Reviewing a Major Incident Plan for Contaminated Casualties from a Naval Base arriving at an NHS Hospital, and Liaison between NHS, MoD and Babcock physicists

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Background: HM Naval Base Devonport and Babcock International's Devonport Royal Dockyard jointly form the largest naval support site in Western Europe. Babcock's facilities include the UK's only licensed site for refitting and refuel of nuclear-powered submarines, including Trafalgar and Vanguard-class submarines. Derriford Hospital in Plymouth would be the receiving trauma centre for any contaminated casualties in the event of an incident at Devonport. Derriford has a Major Incident Plan for receiving potentially contaminated casualties should such an incident occur. Ownership of this is held by the Clinical & Radiation Physics (C&RP) group, with oversight from clinical scientists/RPAs/RWAs within Nuclear Medicine.

The Babcock International Emergency Planning Group based at Devonport has an extensive emergency responder call out list, with certain roles requiring a 24/7 presence on site. Physical resources include dedicated emergency response facilities, vans equipped with monitors and the capability for the decontamination of personnel . By contrast, the C&RP Emergency Call Out list consists of eight people, half of whom do not live in Plymouth, and typical monitoring equipment for a hospital Nuclear Medicine department.

Processes: A strong working relationship has built up over time between C&RP and the Devonport Emergency Planning Group. With staff turnover and periodic reviews of practices, we felt that it was important to build stronger links, better communication and greater understanding of each other's procedures. The Derriford contingency arrangements are reviewed and updated every two years. At the latest review, the receiving medical theatre was in the process of being demolished, therefore part of this review involved the designation of a suitable theatre to receive a critically injured contaminated patient, whilst reducing the impact to the rest of the hospital. We further considered the likely support available from medical physics personnel in the event of an incident, and how skills from different staff groups could be best utilised to support monitoring, decontamination and limiting contamination spread.

Lessons Learned: We considered security implications and realistic staffing scenarios for out of hours incidents. We walked through areas of ED and Theatres with local staff to ensure viability of plans. We sought help from the Babcock Emergency Planning Group to discuss handover arrangements for contaminated casualties and likely scenarios.

Best Practice: Several familiarisation visits took place, both for hospital staff to visit the Naval Base and vice versa. Babcock/MoD staff were taken on tours of relevant areas of the hospital to better envisage realistic enactment of the plans. UHP staff visited the Devonport site and watched contingency plan rehearsals. Additionally, we set up a secondment placement scheme for a Babcock Health Physics trainee at Derriford Hospital to help us review our plans and provide insight into what would be expected from an incident at Devonport.

Conclusion: This presentation will discuss an outline of the actions involved when enacting the plan, and how the Derriford Hospital physicists has learned from Babcock and MoD colleagues. A particular highlight was the secondment placement scheme which we hope to run in the future.

Environmental radiation monitoring in and around a radioisotope therapy suite

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Background.

Environmental radiation monitoring is a key part of ensuring compliance with IRR17 [1]. IRR17 regulation 20 IRR17 requires adequate monitoring of designated areas, and within the IRR17 ACOP [2] it is stated that "monitoring is needed both inside and outside the boundaries of controlled and supervised areas".

Methods.

Environmental radiation monitoring was performed in, and around an inpatient molecular radiotherapy suite comprising three en-suite rooms used for I-131 and Lu-177 treatments. Luxel® OSL dosimeters were used to measure the external radiation exposure by Optically Stimulated Luminescence (OSL) technology. The minimum measurable dose by the dosimeters is 0.01 mSv. Monitoring is normally performed every two years; however, it was noted that previous monitoring had not considered areas situated above and below the therapy suite. In this instance dosimeters were placed in, around, above and below the therapy suite for between 47 and 71 days depending on access. TADR2000 values were calculated from the measured values.

Additional dose-rate measurements were performed in one of the areas below the inpatient rooms to ascertain whether the radiation exposure detected on the dosimeters was from the patients above the area, or the soil pipes from the therapy rooms which exits the building through a neighbouring duct. Measurements were performed with a patient treated with I-131-NaI in a patient room in a known location and then using the bathroom.

