EUROPEAN FEDERATION OF RADIOGRAPHER SOCIETIES

Magnetic Resonance Safety Officer (MRSO) Role Descriptor:

An European Qualifications Framework (EQF) benchmarking document

November 2021

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Contents

Introduction

The EU-directive on physical agents (electromagnetic fields, Directive 2013/35/EU [1]) defined exposure limits to electric and magnetic fields in the workplace, including, after consultation, a derogation for MRI. It has always been the expectation that the MR community "displays a high degree of self-regulation" and therefore should proactively develop comprehensive training programs for MRI staff [2]. As a first step, it was then necessary to define the roles and responsibilities of MRI workers, so that appropriate training programs could be developed to address these needs and responsibilities but also define accountability in the case of erroneous results. Variable patient satisfaction and lack of MR safety standardisation globally made this an urgent need [2]. Therefore, the content of the education for MR Safety Officer (MRSO) needs to be defined.

Procedure

The EFRS General Assembly (GA) have asked the EFRS to produce an MRSO European Qualifications Framework (EQF) benchmarking document so that this role can be further defined in terms of knowledge, skills, and competences. This could support radiographers in many countries in being formally identified or appointed as MRSOs. In September 2018, the EFRS Executive Board, on behalf of the GA, established the EFRS MRSO Working Group. This benchmark document was developed via a number of online specialist group meetings and revised following the input of the EFRS members by a small group of experts who were supported by the EFRS president, EFRS CEO, and EFRS Executive Board. Different drafts were discussed between 2019 and 2021 with the EFRS Executive Board. The final version was submitted for approval by the EFRS Executive Board prior to submission to the GA in the EFRS AGM 2021. The group discussed the key MRI safety issues relating to the role of the MRSO as outlined in section 6. Relevant literature was used to update these as required.

Definitions (MRMD, MRRD, MRSO, MRSE)

The challenge has always been to find a generic platform, a universally accepted framework which would appeal to different working practices, safety cultures and legislative environments. The solution involved the creation of distinct roles within the MRI environment, which could be assumed by professionals who had the required education and training to perform the functions described by that role [2].

These roles are:

i) Magnetic Resonance Medical Director (MRMD) or Magnetic Resonance Research Director (MRRD) which is the person who is operationally responsible for the MR facility, usually a medical doctor or the holder of a PhD and often the primary Investigator (PI) for research projects

ii) Magnetic Resonance Safety Officer (MRSO) which is the person who is closely involved with MR scanning, usually a radiographer (in Europe, Australia, New Zealand and parts of Asia) or an MRI technologist (mainly USA and Canada but also in parts of Asia), who typically holds a postgraduate qualification in MRI/MRI Safety

iii) Magnetic Resonance Safety Expert (MRSE) which is the person who has higher level of technical expertise (this could be found locally for larger clinical sites or externally for the smaller ones), usually a MR physicist [2,4].

Depending on national legal and workforce requirements, these roles can be assumed by professionals of different backgrounds and the above scheme is only a recommendation that is not legally binding in any way. The greatest ambiguity exists by far in the role of the MRSO, a role that can be filled by professionals of different educational backgrounds, qualifications, and certifications globally [2,3,5].

Roles and responsibilities of the MRSOs in different countries

In many countries the MRSO remains an informal, not well-defined role and depending on geographical location, national training and legal frameworks, the MRSOs may assume a range of responsibilities [6,7] which might include:

