
Towards an integrated management of health physics and medical physics

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Abstract:

AVN is a licensed body that performs health physics control in different types of installations, from large nuclear facilities to small dentist cabinets. AVN¹ can also provide medical physics services for the quality control of, for instance, medical devices used in a radiology or nuclear medicine department. Radiation protection for personnel and environment (health physics) and radiation protection for the patient (medical physics) are usually treated separately, using different referential documents, such as the European Directives 96/29/Euratom² for health physics and 97/43/Euratom³ for medical physics. This difference is also clearly reflected in the Belgium legislation⁴ (two types of accreditation/licence for inspectors, different chapters in the law,...) From a practical point of view it is sometimes rather difficult to split the task "on site" during an inspection. An RX system not complying with radiation protection criteria can definitively affect the patient as well as the workers. On the other hand, the hospitals, cannot easily differentiate these two tasks because they are not fully aware of the legislation and they are mixing both. Taking into account the health physics guidelines as well as medical physics guidelines, we have decided to move to an integrated approach of these two concepts.

1 INTRODUCTION

In Belgium, the regulatory body is the FANC (Federal Agency for Nuclear Control). For historical reasons, the control tasks in hospitals were and are still mainly done by three licensed bodies: AVN (Association Vinçotte Nuclear), AVC (Association Vinçotte Controlatom) and Technitest. The licensed body has to take over the health physics control of the hospital (through FANC delegation) if the hospital does not have its own expert. This situation is almost the same for the medical physics task. An hospital without a medical physics expert can subcontract this task to an external independent expert. This working manner is only accepted for the nuclear medicine and radiology services. A medical physicist in radiotherapy has to be on the payroll of the hospital where therapy is performed.

To get a license as health physics expert, you must hold a masters degree in engineering or sciences and have to apply to FANC after a 150 hours specialized course. You may have to demonstrate to FANC your knowledge and experience in this field of activities.

For medical physics expertise after an engineering or science masters you have to follow 650 hours of course (including the 150 hours course in health physics) and follow a practical training of one complete year in a hospital institution. The training done in a nuclear medicine department leads to a licensed expertise in nuclear medicine. The training done in a radiology department leads to a licensed expertise in radiology. To get both licences (nuclear medicine + radiology), two trainings have to be followed. Until now there is no possibility to get the three licences (nuclear medicine + radiology + radiotherapy).

This paper describes briefly some challenges that both health physicists and medical physicists are facing in their daily inspection work. The common problems of these two aspects of safety are also discussed driving a clear split of the two tasks to avoid overlaps and to extract synergies.

2 HEALTH PHYSICS CHALLENGE IN HOSPITAL ENVIRONMENT

The role of health physicists in hospitals is quite complex, asking high ranking technical skills as well as some psychology in the way they have to understand other disciplines priorities. At the level of the technical problem, the health physics expert has to focus now and in the future on two problems. The first one came from the invasion of brand new not well known hightech equipment. The second derives from the first one. It is the high turnover of these new equipments and the remaining problem of waste and dismantling of activated material.

2.1 Safety assessment of new technology

Brand-new equipment based on innovative technologies is being introduced in the hospital environment, mainly in imaging services as well as therapy units. They are essential nowadays to treat patients. These extremely useful tools are becoming much more powerful and versatile than in the past. Their complexity and the sensitivity of their technologies made them usually followed up through maintenance contracts with the suppliers. They are also regularly upgraded by the suppliers.

New systems have to be assessed from the safety point of view by the health physics expert. For the setup of new devices, health physics expert have to interact with the hospital organization and with the manufacturers in order to establish for instance :

- controlled areas
- shielding
- interlocking of the systems with environment (door opening), ...

Due to an increased complexity of systems and regulations, the task usually taken over by the health physics expert requires a lot of time and requests, more than in the past, a coordination towards a multidisciplinary approach taking care of other constraints such as :

- HVAC
- pharmaceutical regulation
- fire protection, ...

