New Dimensions in Chest Radiography

LEWIS E. ETTER, M.D.* and LAWRENCE C. CROSS, R.T.**

Pittsburgh, Pennsylvania

Traditionally in the United States, large size chest x-ray film examinations are made with 14 x 17 inch films in 15 x 18 inch cassettes. When a survey minifilm reveals a questionable disease process, large films are ordered for further study. This film has become the accepted size through years of routine practice. Its use is habitual and specified in practically all hospitals, clinics and doctors' offices throughout the country.

The fact that in practically all chest films there is often uselessly exposed film at the top and gray areas, representing the upper abdomen, at the bottom of each film has excited little, if any, comment. As in so many cases where the correctness of long established practices are viewed uncritically or taken for granted, no one has questioned the necessity for the 14 x 17 inch film size and little, if any, analysis has been made of effects in this vital area of the body exposed in such radiography.

A fresh look at this procedure by the radiologist has uncovered some revealing facts and figures—facts which make possible desirable reductions in x-ray film exposure, and figures which open the door to significant economy in film costs. If one looks at a 14 x 17 inch postero-anterior

*Radiologist, Western Psychiatric Institute and Clinic, Professor of Radiology, School of Medicine, University of Pittsburgh.
**Research Technician, WPIC, University of Pittsburgh.

FIGURE 1: Chest radiographs of three types of patient showing exposure on 14 x 17 film above and corresponding 14 x 14 inch film below. Waste of film and unnecessary exposure is demonstrated in the upper examinations.
film of the chest of an average man or woman, one sees wasted film above the shoulders and a gray void beneath the diaphragm. If three inches are eliminated at the bottom of the film, usually nothing of value is lost. Review of the postero-anterior chest films of 500 men and 500 women (including 200 pregnant women), in a total of five hospitals and clinics, revealed that a 14 x 14 inch film would be quite adequate for 98 per cent of the examinations (Fig. 1).

When it is considered that millions of 14 x 17 inch chest films are used in the United States yearly, the economy of reducing the exposed area by approximately 18 per cent is obvious. Probably in excess of 20 per cent of all x-ray film examinations are of the chest for surveys as well as for definitive diagnosis and follow-up examinations.

Rapidly increasing hospital costs make it imperative that such a saving be accomplished. Any measure which would promise reduction of spending of Federal funds as in the Armed Forces, Veterans Administration and the Public Health Service would be most welcome. In these government services alone, it is estimated that $1,500,000 per year could be saved in film costs.

Use of x-ray film has increased about 150 per cent in the past 10 years and it may be expected it will continue to rise. Money saved in making chest x-ray films could be used to buy many needed smaller sizes. At current prices, a box of standard 14 x 17 inch (75) films costs $56.65. A box of the same quality 14 x 14 inch (75) films costs $46.85. This represents a saving of $9.80 on each box and amounts to about $0.13 per film.

Even more important than the economy anticipated would be the reduction of radiation dose. A considerably smaller volume of tissue would be exposed to x rays. Because of the millions of examinations made each

![EXPOSURE DOSES](image_url)

**FIGURE 2**: This bar indicates the total area exposed to ionizing radiation when conventional technique is used with an 8 inch cone or a 5 inch cone, 2mm. of aluminum filtration and a 14 x 17 inch film. Comparison of this technique with one using added filter, fast films, fast screens, fast developer, and additional copper as well as aluminum filtration with rectangular and square beam collimators indicates a tremendous reduction in skin area dose.
FIGURE 3: In this graph, using the Odelca Fairchild photoroentgen machine for chest x-ray film examinations, comparison is made of the doses to the gonads using a 14 x 17 beam collimation vs. a 14 x 14 collimation and increasing amounts of filter to achieve a negligible dose to the ovary and a vanishing dose to the testes.

FIGURE 4: At "A" is shown a typical chest radiographic examination using either an 8" or 5" cone to cover a 15" x 18" cassette. Unnecessary exposure of the upper abdomen as well as other parts of the body are seen in "B".

