



**IAEA**

International Atomic Energy Agency  
*Atoms for Peace and Development*

**Library Bibliography**

A Selection of Records From the  
**IAEA Lise Meitner Library**  
Applicable to the:

**International Conference on  
Hybrid Imaging (IPET 2024)**

7 – 11 October 2024, Vienna, Austria

---





**IAEA**

International Atomic Energy Agency  
Atoms for Peace and Development

# Resources. Day 1

Theranostics.

The following is a non-exhaustive bibliography of systematic reviews that are free to access, published years 2021-2024, on the field of [Theranostics](#).

1

## In Vitro Toxicological Insights from the Biomedical Applications of Iron Carbide Nanoparticles in Tumor Theranostics: A Systematic Review and Meta-Analysis

Antoniou M, Melagraki G, Lynch I, Afantitis A. *Nanomaterials (Basel)*. 2024 Apr 23;14(9):734. doi: 10.3390/nano14090734.PMID: 38727328. Review.

### Abstract

(1) Background: Despite the encouraging indications regarding the suitability (biocompatibility) of iron carbide nanoparticles (ICNPs) in various biomedical applications, the published evidence of their biosafety is dispersed and relatively sparse. The present review synthesizes the existing nanotoxicological data from in vitro studies relevant to the diagnosis and treatment of cancer. (2) Methods: A systematic review was performed in electronic databases (PubMed, Scopus, and Wiley Online Library) on December 2023, searching for toxicity assessments of ICNPs of different sizes, coatings, and surface modifications investigated in immortalized human and murine cell lines. The risk of bias in the studies was assessed using the ToxRTool for in vitro studies. (3) Results: Among the selected studies (n = 22), cell viability emerged as the most frequently assessed cellular-level toxicity endpoint. The results of the meta-analysis showed that cell models treated with ICNPs had a reduced cell viability (SMD = -2.531; 95% CI: -2.959 to -2.109) compared to untreated samples. A subgroup analysis was performed due to the high magnitude of heterogeneity (I<sup>2</sup> = 77.1%), revealing that ICNP concentration and conjugated ligands are the factors that largely influence toxicity (p < 0.001). (4) Conclusions: A dose-dependent cytotoxicity of ICNP exposure was observed, regardless of the health status of the cell, tested organism, and NP size. Inconsistent reporting of ICNP physicochemical properties was noted, which hinders comparability among the studies. A comprehensive exploration of the available in vivo studies is required in future research to assess the safety of ICNPs' use in bioimaging and cancer treatment.

2

## European Association of Nuclear Medicine Focus 5: Consensus on Molecular Imaging and Theranostics in Prostate Cancer

Oprea-Lager DE, MacLennan S, Bjartell A, Briganti A, Burger IA, de Jong I, De Santis M, Eberlein U, Emmett L, Fizazi K, Gillessen S, Herrmann K, Heskamp S, Iagaru A, Jereczek-Fossa BA, Kunikowska J, Lam M, Nanni C, O'Sullivan JM, Panebianco V, Sala E, Sathekge M, Sosnowski R, Tilki D, Tombal B, Treglia G, Tunariu N, Walz J, Yakar D, Dierckx R, Sartor O, Fanti S. *Eur Urol*. 2024 Jan;85(1):49-60. doi: 10.1016/j.eururo.2023.09.003. Epub 2023 Sep 22. PMID: 37743194.

### Abstract

I Background: In prostate cancer (PCa), questions remain on indications for prostate-specific membrane antigen (PSMA) positron emission tomography (PET) imaging and PSMA radioligand therapy, integration of advanced imaging in nomogram-based decision-making, dosimetry, and development of new theranostic applications.

Objective: We aimed to critically review developments in molecular hybrid imaging and systemic radioligand therapy, to reach a multidisciplinary consensus on the current state of the art in PCa.

Conclusions: There was a high proportion of agreement among a panel of experts on the use of molecular imaging and theranostics in PCa. Although consensus statements cannot replace high-certainty evidence, these can aid in the interpretation and dissemination of best practice from centres of excellence to the wider clinical community.



**IAEA**

International Atomic Energy Agency  
Atoms for Peace and Development

# Resources. Day 1

Theranostics

## **3** Follicle-Stimulating Hormone Receptor Expression and Its Potential Application for Theranostics in Subtypes of Ovarian Tumors: a Systematic Review

Bakker ME, Brink GJ, Poot AJ, Braat AJAT, Jonges GN, Zweemer RP. *Cancers (Basel)*. 2024 Mar 13;16(6):1140. doi: 10.3390/cancers16061140. PMID: 38539473. Review.

### Abstract

Ovarian cancer mortality rates have not decreased significantly in the past years. As most women are still diagnosed in an advanced stage, there is a need for new treatment strategies for recurrent disease. A potentially new developing targeted approach, theranostics, combines diagnostics and treatment using radiopharmaceuticals. Through target receptors, imaging and treatment of malignant tissue can be achieved. For ovarian malignancy, the follicle-stimulating hormone (FSH) receptor may serve as a possible target since expression appears to be limited to ovarian cells. In this systematic review, we aim to gather all available literature on the expression of the FSH receptor in ovarian tumors. Pubmed, Embase and the Cochrane databases were searched until December 2023 for eligible studies. The search yielded 41 studies, mostly regarding serous carcinomas, sex cord-stromal tumors (SCSTs) and cell lines of serous and SCSTs. Various techniques were used to analyze the expression of the FSH receptor. For serous carcinomas, conflicting results on the expression of the FSH receptor were found. Studies on SCSTs, mainly studying the subtype of granulosa cell tumors, all showed positive expression of the FSH receptor. In the cell lines studies, the KGN cell line derived from a granulosa cell tumor shows positive expression in all studies. Available studies show that SCSTs express the FSH receptor. A theranostic approach targeting the FSH receptor may, therefore, provide a useful new approach for this malignancy with limited therapeutic options in recurrent disease.

## **4** Fibroblast Activation Protein Inhibitor (FAPI)-Based Theranostics - Where We Are at and Where We Are Heading: a Systematic Review

Sidrak MMA, De Feo MS, Corica F, Gorica J, Conte M, Filippi L, Schillaci O, De Vincentis G, Frantellizzi V. *Int J Mol Sci*. 2023 Feb 15;24(4):3863. doi: 10.3390/ijms24043863. PMID: 36835275. Review.