Because the system is regularly upgraded, the health physics expert could not consider his task as one shot for the set-up. In fact, during the lifetime of the installation, upgrades will usually modify the performances of the system and this will affect the environment and the safety of this environment.

An illustration of this problem could be highlighted by the tremendous increase in power (see table 1) of cyclotrons used for the production of PET emitters. They are usually set-up in an hospital environment. The building of a full PET center will require advice of a multidisciplinary team : the health physics expert, pharmacist, doctor in medicine, radiochemist, physicist ... Compared to the production level of fluor-18 in 1991, cyclotrons are producing 50 times more nowadays bringing the dose rate level in the immediate surrounding of the cyclotron once producing proton beam at 18 MeV on O¹⁸ from 9.3 Sv/h to 64 Sv/h. The global basic design of such a machine in 1991 is almost the same nowadays except for the boost of some subsystems : ion source, cooling efficiencies, ... These upgraded subsystems could be set up on old machines and could drive problems in a facility initially assessed for a certain level of performances : insufficient shielding, contamination problems, radioactive gas release, ...

It is of extreme importance to the health physics expert to follow the history of these types of equipment.

Same trends (and problems) could be met on other devices used for instance in radiotherapy or some imaging modalities. Last but not least, in some hospitals where refurbishment occurs, the decision of moving one system to another location can be taken without great care about the safety.

It is rather evident that the safety culture level is not the same in an hospital compared to nuclear industry.

Table 1 : evolution of the acceptance criteria of cyclotron suppliers for the production of fluoride-18 from $^{18}\text{O}(p,n)^{18}\text{F}$ nuclear reaction at 18 MeV

	^{18}F radioactivity at EOB	^{18}F radioactivity at EOB with dual beam
1991	300 mCi	Not reliable
1995	3000 mCi	Not reliable
1997	5000 mCi	10.000 mCi
2007	7000 mCi	14.000 mCi

EOB : end of bombardment

2.2 Dismantling

Dismantling of activated equipment is becoming a much more important issue in hospitals than in the past. It is common to replace obsolete equipment every 5 to 10 years depending on the evolution of the technology. Some equipment e.g. conventional radiotherapy accelerators are initially delivered free of any radioactive material and they are becoming radioactive by the use in hospital. It is for instance well known that linear accelerators with energy higher than 8 MeV will activate the head of the system through γ,n nuclear reaction. At the end of the cycle of the system and depending on the replacement contract, the activated system will remain in the hospital or will be taken over by the supplier of the new equipment. The old system leaves Belgium to be dismantled in a safe way or is sold as a second hand supply. For the remaining equipment, the hospital has to contact ONDRAF (Office National de Déchets Radioactifs et des matières Fissiles, the Belgian waste agency) in order to set up an evacuation and dismantling program.

Hospitals are reluctant to move into this way because the process is certainly not cost effective and because they do not really have the engineers to fix this task.

3 MEDICAL PHYSICS CHALLENGE

Like health physicist, medical physicists have a role requesting also a high scientific background as well as some psychology to understand the priorities of other disciplines we can meet in hospitals. In Belgium, the reference documents that should be provided by the regulatory body as well as the recognition are the two first problems met by medical physicists. The third problem for medical physics experts comes from the versatile new technology arriving on this market, including the hybrid type of machines.

3.1 References

The guidelines that medical physicists have to follow to control the different systems have to be published by FANC as regulatory body. In absence of this guidelines, FANC recommend to use RP 91⁵ as a base for the quality control that the medical physicist has to establish in the hospital. RP 91 was published in 1997, since this date a lot of new equipments came on the market : Digital Imaging detectors (replacing film), PET, PET/CT, Tomotherapy systems, ... and they are not covered by the guidelines included in RP 91. On the other hand, this reference mixes typical health physics tasks (RX tube leaking) with usual medical physics tasks. RP 91 that is still today the reference document of our regulatory body is insufficient. Depending on the medical physicist personal perception of the quality assurance, an increase of the number of tests is setting up taking into account the complexity of the system tested. We could refer to some excellent references written by the "Société Française des Physiciens d'Hôpitaux"⁶ or "Nederlandse vereniging voor nucleaire geneeskunde"⁷.