- development, documentation, and execution, in conjunction with and under the authority of the MRMD, of safe working procedures for the MR environment;
- ensuring accessibility at all times to the operators of active MR facilities;
- ensuring that proper policies and procedures of the MRMD are implemented and enforced on an ongoing basis;
- ensuring that adequate written safety procedures, emergency procedures, and operating instructions are issued, in consultation with the MRMD and MRSE as needed;
- ensuring the implementation and monitoring of appropriate measures for minimising risks to staff and patients, in cooperation with the MRMD;
- managing hazards posed by the MR equipment and monitoring the measures taken to protect against such hazards;
- discussing MR scanning protocol / pulse sequence modification / optimisation in collaboration with the MRMD / MRSE to optimise safety, particularly for at risk patient cohorts e.g., patients with specific implants in situ, patients with impaired thermoregulatory capacity – (pregnant women, fetus, neonates, young children), patients scanned at high-field (3T and above);
- ensuring, in cooperation with the MRMD, that medical, technical, nursing, emergency, and all other relevant staff groups (including ancillary workers) who may be exposed to the MR environment are educated appropriately and updated as necessary as to MR safety requirements;
- providing and/or ensuring the provision of MR safety education and training in cooperation with and as per the policies of the MRMD;
- consulting the MRMD and/or MRSE when further advice is required regarding MR safety;
- timely reporting back to the MRMD all MR safety-related issues;
- providing expertise, in collaboration with MRMD and MRSE, when procuring new MR-scanners and supporting additional equipment;
- ensuring that there is a clear policy for testing, and clearly marking of all equipment that will be taken into Zones III and IV;
- maintaining regular contact with other relevant groups or committees responsible for the safety and welfare of personnel on site;
- providing expertise in risk assessment and root cause analyses, solutions meetings, etc, related to MRI adverse events;
- reporting incidents / accidents and providing guidance on how to report incidents;
- contributing to local safety committee meetings at departmental and organisational level;
- ensuring, in cooperation with MRMD, that proper staffing policies are implemented to avoid stressful and dangerous situations for patients and staff;
- leading annual clinical audits, service evaluation and quality improvement projects in relation to MRI safety;
- performing Quality Control/ (QC) tests as part of an MRI Quality Assurance (QA) programme.

This is not an exhaustive list and can vary from country to country and even from site to site. The above paragraph is partly based on the ACR 2020 manual for MR safety [6].

This working group suggests that the knowledge of the above topics for someone who assumes the role of the MRSO should be at EQF level 7.

Purpose

The purpose of this document is to propose a robust framework of knowledge, skills and competences required by the MRSOs and to help inform and standardise the requirements for MR safety training of MR radiographers in Europe.

Key MRI safety issues

Different related issues have been highlighted as vital to MR safety in recent years.

These include [6-18]:

a. Risks posed by the static magnetic fields, including high and ultrahigh magnetic fields, such as projectile and torsion events;
b. Risks posed by the radiofrequency (RF) field, including different coils, such as heating and burns;
c. Risks posed by the time varying gradients, such as peripheral nerve stimulation (PNS) or acoustic noise;
d. Management of magnetic field quench;
e. Safety considerations of implants, including the technical aspects, scanning conditions and risks of active implants such as neurostimulators, cardiac devices and cochlear implants together with those associated with passive implants such as orthopaedic hardware, vascular stents, cardiac valves, aneurysm clips;
f. Knowledge and implementation of robust MRI screening techniques, including metal check list design, patient and, where applicable, carer interview, facilitation of patient changing procedures and patient positioning;
g. Management and proper use and implementation of ferromagnetic detection systems, where needed;
h. Risks from the administration of contrast media (CM), such as allergic reactions and nephrogenic systemic fibrosis (NSF) and of the long-term retention and deposition of gadolinium to tissues;
i. Management of adverse events and various emergencies in the MRI department e.g. allergic reactions, cardiac arrest, accidents, injuries, falls, projectile incidents, fire in the MRI scanner, power outage, water damage;
j. Knowledge of MRI safety terminology such as zones I-IV in the MRI department and equipment safety ratings as MR unsafe, conditional and safe;
k. Vetting the examination in collaboration with MRMD and referring consultant for an optimal patient pathway;
l. Awareness of different MRI equipment considerations and of the different specifications of different scanners and how this impacts patients (bore diameter, coil length, examination table length in relation to patient body habitus) in standard and non-standard MRI environments such as intraoperative/interventional MR, positron emission tomography (PET) MR, and MR-guided radiation therapy (MR-LINAC);
m. Management of the anxious and claustrophobic patient;
n. Management of the sedated patient or the patient under general anaesthesia;
o. Person-centred care considerations and communication in the MRI environment for different patients and their parents/partners/carers where applicable (including, but not limited to, infants, children, pregnant patients, geriatric patients, bariatric patients, patients with dementia, cancer, LGBTQIA+ (Lesbian, Gay, Bisexual, Transgender, Queer, Intersex, Asexual) patients, autistic patients, patients with a form of learning disability, deaf, hard of hearing, blind, mute patients or patients with decreased mobility);
p. Optimal communication and handover with other clinical teams and healthcare practitioners;
q. Knowledge of MRI facility design, labelling, ergonomics and patient and staff safety features;
r. Knowledge of standard practice infection control for all patients (including, but not limited to, Covid19 precautions and precautions for other infectious diseases in the MRI department) to avoid cross infection;
s. Optimal patient transfer, manual handling, coordination of emergency resuscitation pathways and cardio-pulmonary resuscitation (CPR) provision as needed and appropriate;
t. Understanding and implementation of safe and ethical consenting practices.

