

PATIENT DOSE IN DIAGNOSTIC X-RAY EXAMINATIONS:
USE OF THE RANDO PHANTOM AND A DESK-TOP COMPUTER

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1. INTRODUCTION

Patient dose during diagnostic x-ray examination is receiving ever more attention from radiation scientist. Methods of estimating patient dose are becoming more sophisticated and analyses of possible radiation responses are becoming more precise. This paper reports several techniques developed to measure patient dose during x-ray examination and the results of application of these techniques to representative examinations.

2. THE RANDO PHANTOM

The Alderson Rando Phantom (Alderson Research Laboratories, Inc.) is a standard device used for radiation therapy dosimetry studies. The phantom can be equally valuable at diagnostic energy levels if one is aware that dosimeter position within the phantom can influence the measurement of dose.

The Rando Phantom consists of a human skeleton encased in tissue equivalent Rando plastic (mass density = .985 gm/cm³, \bar{Z} = 7.30) molded to the shape of the human body and sliced into transverse sections. A coating layer of Rando plastic is applied to each of the section faces and this coating produces discontinuities. Each phantom section is drilled with 5 mm diameter holes which are filled with "Mix D" plugs.

The Alderson Rando manual suggests placing disk type TLD's into a shallow counterbore in the section face above a shortened hole plug.

Since the coating thickness of each section face was approximately equal to the TLD thickness, a study was undertaken to determine if the suggested positioning of the TLD's would result in erroneous dose measurement.

TLD's were positioned mid-way in a phantom section surrounded by equal amounts of "Mix D" plug. An equal number of dosimeters were placed in atop a shortened plug within the coating layer of Rando plastic.

The absorption properties of the coating layer in a lung section result in as much as a 39% error in dose measurement if the dosimeter is located within the coating layer.

3. DESK-TOP COMPUTER PROCESSING

Computer programs were designed for analyzing data obtained using lithium fluoride dosimeters and the Rando phantom. The Wang 720 system has been used to calculate the sensitivity and maintain the exposure history of up to 1,000 dosimeters. The programs also compute the dose to each following experimental irradiation. The system consisted of a Wang 720-C desk top programmable calculator, a Wang 729 random access magnetic tape cassette memory unit and a Wang 702 IBM printer/plotter. The analysis is divided into two programs.

The first program calculates and maintains a history of the radiation response of each TLD. The second program has two segments. Part A calculates a conversion factor (nanocoulombs to millirads) from data supplied by irradiation of control dosimeters to known dose. Part B applies this conversion factor to calculate the dose received by each experimental dosimeter. Finally, the program replaces each TL reading on magnetic tape with the recorded dose. These stored values can be readily accessed for statistical evaluation or interfaced with other interpretative programs.

4. PATIENT DOSE

These procedures have been applied to the measurement of patient dose during various representative x-ray examinations. For each procedure, the Rando phantom was loaded with TLD dosimeters as previously described. Radiographic and fluoroscopic factors as normally employed in our hospital were set. In some instances multiple radiographic exposures were necessary in order to provide for adequate dosimeter response from dital dosimeters. The results show entrance exposures ranging from 1500 mR for a KUB exam to less than 50 mR for a PA chest. Fetal doses from near zero to 700 mrad per view were measured.