3.2 Follow up of the new technology

We assist nowadays to a tremendous evolution of the technologies used in the medical field. Three years ago, hybrid systems were introduced on the Belgium market : PET/CT and SPEcT/CT bringing with them a new conceptual approach of the imaging workflow in hospitals. Two years ago, 5 units of brand new radiotherapy technologies were sold raising a lot of question in terms of the quality assurance program that has to be established to run safely these systems. Some projects of setting up new Protontherapy facilities are under discussion. The analysis of the safety of such new system by using an old referential could lead to some disappointment. It is important that a close collaboration between medical devices suppliers and medical physicist occurs. In that field, some companies are much more open to collaborate than others.

3.3 Course/recognition by the Federal Agency for Nuclear Control

As it was written in the introduction, as a medical physicist expert, you can apply for a health physicist recognition because during your study you have followed the basic course of health physics expert. The regulatory body licenses today without too much problems medical physicists in health physics domains.

For the recognition as medical physics expert, we have a fragmentation in three domains : radiotherapy, nuclear medicine and radiology. Nowadays, the regulatory body tends to increase the fragmentation in the recognition. To get a full a license in radiology, they are asking practical experience in CT, C-arcs, dentistry, mammography and conventional radiology, ... and we observe the same trends in nuclear medicine. In this domain, the regulator asks for experience in PET, SPEcT, ionisation chamber, ... to obtain a full licence in nuclear medicine. This attitude has an important impact on the speed of the recognition (more than one year between the first contact with FANC and the final decision of the regulator) and this hyperspecialisation trend reduces the global overview needed to check the safety of a medical department. This policy has also a side effect : maintaining a penury of specialists on this market.

Does it make sense to deeply test one PET system and search for details if the vial containing the tracer is not correctly labelled and at the end injected in a wrong patient ?

The suppliers of medical devices pursue their research and development effort and in recent conferences, they present what should be future hybrid machine PET/NMR or CT coupled with NMR. NMR does not generate ionizing rays and according to our law should not be

placed under the supervision of a medical physicist expert. However, we are all aware that the coupling of these imaging modalities with PET for instance will affect the range of the positron constraint by the magnetic field of the NMR system and at the end the resolution of the PET system.

Does the regulator have to put in place new recognitions for NMR or echo ?

4 COMMON PROBLEMS

Last year, we met problems where synergies between health and medical physicist are absolutely mandatory. It is the overdoses exposure and the arrival of new hybrid equipment that has to be assessed for safety and accepted by different fields of expertise in medical physics (acceptance testing).

4.1 Overdoses exposure

When a dose has been given accidentally by an imaging medical device, to a pregnant women for instance, it is usually the task of the medical physicist to reconstruct the exact amount of energy absorbed by the body. In AVN, the dose estimation is usually transferred to the doctor, the FANC and the health physics expert of the hospital according to an interpretation of the Belgian law. It is sometimes rather difficult to coordinate the information transfer (without damage to the quality of this information) through all intervenants. On the other hand a clear explanation of the doses calculation could only be done by the medical physicist expert and not the pure health physics expert.