### Abstract

Cancer is the leading cause of death around the globe, followed by heart disease and stroke, with the highest mortality to this day. We have reached great levels of understanding of how these various types of cancer operate at a cellular level and this has brought us to what we call "precision medicine" where every diagnostic examination and the therapeutic procedure is tailored to the patient. FAPI is among the new tracers that can be used to assess and treat many types of cancer. The aim of this review was to gather all the known literature on FAPI theranostics. A MEDLINE search was conducted on four web libraries, PUBMED, Cochrane, Scopus, and Web of Sciences. All of the available articles that included both diagnoses and therapy with FAPI tracers were collected and put through the CASP (Critical Appraisal Skills Programme) questionnaire for systematic reviewing. A total of 8 records were deemed suitable for CASP review, ranging from 2018 to November 2022. These studies were put through the CASP diagnostic checklist, in order to assess the goal of the study, diagnostic and reference tests, results, descriptions of the patient sample, and future applications. Sample sizes were heterogeneous, both for size as well as for tumor type. Only one author studied a single type of cancer with FAPI tracers. Progression of disease was the most common outcome, and no relevant collateral effects were noted. Although FAPI theranostics is still in its infancy and lacks solid grounds to be brought into clinical practice, it does not show any collateral effects that prohibit administration to patients, thus far, and has good tolerability profiles.



**IAEA**

International Atomic Energy Agency  
Atoms for Peace and Development

# Resources. Day 1

Theranostics

5

## **Somatostatin Receptor Targeted PET-Imaging for Diagnosis, Radiotherapy Planning and Theranostics of Meningiomas: a Systematic Review of the Literature**

Filippi L, Palumbo I, Bagni O, Schillaci O, Aristei C, Palumbo B. *Diagnostics (Basel)*. 2022 Jul 8;12(7):1666. doi: 10.3390/diagnostics12071666. PMID: 35885570. Review.

### Abstract

The aims of the present systematic review are to: (1) assess the diagnostic performance of somatostatin receptor (SSR)targeted positron emission tomography (PET) with different tracers and devices in patients affected by meningiomas; and (2) to evaluate the theranostic applications of peptide receptor radionuclide therapy (PRRT) in meningiomas. A systematic literature search according to PRISMA criteria was made by using two main databases. Only studies published from 2011 up to March 2022 in the English language with  $\geq 10$  enrolled patients were selected. Following our research strategy, 17 studies were included for the assessment. Fourteen studies encompassed 534 patients, harboring 733 meningiomas, submitted to SSR-targeted PET/CT ( $n = 10$ ) or PET/MRI ( $n = 4$ ) for de novo diagnosis, recurrence detection, or radiation therapy (RT) planning (endpoint 1), while 3 studies included 69 patients with therapy-refractory meningiomas submitted to PRRT (endpoint 2). A relevant variation in methodology was registered among diagnostic studies, since only a minority of them reported histopathology as a reference standard. PET, especially when performed through PET/MRI, resulted particularly useful for the detection of meningiomas located in the skull base (SB) or next to the falx cerebri, significantly influencing RT planning. As far as it concerns PRRT studies, stable disease was obtained in the 66.6% of the treated patients, being grade 1-2 hematological toxicity the most common side effect. Of note, the wide range of the administered activities, the various utilized radiopharmaceuticals ( $^{90}\text{Y}$ -DOTATOC and/or  $^{177}\text{Lu}$ -DOTATATE), the lack of dosimetric studies hamper a clear definition of PRRT potential on meningiomas' management.

6

## **Potential Targets Other than PSMA for Prostate Cancer Theranostics: a Systematic Review**

Gauthé M, Sargos P, Barret E, Fromont-Hankard G, Beauval JB, Brureau L, Créhange G, Renard-Penna R, Dariane C, Fiard G, Mathieu R, Roubaud G, Ruffion A, Rouprêt M, Ploussard G, On Behalf Of The Cc-Afu. *J Clin Med*. 2021 Oct 24;10(21):4909. doi: 10.3390/jcm10214909. PMID: 34768432. Review.

### Abstract

**Background:** Prostate-specific membrane antigen (PSMA) is not sufficiently overexpressed in a small proportion of prostate cancer (PCa) patients, who require other strategies for imaging and/or treatment. We reviewed potential targets other than PSMA for PCa theranostics in nuclear medicine that have already been tested in humans.

**Results:** We included 38 studies on six different targets: gastrin-releasing peptide receptors (GRPRs) ( $n = 23$ ), androgen receptor ( $n = 11$ ), somatostatin receptors ( $n = 6$ ), urokinase plasminogen activator surface receptor ( $n = 4$ ), fibroblast activation protein ( $n = 2$  studies) and integrin receptors ( $n = 1$ ). GRPRs, the most studied target, has a lower expression in high-grade PCa, CRPC and bone metastases. Its use might be of higher interest in treating earlier stages of PCa or low-grade PCa. Radiolabeled fibroblast activation protein inhibitors were the most recent and promising molecules, but specific studies reporting their interest in PCa are needed. **Conclusion:** Theranostics in nuclear medicine will continue to develop in the future, especially for PCa patients. Targets other than PSMA exist and deserve to be promoted.



**IAEA**

International Atomic Energy Agency  
Atoms for Peace and Development

# Resources. Day 1

Radiology Education.

The following is a non-exhaustive bibliography of systematic reviews that are free to access, published years 2021-2024 on the field of [Radiology Education](#).

7

## **The Scope of Virtual Reality Simulators in Radiology Education: Systematic Literature Review**

*Shetty S, Bhat S, Al Bayatti S, Al Kawas S, Talaat W, El-Kishawi M, Al Rawi N, Narasimhan S, Al-Daghestani H, Madi M, Shetty R. JMIR Med Educ. 2024 May 8;10:e52953. doi: 10.2196/52953.PMID: 38722205. Review.*

### Abstract

Background: In recent years, virtual reality (VR) has gained significant importance in medical education. Radiology education also has seen the induction of VR technology. However, there is no comprehensive review in this specific area. This review aims to fill this knowledge gap.

Conclusions: The evidence from this review shows that the use of VR had significant benefit for students in various aspects of radiology education. However, the variable nature of the studies included in the review reduces the scope for a comprehensive recommendation of VR use in radiology education.

8

## **What Works in Radiology Education for Medical Students: a Systematic Review and Meta-Analysis**

*Wade SWT, Velan GM, Tedla N, Briggs N, Moscovia M. BMC Med Educ. 2024 Jan 10;24(1):51. doi: 10.1186/s12909-023-04981-z.PMID: 38200489.*

### Abstract

Background: Medical imaging related knowledge and skills are widely used in clinical practice. However, radiology teaching methods and resultant knowledge among medical students and junior doctors is variable. A systematic review and meta-analysis was performed to compare the impact of different components of radiology teaching methods (active versus passive teaching, eLearning versus traditional face-to-face teaching) on radiology knowledge / skills of medical students.

