's Radiographic

Types of Film based on their application

1) **Screen Films:**
    - Most commonly used
    - Sensitive to blue light emitted by intensifying screens and direct actions of x-rays
    - Used in cassettes with intensifying screens
    - High speed

Reference: John Ball , Tony Price, Chesney's Radiographic

Types of Film based on their application – Cont.

2) Non-screen / Direct exposure films:

- Has thicker coat of emulsion used without an intensifying screen
- Depends mainly on action of x-ray
- Four times faster than that of screen films
- Must be manually processed because of thick emulsion
- Uses :
  a) To detect intra-ocular foreign bodies
  b) In dental with intra-oral cardboard

Types of Film based on their application – Cont.

3) Mammography film:

- Single coated
- Designed to be used with single intensifying screen
- Combination must be fast to deliver minimum dose to the glandular tissue

Reference: John Ball , Tony Price, Chesney's Radiographic

Types of Film based on their application – Cont.

4) Duplicating Film:

- Used to copy radiograph
- Original cassette to be copied is inserted into a cassette whose opaque front has been replaced by a pane of clear glass
- Special duplicating film is placed with emulsion side down onto the radiograph

Reference: John Ball , Tony Price, Chesney's Radiographic

Types of Film based on their application – Cont.

Differences between single coated and double coated x-ray film		
Characteristic	Single side	Double coated
Radiation dose	Increased	Decreased
Detail	Increased	Decreased
Parallex effect	No	Yes
Contrast	Decreased	Increased

Reference: John Ball , Tony Price, Chesney's Radiographic

Film Artifacts

Reference: John Ball , Tony Price, Chesney's Radiographic

1. Technical artifacts (caused by X-rays tube)

No	Artifacts	Causes	Remedy
1	Over exposure	- High exposure factors - High exposure on fast speed screens	- Use optimum factors - Use film – screen combination
2	Under exposure	- Low exposure factors - Low exposure on slow speed screens	- Use optimum factors - Use film – screen combination

Reference: John Ball , Tony Price, Chesney's Radiographic

1. Technical artifacts (caused by X-rays tube) – Cont.

No	Artifacts	Causes	Remedy
3	Double exposure	- Single film is exposed twice	- Always separate exposed and unexposed cassettes
4	Film fog / noise	- Use of damaged cracked cassette	- Carefully use the cassette - Replace the damaged cassette on time

Reference: John Ball , Tony Price, Chesney's Radiographic

I. Technical artifacts (caused by X-rays tube) – Cont.

No	Artifacts	Causes	Remedy
5	Grid cut off effect	- Due to inaccurate position of patient on the table - Grid is not completely inserted into the table	- The patient's midsagittal plane should be aligned with the mid axis of the table - Grid should be completely inserted into the table

Reference: John Ball , Tony Price, Chesney's Radiographic

2. Positioning artifacts (caused by position of patient, cassette and tube)

No	Artifacts	Causes	Remedy
1	Image blurring	- Due to improper respiration	- Ask patient to practice inspiration, expiration and holding of breath
2	Marker effect	- Due to the use of wrong marker or side placement	- Use accurate markers and on the proper side

Reference: John Ball , Tony Price, Chesney's Radiographic

2. Positioning artifacts (caused by position of patient, cassette and tube) – Cont.

No	Artifacts	Causes	Remedy
3	Movement unsharpness	- Due to patient movement during exposure	- Explain the procedure to the patient - Use immobilization devices - Reduce exposure
4	Metallic Artifact	- Presence of metallic object between tube and film	- Ask the patient to remove the radiopaque objects

Reference: John Ball , Tony Price, Chesney's Radiographic

3. Processing artifacts

No	Artifacts	Causes	Remedy
1	Film fog	- Damaged safe light - Accidental exposure of white light or any general light	- Check safe light periodically or within 15 days - Cassette should be closed - Door interlocked
2	Age fog	- Use of expired film	- Always use film before the expiry date and check the date regularly

Reference: John Ball , Tony Price, Chesney's Radiographic

3. Processing artifacts – Cont.

No	Artifacts	Causes	Remedy
	Age fog	- Storing of film in high temperature and high humidity conditions	- Air conditioner should be installed and check properly
3	Cresenteric effect	- Due to image of finger on film during handling	- Always handle the film carefully with the help of two fingers during loading and unloading

Reference: John Ball , Tony Price, Chesney's Radiographic

3. Processing artifacts – Cont.

No	Artifacts	Causes	Remedy
4	Stain effect (various colours may appear on film during processing		
	Brown colour stain	- Improper fixing - Exhausted fixer - Improper washing	- Proper fixing - Change fixer on time - Proper washing