Results.

In the areas above the therapy suite measurements were all <0.01 mSv. Within the therapy suite itself measured doses varied from 0.17 mSv to 0.89 mSv over 69 days. In the area below the therapy suite doses varied from 0.01 to 0.92 mSv over 69 days, with the highest measurement of 0.92 mSv in a kitchen. The calculated TADR2000 values for this room was 0.009 μSv/hr respectively, equating to a dose per annum of 18 μSv.

Dose-rate measurements within the kitchen increased during patient excretion to 2.5 μSv/hr, 2 and a half hours after administration of 1.1 GBq of I-131 NaI. The highest dose-rates were found at the position of the soil pipes.

Discussion.

The TADR2000 calculations for the staff room and kitchen below the therapy suite were below the 0.15 μSv/hr threshold for a supervised area [3]. Dose-rate measurements showed an increase in the dose-rate at the position of the soil pipes during patient excretion. Soil pipes from the three rooms merge to one pipe through a ducting to leave the building, thus the measured dose-rate will be higher when all three rooms are occupied.

Conclusion.

Area designations within the ward will remain as they are currently. Any further development in the area underneath the therapy suite will have to involve the Radiation Protection Advisor (RPA), and a full review of the radiation risk assessment will be required. The RPA has advised that the pipes are boxed in with lead for any change in room occupancy.

Key references.

1. Ionising Radiation Regulations 2017, UK Statutory instruments No. 1075. 2017. https://www.legislation.gov.uk/uksi/2017/1075/contents
2. Work with Ionising Radiation, Ionising Radiation Regulations 2017, Approved Code of Practice and guidance, HSE, 2018. https://www.hse.gov.uk/pubns/priced/l121.pdf
3. Medical and Dental Guidance Notes, Institute of Physics and Engineering in Medicine, 2002

Title of Study: Absolutely barney? – Radiation protection challenges in an open plan theatres

Submitters details Lauren Tedder, University Hospital Dorset

Abstract no more than 1 page in Arial 11 point, presenting speaker underlined

New barn theatres were opened in Poole Hospital in May 2023. These presented new challenges for radiation protection requirements when mobile image intensifiers were being used.

The presentation will look at these challenges, what was done to overcome them and look at how things are one year on.

Results of a Survey of Staff Perceptions and Concerns in the event of an Incident of a skin dose of 500mSv from either a 99mTc source or an alpha source

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Introduction

A survey was carried out of staffs' feelings of a skin dose incident of 500mSv from a Tc99m source or from an alpha source. Questions included anxiety, concerns for erythema or stochastic effects and aspects of time-off work. The same questions were asked for ^{99m}Tc and for an alpha emitter. Scoring used was 1 (Not concerned)-10 (very concerned).

Results

There were 276 responses. N=159 Physicists, N=79 technologists/radiographers, N=20 Radiopharmacists, N=11 radiopharmacy technologists; 3 medical and 4 nursing responses were too low statistically. Within the Physicist category, there were 39 RPA responses. I have separately analysed the RPA responses and also compared to the other staff categories.

Mean Score	RPA		Other Physicists		Technol. /Radiog.		Radiopharmacy	
	^{99m}Tc	Alpha	^{99m}Tc	Alpha	^{99m}Tc	Alpha	^{99m}Tc	Alpha
Anxious	5.4	6.2	5.5	6.2	6.3	8.0	6.1	7.6
Erythema	2.7	4.0	3.3	5.0	5.3	7.8	5.5	7.0
Stochastic	3.4	4.5	3.8	4.9	5.7	7.7	5.2	7.1
Time off	6.5	6.5	6.5	7.2	5.4	6.6	6.5	7.2

For anxiety, erythema and stochastic risk, all staff groups ,including RPA, scored significantly higher for alpha exposure ($p<0.01$, Wilcoxon signed rank sum). There was no significant difference between the RPA responses and those of other Physicists, but RPA scores were significantly lower for erythema and stochastic concerns compared to Radiopharmacy and Technologists/Radiographers ($p<0.01$, Mann-Whitney U test). The majority of staff expected to have time from work, and there was no significant difference in this for Tc99m or Alpha. However the majority view of all staff [^{99m}Tc N=206/276; alpha N=175/276] was that staff wanted to return to work after review. This was also seen in the RPA group with 22/39 (for Tc99m) and 21/39 (for alpha) wanting to return to work.