Conclusions: Studies of educational interventions are inherently heterogeneous and contextual, typically tailored to specific groups of students. Thus, we could not draw definitive conclusion about effectiveness of the various radiology education interventions based on the currently available data. Better standardisation in the design and implementation of radiology educational interventions and design of radiology education research are needed to understand aspects of educational design and delivery that are optimal for learning.

9

## **The Effectiveness of Spaced Learning, Interleaving, and Retrieval Practice in Radiology Education: a Systematic Review**

*Thompson CP, Hughes MA. J Am Coll Radiol. 2023 Nov;20(11):1092-1101. doi: 10.1016/j.jacr.2023.08.028. Epub 2023 Sep 6.PMID: 37683816.*

### Abstract

Purpose: Radiology is a highly complex field that requires mastery over an ever-expanding body of knowledge. Spaced learning, interleaving, and retrieval practice are evidence-based learning strategies that enhance long-term retention of information. The aim of this systematic review is to assess the effectiveness of these interventions in the setting of radiology education. Conclusions: Despite extensive evidence in support of spaced, interleaved, and retrieval practice within the broader literature, few studies have examined the effectiveness of these strategies in radiology education. Additional trials are required to evaluate the usefulness of incorporating these techniques into educational programs related to medical imaging.



**IAEA**

International Atomic Energy Agency  
Atoms for Peace and Development

# Resources. Day 1

Radiology Education

## **10** Augmented Reality in Interventional Radiology Education: a Systematic Review of Randomized Controlled Trials

*Gelmini AYP, Duarte ML, Silva MOD, Guimarães Junior JB, Santos LRD. Sao Paulo Med J. 2022 Jul-Aug;140(4):604-614. doi: 10.1590/1516-3180.2021.0606.R2.27122021.PMID: 35946678.*

### Abstract

**Background:** Augmented reality (AR) involves digitally overlapping virtual objects onto physical objects in real space so that individuals can interact with both at the same time. AR in medical education seeks to reduce surgical complications through high-quality education. There is uncertainty in the use of AR as a learning tool for interventional radiology procedures.

**Results:** Four randomized clinical trials were included in this review. The level of educational evidence found among all the papers was 2B, according to the Kirkpatrick model. The Cochrane Collaboration tool was applied to assess the risk of bias for individual studies and across studies. Three studies showed an improvement in teaching of the proposed procedure through AR; one study showed that the participants took longer to perform the procedure through AR.

**Conclusion:** AR, as a complementary teaching tool, can provide learners with additional skills, but there is still a lack of studies with a higher evidence level according to the Kirkpatrick model.

## **11** Virtual Reality in Interventional Radiology Education: a Systematic Review

*Gelmini AYP, Duarte ML, de Assis AM, Guimarães Junior JB, Carnevale FC. Radiol Bras. 2021 Jul-Aug;54(4):254-260. doi: 10.1590/0100-3984.2020.0162.PMID: 34393293. Review.*

### Abstract

The aim of this study was to compare virtual reality simulation with other methods of teaching interventional radiology. We searched multiple databases-Cochrane Library; Medline (PubMed); Embase; Trip Medical; Education Resources Information Center; Cumulative Index to Nursing and Allied Health Literature; Scientific Electronic Library Online; and Latin-American and Caribbean Health Sciences Literature-for studies comparing virtual reality simulation and other methods of teaching interventional radiology. This systematic review was performed in accordance with the criteria established by the Preferred Reporting Items for Systematic Reviews and Meta-Analyses and the Best Evidence Medical Education (BEME) Collaboration. Eligible studies were evaluated by using the quality indicators provided in the BEME Guide No. 11 and the Kirkpatrick model of training evaluation. After the eligibility and quality criteria had been applied, five randomized clinical trials were included in the review. The Kirkpatrick level of impact varied among the studies evaluated, three studies being classified as level 2B and two being classified as level 4B. Among the studies evaluated, there was a consensus that virtual reality aggregates concepts and is beneficial for the teaching of interventional radiology. Although the use of virtual reality has been shown to be effective for skill acquisition and learning in interventional radiology, there is still a lack of studies evaluating and standardizing the employment of this technology in relation to the numerous procedures that exist within the field of expertise.



**IAEA**

International Atomic Energy Agency  
Atoms for Peace and Development

# Resources. Day 1

Colorectal Cancer.

The following is a non-exhaustive bibliography of systematic reviews that are free to access, published years 2021-2024 on the field of [Colorectal Cancer](#).

## **12** Application of Radiomics for Preoperative Prediction of Lymph Node Metastasis in Colorectal Cancer: a Systematic Review and Meta-Analysis

Le Abbaspour E, Karimzadghagh S, Monsef A, Joukar F, Mansour-Ghanaei F, Hassanipour S. *Int J Surg.* 2024 Jun 1;110(6):3795-3813. doi: 10.1097/JS9.0000000000001239.PMID: 38935817.

### Abstract

Background: Colorectal cancer (CRC) stands as the third most prevalent cancer globally, projecting 3.2 million new cases and 1.6 million deaths by 2040. Accurate lymph node metastasis (LNM) detection is critical for determining optimal surgical approaches, including preoperative neoadjuvant chemoradiotherapy and surgery, which significantly influence CRC prognosis. However, conventional imaging lacks adequate precision, prompting exploration into radiomics, which addresses this shortfall by converting medical images into reproducible, quantitative data.

Conclusion: Artificial intelligence-based radiomics shows promise in preoperative lymph node staging for CRC, exhibiting significant predictive performance. These findings support the integration of radiomics into clinical practice to enhance preoperative strategies in CRC management.

## **13** Added Value of Liver MRI in Patients Eligible for Surgical Resection or Ablation of Colorectal Liver Metastases Based on CT: a Systematic Review and Meta-Analysis

Görgec B, Verpalen IM, Sijberden JP, Abu Hilal M, Bipat S, Verhoef C, Swijnenburg RJ, Besselink MG, Stoker J. *Ann Surg Open.* 2024 Mar 18;5(1):e401. doi: 10.1097/AS9.0000000000000401. eCollection 2024 Mar.PMID: 38883954.

### Abstract

Background: Abdominal computed tomography (CT) is the standard imaging modality for detection and staging in patients with colorectal liver metastases (CRLM). Although liver magnetic resonance imaging (MRI) is superior to CT in detecting small lesions, guidelines are ambiguous regarding the added value of an additional liver MRI in the surgical workup of patients with CRLM. Therefore, this systematic review and meta-analysis aimed to evaluate the clinical added value of liver MRI in patients eligible for resection or ablation of CRLM based on CT.