MRSO Knowledge, Skills and Competence

Different levels of knowledge, skills and competence (KSCs) within MRI safety roles were identified as below:

a. first level includes **generic** knowledge, skills and competence in a clinical environment: this might include things like infection control, manual handling, basic CPR techniques, patient positioning, effective communication skills within teams.
b. second level includes **advanced** knowledge such as awareness of acoustic noise and SAR limits, knowledge of the respective magnetic field maps (dB/dz), knowledge of the safety profile of specific implants in the respective MRI scanner and consequent expert sequence modification/optimisation to minimise risks and increase benefits for a successful examination, specialised knowledge of person-centred care.
c. third level includes **more specialist** knowledge such as safe operation of ultrahigh field systems (7.0 Tesla), scanning of pacemakers, imaging in non-conventional MR environments such as hybrid imaging (PET-MR) or interventional MRI or ultrasound-guided MRI, or MR guided treatment using High Energy Focused Ultrasound (HIFU) or MR-guided radiation therapy such as MR-LINAC, treatment planning or animal, post-mortem, forensic, archaeological MRI or MRI scanning involving pieces of art.

This work covers levels 1 and 2 in more detail, as it would be impossible to cover level 3 without some further detailed research being conducted in these areas.

The following KSCs tables were constructed based on the following 3 thematic areas, under which all the MRI safety key issues identified by the group of experts were organised:

1. patient care and safety
2. safe use of equipment (hardware and software)
3. communication (including communication with patients, volunteers, parents, interpreters, partners, carers and healthcare staff either within Medical Imaging or from other healthcare services.

MRSO Knowledge, Skills and Competences (KSC) proposed framework

Knowledge	Skills	Competences
Patient care and safety		
K1. Have a thorough understanding of the MRI examination process as a whole, including patient preparation, MRI scanning and patient aftercare.	**S1.** Be able to explain the MRI examination process to all patients and healthy volunteers and their relatives/ accompanying carers and other non-MR healthcare professionals, as required, to ensure full co-operation	**C1.** Be mindful and thoughtful of the individualised communication needs required for certain service users (please see the communication section, for further discussion) to ensure truly person and patient-centred care. This is also in line with the EFRS person centred care statement published in 2021.
K2. Have a thorough understanding of infectious diseases, the considerations for the MRI environment, and relevant infection control precautions, including but not limited to those relating to Covid19 or other global pandemics or infectious diseases.	**S2.** Be able to apply in practice infection control processes for patients and staff to prevent cross-infection in the MRI environment	**C2.** Be able to manage clinical workflow to better apply infection control measures, preventing cross-infection in MRI environment.
K3. Have a thorough understanding of manual handling, patient transfer and cardiopulmonary resuscitation (CPR)	**S3.** Ensure principles of manual handing and CPR are applied to prevent occupational hazards from poor lifting and patient transfer practices	**C3.** Be able to ensure that staff are able to apply CPR when needed and certify that all ergonomic safety measures are provided and catered for.
K4. Understand the safe consenting practices (local, national and international) for patients and healthy volunteers enrolled in MRI research projects.	**S4.** Ensuring compliance with local Institutional Review Board/ Ethics board requirements for written/ documented informed consent. Also, ensure that patients receive the information they ask for and that they fully understand what they commit to as far as the MRI examination is concerned.	**C4.** Be in a position to identify and support non-consenting individuals to ensure nobody is coerced to be MRI-scanned for research purposes. Be able to escalate any concerns for suspected coercion or consenting malpractice to the relevant PI/ MRMD/ MRRDs.
K5. Knowledge of internal procedures, national guidelines and scanner and site specifications for the management of adverse events such as allergic reactions, cardiac arrest, accidents, injuries, falls, fire in the MRI scanner, power outage, water damage	**S5.** Be able to identify adverse events quickly and act accordingly. Also, be able to liaise with the relevant expert and non-expert practitioners for a safe resolution of these adverse events.	**C5.** For human MR scanning, ensure the availability of an additional MRI radiographer; this person will act as support personnel in the event of an emergency during scanning, including the case when this affects the MR system operator.