Discussion

500mSv indicates the same stochastic risk for [^{99m}Tc] or alpha. However there is a consistent trend for alpha to be seen as higher risk. Also, the radiation factor of x20 should not be included for deterministic effects, significantly lowering the dose for erythema consideration. The threshold for erythema is also considerably higher for alpha, and there is therefore no risk of erythema for alphas, or electrons. Nevertheless, high concerned scores were in all groups. The overall stochastic risk for a small area of skin is also very low.
Although the majority of staff said they expected to have to take time off, the majority of staff felt that they would prefer not to be removed from work.

Conclusion

The associated risks of this level of skin dose, particularly in relation to alpha exposures, may need to be more clearly expressed in relation to skin contamination incidents. Despite the high level of exposure, the majority of staff wanted to continue working with minimal delay.

Review of radiation protection practice in radiosynoviorthesis procedures

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Background: At the authors' site, radiosynoviorthesis is performed on patients with chronic inflammatory rheumatoid arthritis involving knee joints (Kampen et al., 2022). Yttrium-90 [^{90}Y] Citrate is administered via intraarticular injection. Accurate delivery of the radiopharmaceutical being critical to avoid any joint leakage with associated risks. The administration is performed by a Consultant Rheumatologist, IR(ME)R licenced practitioner, with support from Medical Physics.

Currently numbers are relatively low, approximately 20 treatments per year. However, the potential for staff exposure is significant, either without optimised radiation protection technique, or in the event of an accident. For an administered activity of 220MBq, a contact dose rate of around 1.5mSv/sec can result in finger doses either approaching or exceeding dose limits.

Radiation dosimetry is challenging for ^{90}Y, with compromise between comfort and utility necessary. A strong dose gradient means ring dosimeters are unlikely to measure a representative maximum dose if the fingers are too close to the syringe, yet fingertip dosimeters result in reduced clinical confidence with impact on dexterity.

A local fingertip monitoring trial demonstrated unacceptably high finger doses for the clinician, at up to 52mSv for a single clinic of three procedures, prompting a radiation protection review of technique.

A literature review found a technique where the use of tongs allows the clinician to increase distance between fingers and syringe while ensuring adequate placement of the needle. Locally, the clinician had concerns about detecting any movement for accurate delivery of radiopharmaceutical. This work focusses on the development of an in-house extension to the shielding provided by the standard syringe shield, enabling the clinician to maintain close contact, but at significantly reduced dose rate.

Methods: A low-cost finger shield has been designed using CAD software and 3D printed using resin material. The shield has a similar density to Perspex, providing total attenuation of ^{90}Y beta-particles, and maintaining a minimum 2cm working distance from the syringe. The shield has been approved for testing locally, and comparable dose rates will be measured using a simulated clinical setup and finger dosimeters.

Results: Not yet completed.

Discussion: Prior to review of radiation protection practice, finger doses were determined to be unacceptably high, with the high dose gradient meaning that ring dosimeters were not reliable. Use of the finger shield is expected to reduce routine rheumatologist finger doses to around 2mSv per year, in line with the local risk assessment.

Conclusion: A finger shield has been designed and printed enabling the continued safe delivery of radiosynoviorthesis treatments. Use of tongs was not found practicable by local clinician due to increased patient risk if there is undetected movement of the needle. The shield is designed to grip the needle neck and allow close contact to be maintained throughout the procedure while maintaining ALARP.