Conclusions: This systematic review and meta-analysis found that liver MRI changed the preinterventional local treatment plan in approximately one-fifth of patients eligible for surgical resection or ablation of CRLM based on CT. These findings suggest a clinically relevant added value of routine liver MRI in the preinterventional workup of CRLM, which should be confirmed by large prospective studies.



# Resources. Day 1

## Colorectal Cancer

### **14** Lymph Nodes Primary Staging of Colorectal Cancer in 18F-FDG PET/MRI: a Systematic Review and Meta-Analysis

Ren Q, Chen Y, Shao X, Guo L, Xu X. *Eur J Med Res*. 2023 May 4;28(1):162. doi: 10.1186/s40001-023-01124-4. PMID: 37143144. Review.

#### Abstract

Objective: To assess the diagnostic efficacy of 18F-FDG PET/MRI for lymph node (LN) metastasis primary staging in patients with colorectal cancer (CRC).

Conclusion: 18F-FDG PET/MRI has shown remarkable diagnostic performance in identification of LN metastases in newly diagnosed CRC patients. It would be of great application value for the primary staging of CRC lymph node metastases.

### **15** Repeatability of Radiomics Studies in Colorectal Cancer: a Systematic Review

Liu Y, Wei X, Feng X, Liu Y, Feng G, Du Y. *BMC Gastroenterol*. 2023 Apr 14;23(1):125. doi: 10.1186/s12876-023-02743-1. PMID: 37059990.

#### Abstract

Background: Recently, radiomics has been widely used in colorectal cancer, but many variable factors affect the repeatability of radiomics research. This review aims to analyze the repeatability of radiomics studies in colorectal cancer and to evaluate the current status of radiomics in the field of colorectal cancer.

Conclusions: The RQS score was moderately low, and most studies did not consider the repeatability of radiomics features, especially in terms of Intra-individual, scanners, and scanning parameters. To improve the generalization of the radiomics model, it is necessary to further control the variable factors of repeatability.

### **16** [18F]FDG PET/CT versus [18F]FDG PET/MRI for the Diagnosis of Colorectal Liver Metastasis: a Systematic Review and Meta-Analysis

Miao Z, Zhao X, Li X. *Front Oncol*. 2023 Feb 13;13:1114059. doi: 10.3389/fonc.2023.1114059. eCollection 2023. PMID: 36860315.

#### Abstract

Purpose: The purpose of our meta-analysis and systematic review was to compare the diagnostic performance of [18F]FDG PET/CT and [18F]FDG PET/MRI in colorectal liver metastasis.

Conclusion: [18F]FDG PET/CT shows similar performance compared to [18F]FDG PET/MRI in detecting colorectal liver metastasis. However, pathological results were not obtained for all patients in the included studies and PET/MRI results were derived from studies with small sample sizes. There is a need for additional, larger prospective studies on this issue.



**IAEA**

International Atomic Energy Agency  
Atoms for Peace and Development

# Resources. Day 1

Colorectal Cancer

## **17** Systematic Review of Machine Learning-Based Radiomics Approach for Predicting Microsatellite Instability Status in Colorectal Cancer

Wang Q, Xu J, Wang A, Chen Y, Wang T, Chen D, Zhang J, Brismar TB. *Radiol Med.* 2023 Feb;128(2):136-148. doi: 10.1007/s11547-023-01593-x. Epub 2023 Jan 17. PMID: 36648615. Review.

### Abstract

This study aimed to systematically summarize the performance of the machine learning-based radiomics models in the prediction of microsatellite instability (MSI) in patients with colorectal cancer (CRC). It was conducted according to the preferred reporting items for a systematic review and meta-analysis of diagnostic test accuracy studies (PRISMA-DTA) guideline and was registered at the PROSPERO website with an identifier CRD42022295787. Systematic literature searching was conducted in databases of PubMed, Embase, Web of Science, and Cochrane Library up to November 10, 2022. Research which applied radiomics analysis on preoperative CT/MRI/PET-CT images for predicting the MSI status in CRC patients with no history of anti-tumor therapies was eligible. The radiomics quality score (RQS) and Quality Assessment of Diagnostic Accuracy Studies 2 (QUADAS-2) were applied to evaluate the research quality (full score 100%). Twelve studies with 4,320 patients were included. All studies were retrospective, and only four had an external validation cohort. The median incidence of MSI was 19% (range 8-34%). The area under the receiver operator curve of the models ranged from 0.78 to 0.96 (median 0.83) in the external validation cohort. The median sensitivity was 0.76 (range 0.32-1.00), and the median specificity was 0.87 (range 0.69-1.00). The median RQS score was 38% (range 14-50%), and half of the studies showed high risk in patient selection as evaluated by QUADAS-2. In conclusion, while radiomics based on pretreatment imaging modalities had a high performance in the prediction of MSI status in CRC, so far it does not appear to be ready for clinical use due to insufficient methodological quality.

## **18** The Value of (18)F-FDG-PET-CT Imaging in Treatment Evaluation of Colorectal Liver Metastases: A Systematic Review

Bijlstra OD, Boreel MME, van Mossel S, Burgmans MC, Kapiteijn EHW, Oprea-Lager DE, Rietbergen DDD, van Velden FHP, Vahrmeijer AL, Swijnenburg RJ, Mieog JSD, de Geus-Oei LF. *Diagnostics (Basel)*. 2022 Mar 15;12(3):715. doi: 10.3390/diagnostics12030715. PMID: 35328267. Review.

### Abstract

(1) Background: Up to 50% of patients with colorectal cancer either have synchronous colorectal liver metastases (CRLM) or develop CRLM over the course of their disease. Surgery and thermal ablation are the most common local treatment options of choice. Despite development and improvement in local treatment options, (local) recurrence remains a significant clinical problem. Many different imaging modalities can be used in the follow-up after treatment of CRLM, lacking evidence-based international consensus on the modality of choice. In this systematic review, we evaluated 18F-FDG-PET-CT performance after surgical resection, thermal ablation, radioembolization, and neoadjuvant and palliative chemotherapy based on current published literature. (2) Methods: A systematic literature search was performed on the PubMed database. (3) Results: A total of 31 original articles were included in the analysis. Only one suitable study was found describing the role of 18F-FDG-PET-CT after surgery, which makes it hard to draw a firm...



# Resources. Day 3

Imaging in Paediatric Oncology.