4.2 Hybrid systems

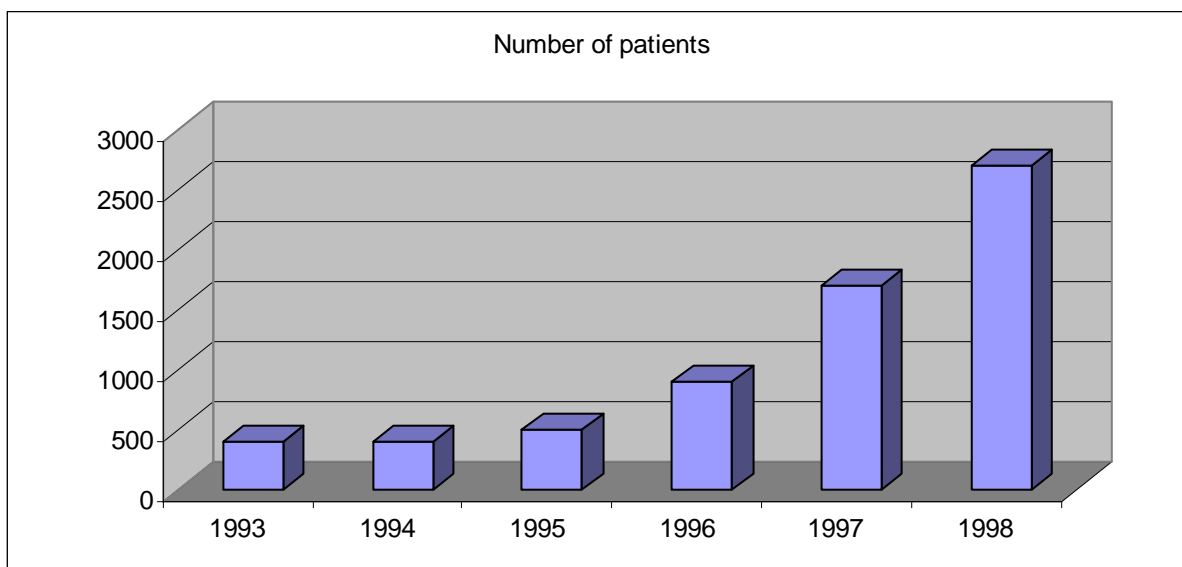
This last 5 years, a lot of hybrid systems combining nuclear medicine modalities (PET or SPEcT) and radiology (CT) came on the Belgium market. As it was highlighted in 3.3, FANC only delivers a license for one field of expertise. In theory, the full control of an hybrid system in terms of health physics as well as medical physics requires the presence of three licensees :

- licensee in medical physics specialities nuclear medicine
- licensee in medical physics radiology
- licensee as health physics expert

By the way, using three independent licensees does not give a global overview over the safety of the running system but a partial view of each subsystem of the hybrid cameras. The gain expected by the supplier and the users by merging the different imaging modalities disappear if this control is not made by a medical physicist with a global overview of the system including the health physics aspect. This global overview is extremely important specially because one imaging modality impacts the other and vice versa.

On the other hand, the technology improvement could drive indirect effect like a patient exams increase per day. The safety principle, which has to be taken over by the health physics control will be modified (see table 2).

Table 2 : influence of the introduction of a new PET/CT system on the number of patients treated.



As it was demonstrated previously it is sometimes not easy to make a clear difference between the medical and health physics tasks in hospital. These two fields interact a lot in some cases. Beginning 2007, AVN decided that our medical physicist expert will try to apply for health physics recognition as well as usual medical physics recognition. Taking account of RP91, we clearly split the task between health and medical physics but these tasks are done by the same expert (one reference for one hospital). Their field of expertise is quite broad and they have a global overview about the safety of equipment in hospitals : patient as well as worker care. For punctual specialized problems, we could imagine subcontracting some tasks.

5 CONCLUSION

The licence fragmentation leads to a partial specialised view of some applications used in hospitals.

This approach affects the general safety overview we are thinking we must have to check a medicine service.

AVN came to the conclusion that the only way to establish again this general overview consists in encouraging medical physics experts in applying also for health physics recognition.

On the other hand, as it was demonstrated previously, it is sometimes not easy to make a clear difference between the medical and health physics task in hospital. These two fields interact a lot in some cases. Taking account of RP91 (still the official, the available reference today), we clearly split the task between health and medical physics but these tasks are done by the same expert (one expert for one hospital). Their field of expertise is quite broad and they have a global overview about the safety of equipment in hospitals : patient as well as worker care. For punctual specialized problems we could imagine subcontracting some tasks.

For the concerned hospitals, we feel it is more convenient for them to have one responsible external contact person for all radiation protection matters, be it environmental, professional or patientwise.

6 REFERENCES

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