Key references

HSE 2018 Work with ionising radiation. Ionising Radiations Regulations 2017, Approved Code of Practice and Guidance Publication L121 (second edition) London, UK: Health and Safety Executive, The Stationary Office.

Kampen, W. U., et al. (2022). 'The EANM guideline for radiosynoviorthesis', *European journal of nuclear medicine and molecular imaging*, 49 (2), pp. 681-708. doi: 10.1007/s00259-021-05541-7.

Experience with the radiation protection aspects of commissioning Varian Halcyon radiotherapy treatment systems in existing bunkers.

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Background

The Varian Halcyon radiotherapy treatment system is radically different to C-arm mounted systems in that all radiation delivery and detection equipment is mounted on a single slip-ring assembly, rather like a diagnostic CT scanner. This incorporates a 6 MV linear accelerator delivering a radiation dose rate of 800 cGy/min FFF at isocentre, 5 mm multi-leaf collimator, MV imaging detector, X-ray tube, kV imaging detector and primary radiation beam absorber. This has the advantage of enabling the system to rotate at a greater velocity (4 rotations per minute), generate both kV and MV images without physical system set-up and enable the system to be installed in a bunker without a primary radiation barrier. Varian Halcyon units have been installed in three bunkers previously specified for operation up to and including 10 MV, 600 cGy at isocentre.

Methods

A simplified approach to assessment of the bunkers for operation with the Halcyon units was undertaken, based on measurements of environmental radiation dose rate around the bunkers when housing the original linear accelerators. The isocentres of the Halcyon units were shifted away from the inner maze entrance, thus taking advantage of their more compact design and lack of need of a primary radiation barrier. Corrections for inverse square law were implemented and dose rates at maze entrance estimated based on slightly revised radiation scatter pathway and path lengths. Measured environmental radiation dose rates with the Halcyon units were compared with predicted values.

Results

Generally, measured radiation dose rates around the bunkers housing the Halcyon units were either similar to or less than the values estimated using the simple assessment approach. This validates the approach taken and the recommendations that no additional radiation shielding to the bunkers was needed.

Discussion around results

The simplified approach to assessing the performance of the existing linear accelerator bunkers appears to have been conservative and reasons will be considered. This includes margins of safety arising from slightly more favourable geometry in terms of scatter processes contributing to radiation dose rate at outer maze entrance and primary radiation scatter off the systems' internal primary radiation barriers.

Key Words: Radiation protection, radiotherapy, linear accelerator, Halcyon

Potential High Skin doses from contamination in Nuclear Medicine – are departments using appropriate PPE?

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Introduction

There has been increased awareness of the potential for high skin doses following a contamination incident. This is particularly the case for alpha emitters increasingly being used in Nuclear medicine, with skin contamination activities on the arms/legs as low as 24Bq (3hr biol. T1/2) potentially leading to 500mSv (1).

Method

We carried out a survey of current PPE use for injections in departments. The survey was sent to the senior technologist/radiographer in a department to ensure a single response per department. We asked for an indication of current PPE use, and also asked if 'bare below the elbow' had been a concern, whether outdoor shoes were used, and whether staff might consider using a visor.

Results

There were 22 department replies. All carried out NM injections. 7/22 also responded for PET and 14/22 also responded for Therapy.

Modality	Gloves	Apron	Disposable arm coverings	Long Sleeve disposable gown	Goggles	Visors	Mask
Conventional NM (22)	22	14	2/14	9	3	9[1]	3[2]
PET/CT (7)	7	4	2/4	3	-	1	1
Molecular Therapy (14)	13	10	4/10	7	2	5	-

[1] 6/9 for high pressure risk injections only (e.g. lymphoscintigraphy)

[2] 2/3 only wear mask for ventilation procedures

In addition 17 departments (77%) indicated staff wear their own 'outdoor' shoes at work. Also, 7 departments had been specifically told by Infection Control to observe "bare below the elbows", with 5/7 over-riding this on radiation protection grounds. However 11 departments still operate 'bare below the elbow' , using aprons without arm covers. 13 departments not currently using visors responded, with 8/13 indicating they would use this if made available, possibly for 'higher pressure' injections.