The following is a non-exhaustive bibliography of systematic reviews that are free to access, published years 2021-2024 on the field of [Imaging in Paediatric Oncology](#).

18

...conclusion. 18F-FDG-PET-CT showed to be of additional value in the follow-up after thermal ablation, palliative chemotherapy, and radioembolization. 18F-FDG-PET-CT was found to be a poor to moderate predictor of pathologic response after neoadjuvant chemotherapy. (4) Conclusions: 18F-FDG-PET-CT is superior to conventional morphological imaging modalities in the early detection of residual disease after thermal ablation and in the treatment evaluation and prediction of prognosis during palliative chemotherapy and after radioembolization, and 18F-FDG-PET-CT could be considered in selected cases after neoadjuvant chemotherapy and surgical resection.

19

## Improved Sensitivity and Positive Predictive Value of Contrast-Enhanced Intraoperative Ultrasound in Colorectal Cancer Liver Metastasis: a Systematic Review and Meta-Analysis

Chen JY, Dai HY, Li CY, Jin Y, Zhu LL, Zhang TF, Zhang YX, Mai WH. *J Gastrointest Oncol.* 2022 Feb;13(1):221-230. doi: 10.21037/jgo-21-881.PMID: 35284117.

### Abstract

Background: Surgery is an effective treatment for improving the survival rate of patients with colorectal cancer liver metastases (CRLM). However, accurately determining the resection margin of liver lesions during surgery remains challenging. Therefore, this study aimed to evaluate the sensitivity and predictive value of intraoperative contrast-enhanced ultrasound (CE-IOUS) in CRLM patients undergoing surgery.

Results: A total of 10 articles met the inclusion criteria. The meta-analysis results showed that the overall sensitivity and specificity of CE-IOUS were 0.96 [95% confidence interval (CI), 0.95-0.97] and 0.75 (95% CI, 0.70-0.80), respectively. The overall sensitivity and specificity of IOUS were 0.84 (95% CI, 0.82-0.86) and 0.82 (95% CI, 0.77-0.87), respectively. The area under the summary receiving operating characteristic (SROC) curves (AUCs) of CE-IOUS and IOUS were 0.9753 and 0.8590, respectively. The odds ratio (OR) and 95% CI of CE-IOUS changed the surgical margin were 0.205 and 0.071-0.465,  $P=0.000$ , the difference was statistically significant.

Discussion: Based on the results of this meta-analysis, CE-IOUS improved the sensitivity and predictive value of CRLM detection compared with IOUS, and is more suitable for intraoperative planning of surgical margins. At present, it is the most sensitive imaging method available, and is recommended for use during liver resection to provide doctors with more reliable information during surgery.



**IAEA**

International Atomic Energy Agency  
Atoms for Peace and Development

# Resources. Day 3

Imaging in Paediatric Oncology

19

## Structural and Functional Brain Imaging in Long-Term Survivors of Childhood Acute Lymphoblastic Leukemia Treated With Chemotherapy: A Systematic Review

Gandy K, Scoggins MA, Jacola LM, Litten M, Reddick WE, Krull KR. *JNCI Cancer Spectr.* 2021 Aug 11;5(5):pkab069. doi: 10.1093/jncics/pkab069. eCollection 2021 Oct. PMID: 34514328.

### Abstract

Background: The effect of chemotherapy on brain development in long-term survivors of pediatric acute lymphoblastic leukemia (ALL) was systematically reviewed.

Conclusion: Although the neurotoxic effects of cancer treatment are reduced in the absence of cranial radiation, survivors treated on chemotherapy-only protocols still display long-term alterations in brain structure and function, which contribute to lifelong neurocognitive late effects.

20

## Whole-Body Magnetic Resonance Imaging for the Diagnosis of Metastasis in Children and Adolescents: a Systematic Review and Meta-Analysis

Valduga SG, Forte GC, Paganin RP, Abreu DG, Medeiros TM, Irion K, Hochhegger B, Mattiello R. *Radiol Bras.* 2021 Sep-Oct;54(5):329-335. doi: 10.1590/0100-3984.2020.0183. PMID: 34602669. Review.

### Abstract

Whole-body magnetic resonance imaging (WB-MRI) is a noninvasive imaging method that can be used to diagnose and stage tumors, as well as to assess therapeutic responses in oncology. The objective of this meta-analysis was to evaluate the accuracy of WB-MRI for the diagnosis of metastases in pediatric patients. The following electronic databases were searched: Medline, Embase, Cochrane Central Register of Controlled Trials, Scientific Electronic Library Online, Latin-American and Caribbean Health Sciences Literature, Cumulative Index to Nursing and Allied Health Literature, Web of Science, and ClinicalTrials.gov. All of the selected studies included children and adolescents with histopathological confirmation of a primary tumor. Collectively, the studies included 118 patients ranging in age from 7 months to 19 years. The pooled sensitivity and specificity of WB-MRI were, respectively, 0.964 (95% CI: 0.944-0.978; I<sup>2</sup> = 0%) and 0.902 (95% CI: 0.882-0.919; I<sup>2</sup> = 98.4%), with an area under the curve (AUC) of 0.991. We found that WB-MRI had good accuracy for the diagnosis of metastases in pediatric patients and could therefore provide an alternative to complete the staging of tumors in such patients, being a safer option because it does not involve the use of ionizing radiation.



**IAEA**

International Atomic Energy Agency  
Atoms for Peace and Development

# Resources. Day 3

Imaging in Paediatric Oncology

## **21** FDG-PET/CT Versus Bone Marrow Biopsy in Bone Marrow Involvement in Newly Diagnosed Paediatric Lymphoma: a Systematic Review and Meta-Analysis

*Li Z, Li C, Chen B, Shi L, Gao F, Wang P, Sun W. J Orthop Surg Res. 2021 Aug 9;16(1):482. doi: 10.1186/s13018-021-02521-3. PMID: 34372894. Review.*

### Abstract

Background: Bone marrow infiltration (BMI) is a devastating stage of paediatric lymphoma. Prompt diagnosis of BMI in newly diagnosed paediatric lymphoma patients is critical but can be very challenging at present.

Conclusion: Compared with BMB, FDG-PET/CT was a more valuable diagnostic method for evaluating BMI in paediatric Hodgkin and non-Hodgkin lymphoma patients with extremely high diagnostic accuracy.