Patient care and safety (cont.)		
K6. Understand the importance of patient preparation for a successful MRI examination. These should include metal check guidelines, patient attire, patient communication pathways (e.g., buzzer) and patient monitoring pathways (e.g., vital signs monitoring, when required or indicated), pregnancy status checks, hearing protection, patient positioning to avoid superconductive loops or lowered blood pressure (inferior vena cava syndrome).	**S6.** Ensure all patient preparation procedures are clear and known to everyone through local SOPs.	**C6.** Be able to intervene, troubleshoot and escalate when local SoPs are not followed.
K7. Have a thorough understanding of metal screening (both verbal -via patient interview- and visual) processes for patients, volunteers, accompanying people and staff. Knowledge of MR safe, conditional and unsafe labelling for equipment, passive and active implants. In specialist centres, this knowledge might even include the safe scanning of patients with cardiac implantable devices (such as pacemakers, ICDs, CRTs) and other active medical devices.	**S7.** Be stringent about applying these metal screening and safe scanning processes to protect patients, volunteers, accompanying people and staff. Ensure that patients with active medical devices are scanned according to manufacturers' conditions.	**C7.** Be able, in cases of non-compliance, to explain the need for metal check and enforce the departmental policy, as required. Also, be in position to identify potentially high-risk metal materials from individuals to be scanned which fall outside the standard/expected metal objects. Be able to modify scanning parameters and other factors (such as B1+rms) during a MRI examination, when needed, in patients with active medical devices.
K8. Be aware of the possible side effects or sensations during and after an MRI scan (relating to the static magnetic field, gradient fields or RF fields as well). Possible side effects or sensations, include: dizziness, nausea, metallic taste, possible temperature elevations, focal or diffuse, peripheral nerve stimulation (PNS), discomfort from increased acoustic noise or examination table vibration.	**S8.** Explain the most common possible side effects to the individual to be scanned to better prepare them for the examination and remain alert for any sign of rare or new side effects by maintaining good communication and an open mind whilst scanning.	**C8.** Ensure there are clear reporting pathways to identify and report a side effect during or after MRI scanning. Also, be in a position to escalate this to the respective experts for further investigation to identify the underlying reason(s) and prevent re-occurrence during subsequent scanning.
K9. Be aware of the safety considerations for pregnant women, infants and young children in relation to SAR, acoustic noise, PNS and of the different safety limits that apply.	**S9.** Ensure there are clear local guidelines in place and there is always an attending midwife or physician to assist with any emergencies	**C9.** Be in a position to advise on tailoring patient care and safety measures depending on whether the pregnant woman is scanned for an injury, trauma or general pathology concern, a pregnancy concern and/or a fetal concern. If indeed a safety issue arises due the MRI scanning process, be able to seek immediate help and escalate this to the local experts.

Patient care and safety (cont.)		
K10. Be aware of the reasonable adjustments and limitations for scanning patients who are of non-standard body size or habitus or might have specialised patient care needs. These include paediatric patients, pregnant women, immunocompromised patients, geriatric patients, oncology patients after their treatment, bariatric patient, autistic individuals, LGBTQ+ patients, patients with dementia.	**S10.** Be resourceful in the use of imaging coils, positioning aids, ECG cables and connectors to ensure a safe scanning environment. Ensure that patients' needs and preferences are identified and attended to.	**C10.** Be able to recognise those cases where MR scanning cannot be safely performed for any of these populations and have a risk assessment documentation process in place to ensure parity for any future cases.
K11. Understand the safe use and administration of contrast media.	**S11.** Be able to recognize and manage allergic reactions from contrast media administration. Be able to better choose which type of contrast media to administer in each case.	**C11.** Create local guidelines, taking into account national pharmaceutical recommendations and local expertise, in collaboration with the MRMD/MRRDs.
K12. Have an understanding of reasonable adjustments that can be offered locally to an anxious and claustrophobic patient to minimise the need for sedation and anesthesia if possible. Be aware of possible side effects.	**S12.** Be able to pick up on the early warning signs of an anxious and/or claustrophobic patient and understand their needs and preferences. Be aware of how to safely manage patients under sedation and anaesthesia, including recognising early any side effects	**C12.** Have excellent communication skills and liaise with the teams delivering sedation and anesthesia before, during and after the scanning session. Ensure reporting on PACS of any side effects for the same patient in case they need to be scanned again.