Reference: John Ball , Tony Price, Chesney's Radiographic

3. Processing artifacts – Cont.

Artifacts	Causes	Remedy
Yellow colour stain	- Oxidized developer - Use of old developer	- Developer tank should be covered and preservative added - Change developer solution on time
Static elastic effect (stripe)	- Due to friction between two films	- Film should be handled properly and film box should be placed vertically

Reference: John Ball , Tony Price, Chesney's Radiographic

Film Handling & Storage

Reference: John Ball , Tony Price, Chesney's Radiographic

Film Handling

1. Do not flex
2. Hands must be clean
3. Film is sensitive to pressure, scratches, light, x-rays, heat, moisture, electricity and age

Reference: John Ball , Tony Price, Chesney's Radiographic

Film Storage

1. Proper film storage is required for high quality and long-lasting images
2. The location must be clean, dry and light tighten
3. 40-60% humidity and 69° F or 10 – 24 ° C temperature
4. Avoid storing near chemical fumes which can fog the film
5. Safe from radiation exposure

Reference: John Ball , Tony Price, Chesney's Radiographic

Film Storage

6. Expiration date clearly visible
7. Should be stored on edge (like books in a library)
8. Do not stack the film boxes horizontally because film in the bottom may show pressure artifacts
9. Always used older film first

Reference: John Ball , Tony Price, Chesney's Radiographic

Intensifying Screen

Reference: John Ball , Tony Price, Chesney's Radiographic

Intensifying Screen

- An image amplifier converting the aerial image which is relatively made of a few x-rays photons into many thousand times of light photons
- Converts incident x-ray photons to visible light which then exposes the silver halide emulsion on the film
- The image is formed by processing the latent image using dark room procedures

Reference: John Ball , Tony Price, Chesney's Radiographic

Intensifying Screen Construction

- Polyester plastic base – support layer
- Phosphor layer – active layer (X-rays photons converted to light photons) *Photoelectric effect
- Reflective layer – increases screen efficiency
- Protective coating

Reference: John Ball , Tony Price, Chesney's Radiographic

Intensifying Screen Construction – Cont.

Intensifying Screen Phosphor;

1. Rare Earth phosphor (emits green light) *Standard*
   - most efficient and commonly used

2. Calcium Tungstate (emits blue light)
   - not efficient

Reference: John Ball , Tony Price, Chesney's Radiographic

Intensifying Screen Construction – Cont.

1. Rare Earth Screen:

- Higher DQE (detective quantum efficiency)
  **the percentage of x-rays absorbed by the screen*
- Higher x-rays absorption abilities
- Higher CE (Conversion efficiency)
  **the amount of light emitted for each x-rays absorbed*
- More light emitted per x-rays absorbed by the screen

Reference: John Ball , Tony Price, Chesney's Radiographic

Types of Intensifying Screen with different speed

Screen	Speed
High resolution	Slow
Regular or Standard	Medium
Fast	Fast

Reference: John Ball , Tony Price, Chesney's Radiographic

Types of Intensifying Screen with different speed

- Screen speed is defined as a relative number to demonstrate how efficiently x-rays are converted into useable light
  - *Screen speed ranges from 100 (slow) to 1200 (fast)*
  - *Routine - 200 to 800, high detail – 50 to 100*

Faster screen speed - reduces patient exposure

Quantum mottle

Image detail ↓

Image noise (speckled background on the image) ↑

Reference: John Ball , Tony Price, Chesney's Radiographic

Advantages and Disadvantages of Intensifying Screen

Advantages	Disadvantages
A screen can absorb 20 – 40 times more x-rays than film alone	Less detail than direct exposure
Reduced exposure	Formation of quantum mottle and unsharpness
Reduced patient dose	Reduced detail
Increased x – ray tube life	Maintenance of screen

Reference: John Ball , Tony Price, Chesney's Radiographic

Advantages and Disadvantages of Intensifying Screen – Cont.

Advantages	Disadvantages
Contrast good	Screen artifact
Prevent motional lack of sharpness	-
Suitable for pediatric, geriatric and large body parts	-
Short developing time	-

Reference: John Ball , Tony Price, Chesney's Radiographic

Factors Affecting Image Quality

Reference: John Ball , Tony Price, Chesney's Radiographic

Factors affecting image quality

- Rare Earth screen should be used to be a good image quality.
- The use of intensifying screens lowers spatial resolution (good differentiation between two nearby objects) compared with direct-exposure radiographs

Reference: John Ball , Tony Price, Chesney's Radiographic

Factors affecting image quality – Cont.