---

## **22** Diagnostic Performance of (18)F-FDG PET(CT) in Bone-Bone Marrow Involvement in Pediatric Neuroblastoma: A Systemic Review and Meta-Analysis

*Sun L, Zhang B, Peng R. Contrast Media Mol Imaging. 2021 Jun 16;2021:8125373. doi: 10.1155/2021/8125373. eCollection 2021. PMID: 34220381.*

### Abstract

Objective: We sought to perform a systemic review and meta-analysis of the diagnostic performance of 18F-fluorodeoxyglucose (18F-FDG) positron emission tomography (computed tomography) (PET(CT)) in detection of bone and/or bone marrow involvement (BMI) in pediatric neuroblastoma (NB).

Conclusions: Through a meta-analysis, this study suggested that 18F-FDG PET(CT) has a good overall diagnostic accuracy in the detection of bone/BMI in pediatric neuroblastoma.



**IAEA**

International Atomic Energy Agency  
Atoms for Peace and Development

# Resources. Day 3

Imaging in Paediatric Oncology

**23**

## **Whole-Body Magnetic Resonance Imaging in Children - How and Why? A Systematic review**

*Zadig P, von Brandis E, Lein RK, Rosendahl K, Avenarius D, Ording Müller LS. Pediatr Radiol. 2021 Jan;51(1):14-24. doi: 10.1007/s00247-020-04735-9. Epub 2020 Jun 25. PMID: 32588094. Review.*

### Abstract

Whole-body magnetic resonance imaging (MRI) is increasingly being used for a number of indications. Our aim was to review and describe indications and scan protocols for diagnostic value of whole-body MRI for multifocal disease in children and adolescents, we conducted a systematic search in Medline, Embase and Cochrane for all published papers until November 2018. Relevant subject headings and free text words were used for the following concepts: 1) whole-body, 2) magnetic resonance imaging and 3) child and/or adolescent. Included were papers in English with a relevant study design that reported on the use and/or findings from whole-body MRI examinations in children and adolescents. This review includes 54 of 1,609 papers identified from literature searches. Chronic nonbacterial osteomyelitis, lymphoma and metastasis were the most frequent indications for performing a whole-body MRI. The typical protocol included a coronal STIR (short tau inversion recovery) sequence with or without a coronal T1-weighted sequence. Numerous studies lacked sufficient data for calculating images resolution and only a few studies reported the acquired voxel volume, making it impossible for others to reproduce the protocol/images. Only a minority of the included papers assessed reliability tests and none of the studies documented whether the use of whole-body MRI affected mortality and/or morbidity. Our systematic review confirms significant variability of technique and the lack of proven validity of MRI findings. The information could potentially be used to boost attempts towards standardization of technique, reporting and guidelines development.



# Resources. Day 3

## Neuroimaging and Dementias.

The following is a non-exhaustive bibliography of systematic reviews that are free to access, published years 2021-2024 on the field of [Neuroimaging and Dementias](#).

**24**

### Technological Frontiers in Brain Cancer: A Systematic Review and Meta-Analysis of Hyperspectral Imaging in Computer-Aided Diagnosis Systems

Leung JH, Karmakar R, Mukundan A, Lin WS, Anwar F, Wang HC. *Diagnostics (Basel)*. 2024 Aug 28;14(17):1888. doi: 10.3390/diagnostics14171888.PMID: 39272675. Review.

#### Abstract

Brain cancer is a substantial factor in the mortality associated with cancer, presenting difficulties in the timely identification of the disease. The precision of diagnoses is significantly dependent on the proficiency of radiologists and neurologists. Although there is potential for early detection with computer-aided diagnosis (CAD) algorithms, the majority of current research is hindered by its modest sample sizes. This meta-analysis aims to comprehensively assess the diagnostic test accuracy (DTA) of computer-aided design (CAD) models specifically designed for the detection of brain cancer utilizing hyperspectral (HSI) technology. We employ Quadas-2 criteria to choose seven papers and classify the proposed methodologies according to the artificial intelligence method, cancer type, and publication year. In order to evaluate heterogeneity and diagnostic performance, we utilize Deeks' funnel plot, the forest plot, and accuracy charts. The results of our research suggest that there is no notable variation among the investigations. The CAD techniques that have been examined exhibit a notable level of precision in the automated detection of brain cancer. However, the absence of external validation hinders their potential implementation in real-time clinical settings. This highlights the necessity for additional studies in order to authenticate the CAD models for wider clinical applicability.

**25**

### Revolutionizing Early Alzheimer's Disease and Mild Cognitive Impairment Diagnosis: a Deep Learning MRI Meta-Analysis

Wang LX, Wang YZ, Han CG, Zhao L, He L, Li J. *Arq Neuropsychiatr*. 2024 Aug;82(8):1-10. doi: 10.1055/s-0044-1788657. Epub 2024 Aug 15.PMID: 39146974. English.

#### Abstract

**Background:** The early diagnosis of Alzheimer's disease (AD) and mild cognitive impairment (MCI) remains a significant challenge in neurology, with conventional methods often limited by subjectivity and variability in interpretation. Integrating deep learning with artificial intelligence (AI) in magnetic resonance imaging (MRI) analysis emerges as a transformative approach, offering the potential for unbiased, highly accurate diagnostic insights.

**Results:** A total of 18 eligible studies were identified. The Spearman correlation coefficient was -0.6506. Meta-analysis showed that the combined sensitivity and specificity, positive likelihood ratio, negative likelihood ratio, and diagnostic odds ratio were 0.84, 0.86, 6.0, 0.19, and 32, respectively. The AUROC was 0.92. The quiescent point of hierarchical summary of receiver operating characteristic (HSROC) was 3.463. Notably, the images of 12 studies were acquired by T1-weighted MRI alone, and those of the other 6 were gathered by non-T1-weighted MRI alone.

**Conclusion:** Overall, deep learning of MRI for the diagnosis of AD and MCI showed good sensitivity and specificity and contributed to improving diagnostic accuracy.