Knowledge	Skills	Competences
Safe use of equipment (hardware and software)		
K13. Knowledge of MRI equipment specifications such as static magnetic field strength, spatial gradient field map, fringe field maps, gradient field specifications (amplitude, rise time, slew rate) and RF fields (MHz).	**S13.** Be able to understand all the specifications to ensure that all patients are scanned safely.	**C13.** Be able to design and run audits to identify when the SAR has been exceeded and offer a remedial strategy to prevent that in future scanning sessions.
K14. Be aware and up-to-date with site-specific policies on safe MR scanning practices, policies and guidelines. These might include updates and specialist knowledge such as high-field and ultra-high field imaging, imaging in non-conventional environment, like hybrid imaging or treatment planning and the safe use and management of colon capsule endoscopy cameras.	**S14.** Apply specialist knowledge in the areas needed to ensure a safe scanning environment.	**C14.** Be able to design MR safety zones, in collaboration with MRSE and MRMD.
K15. Understand the specifications of use for each MRI system.	**S15.** Be able to perform, analyse and interpret the regular quality assurance/ quality control processes of the MRI scanner to ensure its smooth functionality during the scan.	**C15.** Be able to design and run audits to identify when equipment needs replacement or escalation to the organisation/ company.
K16. Understand the potential risks arising from the static magnetic field. The static magnetic field has a number of associated safety related issues, including but not limited to magnetic field spatial gradient (or static field gradient), projectile effects, torque/ rotational forces, magneto-hydrodynamic effect considerations (for higher field studies).	**S16.** Be in position to apply safe metal screening practices.	**C16.** Be in position to identify those patients with medical implantable devices who may pose a risk when performing an MRI examination without additional safety procedures.
K17. Understand the process of the quench and cryogen safety considerations for systems based on superconductive magnets (as this currently the majority of MR systems).	**S17.** Be able to manage a quench of the MRI magnet if needed.	**C17.** Be able to source appropriate information regarding each device and liaise with relevant personnel (MRSE, MRMD, scanner vendor, device vendor, other MR departments utilising the device etc) to determine in advance its safety characteristics and suitability for use.

Safe use of equipment (hardware and software) (cont.)		
K18. Have a solid understanding of radiofrequency (RF) issues, as they relate to patient heating.	**S18.** Be in a position to apply knowledge relating to reducing the specific absorption rate (SAR) to prevent excessive heating and thermal injury.	**C18.** Be able to select the appropriate Operating Mode for the MR sequence protocol to be used (normal, first level, second level) based on perceived risk to patients.
K19. Recognise MR safety zones controlling access to the MRI environment, including site access restriction for research team and/or other ancillary personnel.	**S19.** Ensure the correct labelling applies in different zones in collaboration with MRSE and MRMD.	**C19.** Be able to modify sequences accordingly or provide extra protection e.g., earplugs, interleave sequences of high or low SAR, patient changing into cotton hospital clothing etc.
K20. Be familiar with equipment, its optimal use, preparation and maintenance: e.g., coils, ECG cables, positioning aids, pump injector)	**S20.** Be able to perform, analyse and interpret the regular quality assurance (QA)/ quality control (QC) processes for the ancillary equipment (coils, positioning aids, ECG cables) to ensure their structural integrity prior to and smooth functionality during the scan so as to safeguard patient and staff safety.	**C20.** Be able to design and run audits to identify when equipment needs replacement or escalation to the organisation/ company.
K21. Understand the difference between MRI conditional and MRI safe equipment	**S21.** Be able to advise and lead on the risk assessment process, evaluation and consultation procedures to ensure the safe use of surgical implants, active and passive, metal prostheses, stents etc and scanning of cardiac implantable devices, neuro stimulators and cochlear implants when appropriate and useful	**C21.** Be in position to identify those patients with medical implantable devices who may pose a risk when performing an MRI examination without additional safety procedures.
K22. Understand the conditions and restrictions for the use of non-standard components (experimental devices, research equipment, non-CE-marked devices, etc.) as identified by their labels	**S22.** Be able to advise on the use of such non-standard components to ensure their safe use	**C22.** Be able to source appropriate information regarding each device and liaise with relevant personnel (MRSE, MRMD, scanner vendor, device vendor, other MR departments utilising the device etc) to determine in advance its safety characteristics and suitability for use
K23. Understand the consequences of the selection of the appropriate Operating Mode for the MR sequence protocol to be used (normal, first level, second level)	**S23.** Be able to determine the International Electrotechnical Commission/ Food and Drug Administration (IEC/FDA) Operating Mode for the MR sequence protocol to be used (normal, first level, second level)	**C23.** Be able to select the appropriate Operating Mode for the MR sequence protocol to be used (normal, first level, second level) based on perceived risk to patients.
K24. Be aware of acoustic noise, PNS, SAR limits for the general population and for pregnancy or lactating service users, infants and children	**S24.** Identify or predict breaches of limits	**C24.** Be able to modify sequences accordingly or provide extra protection e.g., earplugs, interleave sequences of high or low SAR, patient changing into cotton hospital clothing etc.

