Quality control of individual radioprotection equipment: methodology and organization in the Geneva University Hospitals

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Introduction:

In 2018 the new Radioprotection Ordinance in Switzerland came into force requiring the radiation protection equipment (RPE) to be checked annually for its proper performance providing safe operating conditions for staff working with ionizing radiation. It is up to the radiation protection expert to make an inventory of the existing RPE, to assure the follow up and to setup a quality control procedure to ensure its performance. For this purpose, all RPE from the Geneva University Hospitals (HUG) have been introduced in the internal equipment management database system (EMDS). Moreover, a quality control procedure has been established considering the most logical and optimized method for the institution.

In total 670 RPE (skirts, jackets and aprons with their corresponding thyroid shields) are available in HUG belonging to 30 different departments. Through this paper we wish to expose our methods and the results of the "1st check" performed on 60% of the total existing RPE in six months.

Materials and methods:

Self-adhesive labels were used to identify all RPE. Once identified, the aprons, skirts, jackets and protective thyroid shields were tested by three inspectors using different methods: first visually then tactilely and at the end radiographically *(Fig. 1)*. All methods were compared between each others, but only the radiographic method was used to qualify the equipment. Concerning the visual and tactile methods, an agreement is reached when the three inspectors give the same answer.

QUALITY CONTROLS			
	1st : Visual	2nd: Tactile	3rd : X-ray
MODE			
CRITERIA QUESTION	Tear in the outer layer? Defects at the fasteners?	Suspicious mass? Internal tear? Tear at the fasteners/seams?	Internal tear/hole? Tear at the fasteners/seams?
ANSWER	YES / NO	YES / NO	Score (see *Figure 2*)

Figure 1: Methods for quality controls

We chose the EOS® system as radiographic method since it provides 2 acquisitions at the same time (front/profile) in vertical position (wearing position) and without further exposure of the staff. The RPE is held on a radiotransparent mannequin. A score, established according to the location of the detected defects *(Fig. 2)*, is provided as the addition of the defects. Each defect has a different weighting factor depending of its position in the RPE.

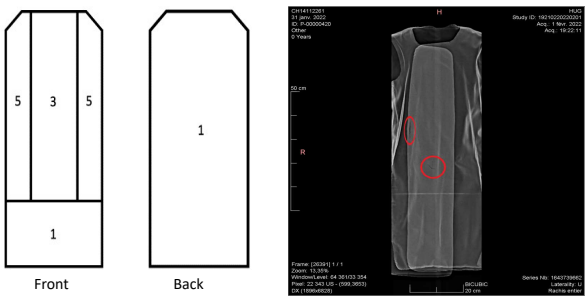

Figure 2: Protective shielding weighting factors to determine a score

Results:

Quality controls are time-consuming and require an extensive logistics. The results for the comparison of the **394 RPE** checked by both visual and tactile methods performed by three different inspectors shows a great disparity in the rate of agreement as shown in Table 1. The highest disagreement was found for the visual method.

INSPECTION MODE	VISUAL		TACTILE		
CRITERIA	Tear in the outer layer	Defects at the fasteners	Suspicious mass	Internal tear	Tear at the fasteners/seams
AGREEMENT BETWEEN THE 3 INSPECTORS	61,9%	69,0%	89,6%	93,4%	98,0%
AVERAGE AGREEMENT	65,5%		93,7%		

Table 1: Comparison results

Furthermore, the visual/tactile methods were compared to the radiographic method. If the answer "yes" was chosen, by at least one or more inspectors, for any of the questions in figure 1 in regard to the visual or tactile method, we concluded that the final result would therefore be "yes". This result was compared to the radiological inspection. It turned out that there was **84.2%** agreement between the visual/tactile and radiological inspection results.

The equipment were scored following the criteria in table 2 and the results validated by a radioprotection expert. The results of the scoring qualifies the equipment as:

0-2	OK – Back to department
3-5	To be withdrawn in the coming months (until new replacement equipment arrives)
>5	To be removed immediately (waste)

Table 2: Classification of RPE

In total, from the 394 RPE checked, **354** were scored 0-2, OK for clinical use (e.g. figures 3a and 3b); **13** had a score 3-5 and should be withdrawn in the upcoming months (e.g. figure 3c) and **27** items were scored >5 and were removed immediately (e.g. figure 3d).

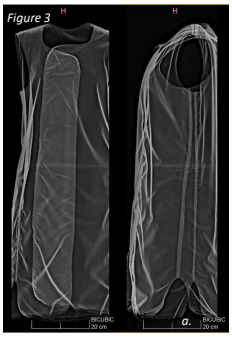

Figure 3a:
Department: Angiography
Manufractured in 2009
*Score: **0** → Back to department*

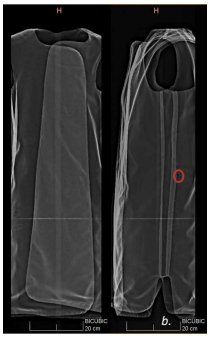

Figure 3b:
Department.: ER Radiology,
Manufractured in 2016
*Score: **2** → Back to department*

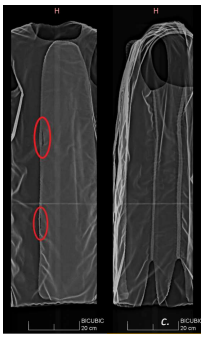

Figure 3c:
Department: CT scan
Manufractured in 2010
*Score: **4** → To be withdrawn asap*

Figure 3d:
Department: Angiography
Manufractured in 2015
*Score: **14** → Go to waste*

Major defects were observed on equipment used in operating theaters, cardiology and angiography rooms. Indeed RPE in those departments are very frequently used. Moreover we have noticed that their storage is not optimal. For those used in conventional radiography, very few defects have been observed. All the RPE classified >5 were over **5 years**.

Conclusions and outlook:

Visual and tactile checks are both inspector dependent, tactile controls require a careful inspection on a flat surface to detect defects. They are insufficient in 15.8 % of cases to guarantee the integrity of personal radiation protection equipment, **imaging is therefore necessary**. We observe that their lifespan depends greatly on their use but also on their storage. A more detailed analysis of the data (being collected) will allow us to define an expiry date for RPE according to their class of use, permitting us to target quality controls while offering controls on demand.

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