**IAEA**

International Atomic Energy Agency  
Atoms for Peace and Development

# Resources. Day 3

Neuroimaging and Dementias

## **26** Appropriate incorporation of Susceptibility-Weighted Magnetic Resonance Imaging into Routine Imaging Protocols for Accurate Diagnosis of Traumatic Brain Injuries: a Systematic Review

*Jaafari O, Salih S, Alkatheeri A, Alshehri M, Al-Shammari M, Maeni M, Alqahtani A, Alomaim W, Hasaneen M.J Med Life. 2024 Mar;17(3):273-280. doi: 10.25122/jml-2023-0487.PMID: 39044937. Review.*

### Abstract

Traumatic brain injury (TBI) results from physical or traumatic injuries to the brain's surrounding bony structures and associated tissues, which can lead to various sequelae, including simple concussion, acute epidural hematoma, parenchymal contusions, subarachnoid hemorrhage, diffuse axonal injury, and chronic traumatic encephalopathy. Susceptibility-weighted imaging (SWI) has enhanced the accuracy of neuroimaging for these injuries. SWI is based on 3D gradient echo magnetic resonance imaging (MRI) with long echo times and flow compensation. Owing to its sensitivity to deoxyhemoglobin, hemosiderin, iron, and calcium, SWI is extremely informative and superior to conventional MRI for the diagnosis and follow-up of patients with acute, subacute, and prolonged hemorrhage. This systematic review aimed to evaluate and summarize the published articles that report SWI results for the evaluation of TBI and to determine correlations between clinical status and SWI results. Consequently, our analysis also aimed to identify the appropriate MRI sequences to use in the assessment of patients with TBI. We searched the Medline and Embase online electronic databases for relevant papers published from 2012 onwards. We found that SWI had higher sensitivity than gradient echo MRI in detecting and characterizing microbleeds in TBIs and was able to differentiate diamagnetic calcifications from paramagnetic microhemorrhages. However, it is important that future research not only continues to evaluate the utility of SWI in TBIs but also attempts to overcome the limitations of the studies described in this review, which should help validate the conclusions and recommendations from our analysis.

## **27** Neural Computation-Based Methods for the Early Diagnosis and Prognosis of Alzheimer's Disease Not Using Neuroimaging Biomarkers: a Systematic Review

*Cabrera-León Y, Báez PG, Fernández-López P, Suárez-Araujo CP. J Alzheimers Dis. 2024;98(3):793-823. doi: 10.3233/JAD-231271.PMID: 38489188.*

### Abstract

**Background:** The growing number of older adults in recent decades has led to more prevalent geriatric diseases, such as strokes and dementia. Therefore, Alzheimer's disease (AD), as the most common type of dementia, has become more frequent too.

**Background: Objective:** The goals of this work are to present state-of-the-art studies focused on the automatic diagnosis and prognosis of AD and its early stages, mainly mild cognitive impairment, and predicting how the research on this topic may change in the future.

**Conclusions:** The introduction of CNNs in the last decade and their superb results with neuroimaging data did not negatively affect the usage of other modalities. In fact, new ones emerged.



# Resources. Day 3

Neuroimaging and Dementias

## **28** Diagnostic Accuracy of Optic Nerve Sheath Diameter on Ultrasound for the Detection of Increased Intracranial Pressure in Patients with Traumatic Brain Injury: a Systematic Review and Meta-Analysis

Chen W, Zhang X, Ye X, Ying P. *Biomed Rep.* 2023 Oct 30;19(6):103. doi: 10.3892/br.2023.1685. eCollection 2023 Dec. PMID: 38025834.

### Abstract

The timely diagnosis and treatment of elevated intracranial pressure (ICP) reduces morbidity rates and prevents mortality. The aim of the present systematic review and meta-analysis was to determine the diagnostic accuracy of optic nerve sheath diameter (ONSD) vs. standard invasive ICP measurements in patients with traumatic brain injury (TBI). The PubMed, Embase, Web of Science and Cochrane Library databases were systematically searched for studies including adult patients with TBI with suspected elevated ICP, and the sonographic ONSD measurements were compared with those from a standard invasive method. The quality of the studies was assessed using the Quality Assessment of Diagnostic Accuracy Studies-2 tool by two independent authors. A bivariate random effects model was used to summarize the pooled sensitivity, specificity and diagnostic odds ratio (DOR). A total of eight prospective studies with 222 patients with TBI were included. The pooled sensitivity was 0.82 [95% confidence interval (CI), 0.75-0.88], the specificity was 0.82 (95% CI, 0.71-0.90) and the DOR was 17.75 (95% CI, 7.02-44.83) with partial evidence of heterogeneity. The accuracy of the area under the summary ROC was 0.87. An ultrasound-determined elevated ICP has reasonable performance indicators with high sensitivity and specificity in patients with TBI. As such, this method may be a useful complementary monitoring tool in acute care.

## **29** Arterial Spin Labeling (ASL-MRI) versus Fluorodeoxyglucose-PET (FDG-PET) in Diagnosing Dementia: a Systematic Review and Meta-Analysis

Haidar H, Majzoub RE, Hajeer S, Abbas LA. *BMC Neurol.* 2023 Oct 24;23(1):385. doi: 10.1186/s12883-023-03432-y. PMID: 37875879.

### Abstract

**Background:** Dementia is generally caused by neurodegenerative diseases affecting the brain, which leads to a progressive neurocognitive decline characterized by inability to perform major higher functioning tasks. Fluorodeoxyglucose-positron emission tomography (FDG-PET) scan is one of the main imaging tests performed for diagnostic purposes. However, with FDG-PET being quite expensive and not widely available, an attempt to find an alternative is set. Arterial-spin-labelling magnetic resonance imaging (ASL-MRI) is an increasingly investigated substitute to FDG-PET for the diagnosis of dementia. Thereby, the main purpose of this systematic review and meta-analysis is to compare the diagnostic ability of FDG-PET and ASL-MRI in detecting dementia.

**Conclusions:** Comparing the diagnostic value of FDG-PET and ASL-MRI, the results of this systematic review and meta-analysis indicate that FDG-PET still has an advantage over ASL-MRI. Such implication could be related to the technical differences relating to both modalities, with ASL-MRI having lower temporal resolution. It's worth mentioning that specificity was rather quite similar among both modalities and some studies found an overridden metabolic and perfused images. These findings call for future research to focus their scope of investigation while exploring the diagnostic value of ASL-MRI.



**IAEA**

International Atomic Energy Agency  
Atoms for Peace and Development

# Resources. Day 3

Neuroimaging and Dementias

## **30** The Role and Potential of Using Quantitative MRI Biomarkers for Imaging Guidance in Brain Cancer Radiotherapy Treatment Planning: a Systematic Review

*Aldawsari AM, Al-Qaisieh B, Broadbent DA, Bird D, Murray L, Speight R. Phys Imaging Radiat Oncol. 2023 Jul 25;27:100476. doi: 10.1016/j.phro.2023.100476. eCollection 2023 Jul. PMID: 37565088. Review.*

### Abstract

Background and purpose: Improving the accuracy of brain tumour radiotherapy (RT) treatment planning is important to optimise patient outcomes. This systematic review investigates primary studies providing clinical evidence for the integration of quantitative magnetic resonance imaging (qMRI) biomarkers and MRI radiomics to optimise brain tumour RT planning.