Knowledge	Skills	Competences
Communication with patients, volunteers, medical imaging and ancillary* non MRI trained staff * (e.g., clinicians, administrators, cleaners etc)		
K25. Understand the importance of clear and accurate communication with the patient/volunteer, their accompanying person and co-workers for a successful and safe MRI examination.	**S25.** Ensure clear communication is established in relation to patient preparation before the scan (fasting, medication, contraindications). Subject monitoring should include two-way verbal communication, and visual supervision (direct and/or electronic).	**C25.** Be able to provide patients/ volunteers with adequate information before, during and after the MR examination.
K26. Be aware of relevant national and international policies and guidelines relating to complaint reporting, unexpected radiological findings, human subject privacy requirements, including data protection, and the traceability of subjects.	**S26.** Ensure the existence of site policies relating to complaint reporting, unexpected radiological findings, human subject privacy requirements (data protection), and the traceability of subjects.	**C26.** Be able to advise and/or escalate as required for non-standard occurrences relating to complaint reporting, unexpected radiological findings, human subject privacy requirements (data protection), and the traceability of subjects in complex cases
K27. Understand the currently available guidelines and be aware of currently available literature relating to vulnerable patients., given their potential for increased MR safety concerns. These include: pediatric patients, patients with impaired thermoregulatory capacity, patients with mental health concerns, with invisible disabilities, communication difficulties, potential language barriers, different disease processes, which may impact their understanding or co-operation with medical imaging personnel and hinder a successful and safe MRI examination.	**S27.** Ensure the existence of local policies and stringent procedures relating to possible "higher-risk" subjects to be studied, given their potential for increased MR safety concerns. These include paediatric patients, patients with mental health concerns, with invisible disabilities, communication difficulties, potential language barriers, different disease processes, which may impact their understanding or co-operation with medical imaging personnel and hinder a successful and safe MRI examination.	**C27.** Lead the communication with high-risk individuals and their accompanying people, as required, and train others to be able to do so when needed. Know how to reduce heat deposition in tissue and therefore the associated SAR.
K28. Understand the safe scanning consenting practices (local, national and international) for patients and healthy volunteers enrolled in research projects.	**S28.** Ensuring compliance with local Institutional Review Board/ Ethics Board requirements for written/ documented informed consent. Also, ensure patients receive the information they ask for and that they fully understand what they commit to as far as the MRI examination is concerned.	**C28.** Be in a position to identify and support non-consenting individuals to ensure nobody is coerced to be MRI-scanned for research purposes. Be able to escalate any concerns for suspected coercion or consenting malpractice to the relevant PIs.

Acknowledgments

This document was developed by the EFRS MR experts who made up the EFRS MRSO Working Group, presented here in alphabetical order by their surname: Anne Dorte Blankholm (Aarhus University Hospital, Denmark), Charalambos Bougias (Working Group Co-Chair, University Hospital of Ioannina, Greece), Christina Malamateniou (Working Group Co-Chair, City, University of London, UK), Allison McGee (University College Dublin, Ireland), Titti Owman (Lund University, Sweden), Vitor Silva (Centro Hospitalar e Universitário de São João, Porto, Portugal). The group was supported by: Jonathan McNulty (past president EFRS), Charlotte Beardmore (President EFRS) and Dorien Pronk-Larive (CEO EFRS).

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