- Spatial Resolution:
  - The higher the lp/mm the smaller the object that can be imaged

    Very fast screens - 7 lp/mm

    Fine-detail screens - 10 lp/mm

    Direct-exposure screens - 50 lp/mm

Spatial resolution is expressed by the number of line pairs per millimeter (lp/mm)

Reference: John Ball , Tony Price, Chesney's Radiographic

Factors affecting image quality – Cont.

- Noise reduces the image contrast
  **caused by high kvp and fast screens used*
- Artifacts (unwanted information in the image) reduces the image quality
  - Small scratches and dirty screen

  Screens should be cleaned once each month with manufacturer's cleaner with antistatic compounds

Reference: John Ball , Tony Price, Chesney's Radiographic

Film Cassette

Reference: John Ball , Tony Price, Chesney's Radiographic

What is a Film Cassette?

"A film cassette is a container for exposed or unexposed film."

Functions:

- To hold intensifying screen and protect them from damage
- To exclude all light from entering the cassette and fogging the film
- To maintain a close and uniform contact between the film and screens
- To exclude dust and dirt from the sensitive screens

Reference: John Ball , Tony Price, Chesney's Radiographic

Care of cassette

- Do not scratch the surface
- Keep clean (use mild soap and water on a regular basis)
- Do not allow the screen to become wet
- Record the date of cleaning

Reference: John Ball , Tony Price, Chesney's Radiographic

Care of cassette – Cont.

- Hold it gently and store in a standing position
- Do not store cassette near sources of heat
- Do not leave the cassette open
- Ensure the screen is fully dry before reloading the cassette

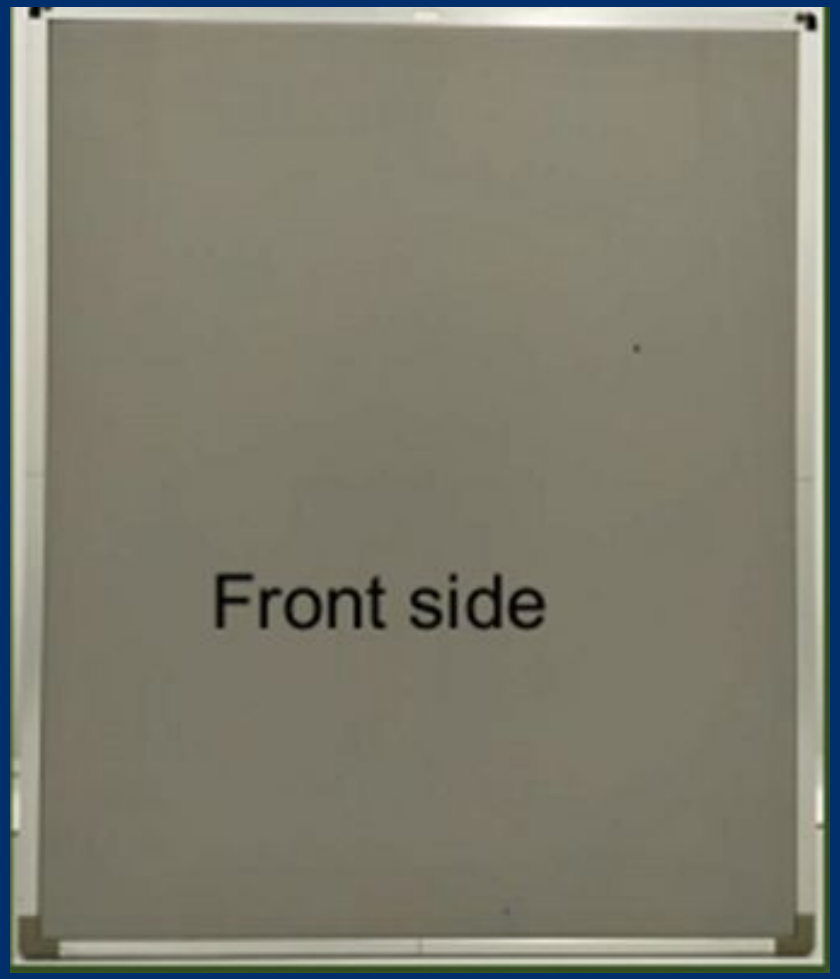
Reference: John Ball , Tony Price, Chesney's Radiographic

Cassette storage

- Upright and away from radiation
- Do not stack
- Should always be loaded and ready to use
- Avoid humidity and dust

**Number the cassettes so repeat problems can be easily identified*

Reference: John Ball , Tony Price, Chesney's Radiographic



Cassette

Consultant's own training material

Film Processing

Reference: John Ball , Tony Price, Chesney's Radiographic

Manual Film Processing:

- Involves the processing of the film by chemicals with the help of a person
- Latent image is converted into visible image in this process

