Eur Radiol (2005) 15: 1477–1484
DOI 10.1007/s00330-004-2571-2

PHYSICS

M. Finnerty
P. C. Brennan

Protective aprons in imaging departments: manufacturer stated lead equivalence values require validation

Received: 9 June 2004
Revised: 5 October 2004
Accepted: 15 October 2004
Published online: 24 March 2005

M. Finnerty · P. C. Brennan (✉)
UCD School of Diagnostic Imaging,
St Anthony's, Herbert Avenue,
Dublin 4, Ireland
e-mail: patrick.brennan@ucd.ie
Tel.: +353-1-2094424
Fax: +353-1-2837425

Abstract The composition of protective aprons worn by X-ray personnel to shield against secondary radiation is changing. Lead is being replaced by either lead-free or composite (lead with other high atomic numbered elements) materials. These newer aprons are categorised by manufacturers in terms of lead equivalent values, but it is unclear how these stated values compare with actual lead equivalent values. In this work, the actual lead equivalence of 41 protective aprons from four manufacturers, all specified as having 0.25 mm lead equivalence, were investigated with transmission experiments at 70 and 100 kVp. All aprons were in current use. The aprons were screened for defects, and age, weight and design was recorded along with details of associated quality assurance (QA). Out of the 41 protective aprons examined for actual lead equivalence, 73% were outside tolerance levels, with actual levels in some aprons demonstrating less than half of the nominal values. The lack of compatibility between actual and nominal lead equivalent values was demonstrated by aprons from three of the four manufacturers investigated. The area of the defects found on screening of the protective aprons were within recommendations. The results highlight the need for acceptancy and ongoing checks of protective aprons to ensure that radiation exposure of imaging personnel is kept to a minimum.

Keywords Radiation dose · Defects · Transmission

Introduction

Protective aprons play a key role in the radiation protection of personnel in radiology departments. They are worn in examination rooms during radiological examinations and their specific function is to provide shielding against secondary radiation. Practically, they are used for a variety of diagnostic imaging procedures including angiography, fluoroscopy, mobiles and theatre, and are designed to shield approximately 75% of radiosensitive red bone marrow [1]. The Medical Guidance notes (2002) issued by the Institute of Physics and Engineering in Medicine (IPEM) regarding protective clothing states "Body aprons should be available with a protective equivalent of not less than 0.25 mm lead for X-rays up to 100 kV and not less than 0.35 mm lead for X-rays over 100 kV" [2].

Protective aprons have evolved through the years. Originally, protective aprons consisted of lead-impregnated vinyl or rubber with a shielding equivalent given in millimetres of lead. All contained up to 1 mm of lead and were heavy and uncomfortable for the wearer, particularly when worn for long periods. Recent evidence has been provided demonstrating that lead apron use may be linked to development of back pain [3], and this has led to a number of investigations looking at producing protective aprons at a reduced weight. Uniform layers of iodine (Z=53), tin (Z=50)