FIGURE 5: "A" demonstrates positioning patient for 6 feet chest x-ray examination using a square beam collimator to exactly cover a 15" x 15" cassette shown at "B". The fundus of the uterus and gonads of the fetus are out of the direct beam.
year, this becomes important in relation to total population exposure to ionizing radiation. Conventional techniques for surveys using PR machines, in vogue in most states, deliver doses to the skin in amounts of as much as 0.8r per PA film. With addition of 2 mm. of aluminum, this can be reduced about 60 per cent. By using higher kilovoltage, shorter time of exposure, fast films, hi-speed screens and aluminum combined with copper filters, a tremendous reduction in dose can be achieved. The use of a rectangular or square collimator* further reduces the volume dose and dose to the skin and gonads. Figures 2 and 3 show marked radiation reduction in the area exposed by using five inch instead of eight inch cones and marked further reduction of dose by using rectangular and square beam collimators with additional filters. The lowest

*Only Pennsylvania, New York, Michigan and Texas have laws requiring at least 2 mm. added filter in the x-ray tube.

*A special device adjustable with lights to outline square or rectangular fields used instead of cones which limit circular fields.

FIGURE 6: Radiograph of AP lordotic projection on an 11" x 14" film which clearly shows infraclavicular disease but not unnecessary exposure beneath the diaphragm.

FIGURE 7: Opened 15" x 18" cassette showing 11" x 14" film in place for AP lordotic projection of chest.
possible dose is obtained by combining all the factors viz, square beam collimation with 14 x 14 inch film size, fast films, fast screens, fast developer and copper with aluminum filters (Figs. 2 and 3).

X-ray technique is of particular importance in prenatal examinations. In the last trimester of pregnancy, the uterine fundus will almost always lie in the field of radiation when an exposure is made on a 14 x 17 inch area (Fig. 4). Inasmuch as the diaphragm is high during pregnancy, there is little difficulty experienced in getting all of the lung fields on a 14 x 14 inch film (Fig. 5). It is true that in many women, the chest can be completely visualized on an 11 x 14 inch film. Furthermore, since most presentations are cephalic, the gonads of the fetus are near the fundus and would be spared direct radiation when the square film with beam collimator is used. Geneticists are in general agreement that there is no threshold below which radiation may not be dangerous to the gonads. Certainly, inclusion of the developing embryo in utero would represent a most critical situation.3,4,5

Throughout the United States, many AP lordotic views of the chest are made to search for possible infraclavicular extension of disease (Fig. 6). In these views, the area of interest is positioned high on the film. At least the lower one-third, if not more, of the film is wasted, and is not needed for study. For this kind of view, it is suggested that an 11 x 14 inch film (commercially available) be used, placing it in the upper part of the 15 x 18 inch cassette (Fig. 7). As with the 14 x 14 inch film using

FIGURE 8: Use of a square beam collimator or cut-out lead aperture is illustrated in PR unit. Unnecessarily large field is irradiated with cone versus collimated beam adjusted to 14" x 14" area for production of 4" x 4" survey film.

FIGURE 9: Opened 15" x 18" cassette showing positioning of 14" x 14" film in upper portion where pressure of screens will retain it.
square collimation of the beam, a rectangular field of x rays would be projected to the area of interest, thus achieving a great reduction in dosage.

With the collimator adjusted for a square zone of radiation, the 14 x 14 inch film may be used equally well for lateral and oblique views of the chest. It will be necessary, and this may require close supervision and added training, for x-ray technicians to be more exact in positioning the patient and centering the beam to achieve uniformly good results.

A square beam collimator can also be used for minifilms when a 4 x 4 inch film can be substituted for one 4 x 5 inches (Fig. 8). There will result a small saving in cost but a considerable reduction in dosage because of irradiation of smaller volume of tissue.

There may be some questions about “retooling” for this procedure. The first thing to do is order 14 x 14 inch films and processing hangers for posterio-anterior, lateral and oblique chest x-ray film examinations. These are commercially available from suppliers. While it would be easier to buy and use 15 x 15 inch cassettes, this is not necessary. A 14 x 14 inch film may be placed in a 15 x 18 inch cassette by pushing it to the hinged end where the screen pressure will hold it in place (Fig. 9). When it becomes necessary to buy new cassettes to replace 15 x 18 inch ones, only 15 x 15 inch cassettes and screens need be purchased for chest x-ray film examinations, thus effecting another considerable saving in cost of equipment.

It is routine in many hospitals and clinics to make a film of the abdomen in addition to one of the chest. When 14 x 17 inch films are used for both of these examinations, there is obviously an overlap of radiation in the region of the diaphragm. Since anything less than a 14 x 17 inch film is not adequate for the adult abdomen, this double exposure can be prevented by use of a 14 x 14 inch chest film with square collimation.