Discussion

11 (50%) departments are working "bare below the elbows". This will significantly increase the risk of skin contamination in an incident. Visors are in use in 9 departments, and 8 departments indicated they would like to use visors. In 17 departments staff wear their outdoor shoes and there was no indication of having any spare footwear. Clogs are in use in other departments and are a relatively cheap alternative.

Conclusion

There is considerable variation in PPE use in Nuclear Medicine departments, including a significant number still working "bare below the elbows". .Many staff also use their own shoes without 'spares' available. Visors are in use, with some for higher risk studies (pressurised injections e.g. lymphoscintigraphy), and 8 departments indicating they would consider using visors.

1.WH Thomson Using VARSKIN+v1.2 to estimate dose from direct skin contamination with radionuclides 223Ra, 212Pb and 225Ac; considerations for Nuclear Medicine staff and associated Personal Protective Equipment (PPE) . Nucl.Med. Commun. 2024 45:159-168

Is AI of any help in Radiation Protection?

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Background

With the introduction of Google Gemini and OpenAI ChatGPT, Artificial Intelligence (AI) is becoming widely publicised in its many possible applications. The IPEM's recent submission to the House of Commons Science and Technology Committed suggested that: "healthcare workers are best placed to make the use of AI more transparent and explainable to the public. Improving their understanding of AI should therefore be a priority." This submission was primarily concerned with the medical use of AI but is uses in other areas of practice, such as Radiation Protection, should also be considered.

Method

Google Gemini was used to provide content for a IRR17 update for Nuclear Medicine staff. Aspects of this talk will be presented to highlight the potential uses of AI in radiation protection and improving the understanding of AI.

Results

A "discussion" with Gemini to provide information for the IRR17 update talk provided useful content but also highlighted some of the current concerns around the use of Large Language Model (LLM) AI applications. The talk updated staff or current topical radiation protection issues in Nuclear Medicine but also improved their understanding of AI and its risks and limitations. Informal feedback suggested the talk was well received.

Discussion

The use of AI is not just limited to is role in medical applications. Specific AI applications for Radiation Protection may well be developed in the future, however even the currently freely available LLM AI applications have the potential to help in radiation protection. Healthcare professionals should be encouraged to explore their use. It is also important that the current limitations are well understood and in future robust validation methods are developed if these applications are to be safely and effectively used.

Conclusion

LLM AI applications can help in radiation protection and facilitate routine training updates as an example. Combining the use of the currently freely available AI tools in radiation protection training is also one way of improving the practical understanding of AI for healthcare workers, which the IPEM suggests is a priority.

Key Words
AI, Radiation Protection.

Radiation Safety Management Framework in a large NHS Trust

Julie Horrocks, Barts Health NHS Trust

Background

In May 2021, The Trust had an unannounced joint HSE and CQC inspection of Imaging at two of the Trust hospital sites which led to a number of enforcement notices served on the Trust. This presentation outlines the Trust response to the notices and the ongoing improvements in the management, resources, awareness and culture around radiation safety.

Method

The initial responses to the notices was overseen through weekly meetings chaired by the Trust deputy CEO until the required actions and evidence to support the improvements to close the notices had been submitted. Part of the response was to review the management and governance framework across the Trust around radiation safety to ensure that each hospital site and the clinical divisions at each site had improved awareness of their responsibilities and oversight of compliance within the site/ division. Each of the 4 hospitals within the Trust was required to submit an improvement plan. There was agreement to increase staffing within Medical Physics and a new Radiation Assurance team was formed to help ensure visibility of agreed compliance metrics.

Discussion

This talk will detail the management, governance and operational changes made in radiation safety in the Trust, applied across all services working with radiation and the benefits and challenges involved in the on-going process.