- This process contains (5) steps:
  1) Developing
  2) Rinsing
  3) Fixing
  4) Washing
  5) Drying

Reference: John Ball , Tony Price, Chesney's Radiographic

1. Developing

Developing

Is a chemical process in which the latent image is converted into a visible image

To convert metallic silver into black metallic silver by reduction process

Reference: John Ball , Tony Price, Chesney's Radiographic

I. Developing – Cont.

- ***A developer solution contains:***
  - i. Solvent
  - ii. Developing agent
  - iii. Activator
  - iv. Preservative
  - v. Restrainer

Reference: John Ball , Tony Price, Chesney's Radiographic

I. Developing – Cont.

i. Solvent
   - Commonly used solvent is water
   - The solvent dissolves chemicals and also aids ionization

ii. Developing agent
   - Hydroquinone, phenidone and metol
   - The purpose of developing agent is to convert exposed AgBr crystals to black metallic silver
   - Hydroquinone is responsible for high contrast
   - Metol responsible for grey shades

Reference: John Ball , Tony Price, Chesney's Radiographic

I. Developing – Cont.

- Hydroquinone is always used in combination with metol to shorten the developing time
- Works more efficiently when the solution temperature is less than 20 degree Celsius

iii. Activator

- Commonly used hydroxide, sodium carbonate and sodium metaborate
- Used to open the pores of the film and allow the developing agent to do their work
- Optimum pH is range from 10 to 11

Reference: John Ball , Tony Price, Chesney's Radiographic

I. Developing – Cont.

iv. Preservative

- Use sodium sulphate or potassium metabisulphite
- Decrease the rate of oxidation of hydroquinone (developing agent)
- Increases the life of the developer solution

v. Restrainer

- Use potassium bromide solution
- It is also called the anti fogging agent

Reference: John Ball , Tony Price, Chesney's Radiographic

2. Rinsing

- When the x-ray film is removed from the developer, some chemicals remain on the film
- The film should be rinsed to remove these chemicals
- To stop the reaction of development of the developer and neutralization the basicity of the residual developer solution
- In a water bath, rinsing the film for 30 seconds

Reference: John Ball , Tony Price, Chesney's Radiographic

3. Fixing

- Is the process of removing the unexposed AgBr without damaging the image formed by metallic silver
- It also hardens the gelatin emulsion
- The optimum temperature is 18-24 degree Celsius
- Fixing time is one to four minutes

Reference: John Ball , Tony Price, Chesney's Radiographic

3. Fixing – Cont.

- ***The fixing solution contains:***
  - i. Solvent
  - ii. Acidifier
  - iii. Clearing agents
  - iv. Hardening agent
  - v. Preservative

Reference: John Ball , Tony Price, Chesney's Radiographic

3. Fixing – Cont.

i. Solvent

- Water is normally used as solvent
- Used to dissolve the chemicals

ii. Acidifier

- Commonly use sulphuric or acetic acid
- Neutralize the basicity of the residual developer which remains on the film
- It also provides the suitable medium for the fixer and hardener to act

Reference: John Ball , Tony Price, Chesney's Radiographic

3. Fixing – Cont.

iii. Clearing agents

- Commonly use sodium or ammonium thiosulphate salt
- Also acts as fixing agent

iv. Hardening agent

- Commonly used chemical is potassium Alum
- To hard the gelatin emulsion
- Decrease the physical injury of the film

Reference: John Ball , Tony Price, Chesney's Radiographic

3. Fixing – Cont.

v. Preservative

- Commonly use chemical sodium sulphite
- Increase the life of the fixer solution
- Protects the fixing agent from decomposition (damage)

Reference: John Ball , Tony Price, Chesney's Radiographic

4. Washing

Washing:

- After fixing the film, the film must be washed with water
- Washing removes the residual processing solution and fixing chemicals
- If these chemical are not removed the image will discolor and fade
- Normally, x-ray film should be washed with distilled water or tap water
- Washing time is normally about 20 min at 20 degree Celsius

Reference: John Ball , Tony Price, Chesney's Radiographic

Limitations

Reference: John Ball , Tony Price, Chesney's Radiographic

Limitations in Conventional Radiography

- The radiographic speed is fixed and not possible to adjust patient dose
- Narrow exposure latitude (low visualization of soft tissue and bone)
- Fixed brightness and grey-scale that cannot be adjusted
- Many toxic chemicals are used

Reference: John Ball , Tony Price, Chesney's Radiographic

Limitations in Conventional Radiography – Cont.

- High repeat exposure rate
- Imaging archiving is difficult
- Time intensive
- Increased radiation dose

Reference: John Ball , Tony Price, Chesney's Radiographic

THANK YOU !