SUMMARY

The advantages of a 14 x 14 inch film of the chest compared with a standard size 14 x 17 inch one are as follows:

1) Saving of approximately 18 per cent in cost by purchase of the smaller size film. This figure is about $0.13 less per film and would represent a tremendous savings since millions of chest x-ray film examinations are being made in the United States today. A proportionately smaller total dollar saving but a higher percentage saving (20 per cent) would be effected by using a 4 x 4 inch film instead of the 4 x 5 inch one in photogrammetry.

2) Lower volume doses to critical areas of the body as well as smaller skin and gonad doses are obtained when the beam collimator is used with a 14 x 14 inch film or the smaller 4 x 4 inch PR film.

3) Vital reduction of x-ray exposure to the mother and to the gonads of the fetus in prenatal x-ray examinations, either by using the 14 x 14 inch film or the 4 x 4 inch PR films.

RESUMEN

Las ventajas de la película de 14 x 14 pulgadas sobre la estandar de 14 por 17, son las siguientes:

1) Ahorro de aproximadamente el 18 por ciento de costo. Esto significa aproximadamente $0.13 menos por película, lo que es un tremendo ahorro ya que se hacen millones de películas de tórax en los Estados Unidos en la actualidad. Un ahorro proporcionalmente menor del total de dólares, pero un porcentaje mayor (20%) sería el obtenido usando películas de 4 x 4 pulgadas en lugar de 4 x 5 en roentgenografía.
2) Menor volumen de dosis de radiación sobre áreas más sensibles del cuerpo así como dosis menores sobre piel y gonadas se obtienen cuando se usa el colimador del haz con la película de 14 x 14 cm con la de 4 x 4 en Roentgenfotografía.

3) Reducción vital de exposición a los rayos X de las madres y de las gonadas del feto con los exámenes prenatales, ya sea usando la 14 x 14 o la 4 x 4 en las respectivas técnicas.

RESUMÉ

Les avantages du film thoracique de 35 cm x 35 cm comparé à la dimension standard de 35 x 43 cm sont les suivants:

1) Une économie d'environ 18% du prix de revient par l'achat de film de taille plus petite. Ce chiffre est d'environ 0.13 dollar de moins par film et représenterait une économie énorme sur les millions d'examens radiographiques thoraciques qui sont actuellement pratiqués aux Etats-Unis. Une économie totale proportionnellement plus petite en dollar mais plus grande du pourcentage (20%) serait effectuée en utilisant un film de 10 cm x 10 cm au lieu de 10 cm x 13 cm en radiographie.

2) Des doses plus faibles en volume pour les zones critiques du corps ainsi que des doses cutanées et gonadiques plus petites sont obtenues quand on utilise un film de 35 x 35 cm ou la radiographie plus petite de 10 x 10.

3) La réduction vitale de l'exposition aux rayons pour la mère et pour les gonades du fœtus dans les examens radiologiques prénataux, soit en utilisant le film de 35 x 35 ou la radiographie de 10 x 10.

ZUSAMMENFASSUNG

Die Vorzüge eines 35.6 x 35.6 cm Films des Thorax im Vergleich zur Standardgröße von 35.6 x 43.3 cm sind folgende:

1) Einsparung von etwa 18% der Kosten beim Einkauf des kleineren Formats. Dieser Wert liegt bei ungefähr 0.13 $ pro Film und würde eine ganz enorme Ersparnis bedeuten; werden doch heute in den USA Millionen von Thorax-Röntgenaufnahmen angefertigt. Eine verhältnismäßig geringere Geldersparnis, jedoch eine höhere prozentuale Ersparnis (20%) würde erreicht bei Verwendung von 10 x 10 cm Filmen anstelle der 10 x 13 cm Filmen, die für die Schirmbildaufnahme gebraucht werden.

2) Geringere Volumendosen für die kritischen Körperabschnitte ebenso wie niedrigere Haut- und Gonaden-Dosen bekommt man bei Benutzung des Stahlen-Colimators in Verbindung mit einem Film der Größe 35.6 x 35.6 cm oder des kleineren 10 x 10 cm Schirmbildfilmes.

3) Man erzielt eine äußerst wesentliche Verringerung der Röntgenstrahlenbelastung für die Mutter und die Gonaden des Fetus bei vorgeburtlichen Röntgenuntersuchungen sowohl bei Verwendung des 35.6 x 35.6 cm Films wie auch des 10 x 10 cm Schirmbildfilmes.

REFERENCES


3 A Practical Manual on the Medical and Dental Use of X Rays with Control of Radiation Hazards, Published by The American College of Radiology, p. 9.