Conclusions: Integration of qMRI metrics into RT planning offers the potential to improve delineation and OAR sparing. Clinical trials and consensus guidelines are required to demonstrate the clinical benefits of such approaches.

## **31** The Diagnostic Performance of Functional Dopaminergic Scintigraphic Imaging in The Diagnosis of Dementia with Lewy Bodies: an Updated Systematic Review

*Jreige M, Kurian GK, Perriraz J, Potheegadoo J, Bernasconi F, Stampacchia S, Blanke O, Alessandra G, Lejay N, Chiabotti PS, Rouaud O, Nicod Lalonde M, Schaefer N, Treglia G, Allali G, Prior JO. Eur J Nucl Med Mol Imaging. 2023 Jun;50(7):1988-2035. doi: 10.1007/s00259-023-06154-y. Epub 2023 Mar 15. PMID: 36920494. Review.*

### Abstract

Introduction: Dopaminergic scintigraphic imaging is a cornerstone to support the diagnosis in dementia with Lewy bodies. To clarify the current state of knowledge on this imaging modality and its impact on clinical diagnosis, we performed an updated systematic review of the literature.

Conclusion: Our systematic review confirms the major role of dopaminergic scintigraphic imaging in the assessment of dementia with Lewy bodies. Early diagnosis could be facilitated by identifying the prodromes of dementia with Lewy bodies using dopaminergic scintigraphic imaging coupled with emphasis on clinical neuropsychiatric symptoms. Most published studies use a semi-quantitative analytical assessment of tracer uptake, while there are no studies using quantitative analytical methods to measure dopamine transporter loss. The superiority of a purely quantitative approach to assess dopaminergic transmission more accurately needs to be further clarified.



**IAEA**

International Atomic Energy Agency  
Atoms for Peace and Development

# Resources. Day 3

Neuroimaging and Dementias

**32**

## **Imaging the Brain and Vascular Reactions to Headache Treatments: a Systematic Review**

*Messina R, Christensen RH, Cetta I, Ashina M, Filippi M. J Headache Pain. 2023 May 24;24(1):58. doi: 10.1186/s10194-023-01590-5. PMID: 37221469. Review.*

### Abstract

**Background:** Neuroimaging studies have made an important contribution to our understanding of headache pathophysiology. This systematic review aims to provide a comprehensive overview and critical appraisal of mechanisms of actions of headache treatments and potential biomarkers of treatment response disclosed by imaging studies.

**Conclusion:** Several aspects of headache treatments remain to be elucidated using imaging approaches, such as how pharmacological preventive therapies work, whether treatment-related brain changes may influence therapy effectiveness, and imaging biomarkers of clinical response. In the future, well-designed studies with homogeneous study populations, adequate sample sizes and statistical approaches are needed.

**33**

## **Prognostic Value of Initial Diagnostic Imaging Findings for Patient Outcomes in Adult Patients with Traumatic Brain Injury: a Systematic Review and Meta-Analysis**

*Yu H, Ande SR, Batoo D, Linton J, Shankar J. Tomography. 2023 Feb 24;9(2):509-528. doi: 10.3390/tomography9020042. PMID: 36961001. Review.*

### Abstract

**Introduction:** Termed the "silent epidemic," traumatic brain injury (TBI) is one of the greatest global contributors not only to post-traumatic death but also to post-traumatic long-term disability. This systematic review and meta-analysis aims to specifically evaluate the prognostic value of features on initial imaging completed within 24 h of arrival in adult patients with TBI.

**Conclusion:** In meta-analysis, only SDH with mortality in all TBI patients had a moderate but significant association. Given the small number of studies, additional research focused on initial imaging, particularly for imaging modalities other than NECT, is required in order to confirm the findings of our meta-analysis and to further evaluate the association of imaging findings and outcome.



# Resources. Day 3

## Neuroimaging and Dementias

### **34** Adoption of Hybrid MRI-Linac Systems for the Treatment of Brain Tumors: A Systematic Review of the Current Literature Regarding Clinical and Technical Features

Guerini AE, Nici S, Magrini SM, Riga S, Toraci C, Pegurri L, Facheris G, Cozzaglio C, Farina D, Liserre R, Gasparotti R, Ravanelli M, Rondi P, Spiazzi L, Buglione M. *Technol Cancer Res Treat.* 2023 Jan-Dec;22:15330338231199286. doi: 10.1177/15330338231199286.PMID: 37774771. Review.

#### Abstract

Background: Possible advantages of magnetic resonance (MR)-guided radiation therapy (MRgRT) for the treatment of brain tumors include improved definition of treatment volumes and organs at risk (OARs) that could allow margin reductions, resulting in limited dose to the OARs and/or dose escalation to target volumes. Recently, hybrid systems integrating a linear accelerator and an magnetic resonance imaging (MRI) scan (MRI-linacs, MRL) have been introduced, that could potentially lead to a fully MRI-based treatment workflow.

Conclusions: The adoption of an MRI-only workflow is feasible and could offer several advantages for the treatment of brain tumors, including superior image quality for lesions and OARs and the possibility to adapt the treatment plan on the basis of daily MRI. The growing body of clinical data will clarify the potential benefit in terms of toxicity and response to treatment.

### **35** Differentiation of High Grade Glioma and Solitary Brain Metastases by Measuring Relative Cerebral Blood Volume and Fractional Anisotropy: a Systematic Review and Meta-Analysis Of MRI Diagnostic Test Accuracy Studies

Fioni F, Chen SJ, Lister INE, Ghalwash AA, Long MZ. *Br J Radiol.* 2023 Jan 1;96(1141):20220052. doi: 10.1259/bjr.20220052. Epub 2022 Dec 8.PMID: 36278795.

#### Abstract

Objective: This study aims to research the efficacy of MRI (I) for differentiating high-grade glioma (HGG) (P) with solitary brain metastasis (SBM) (C) by creating a combination of relative cerebral blood volume (rCBV) (O) and fractional anisotropy (FA) (O) in patients with intracerebral tumors.

Conclusion: Combining rCBV and FA measurements in the peritumoral region and FA in the intratumoral region increase the accuracy of MRI examination to differentiate between HGG and SBM patients effectively. Confidence in the accuracy of our results may be influenced by major interstudy heterogeneity. Whereas the I2 for the rCBV in the intratumoral subgroup was 80%, I2 for the rCBV in the peritumoral subgroup was 39%, and I2 for the FA in the intratumoral subgroup was 69%, and I2 for the FA in the peritumoral subgroup was 74%. The predefined accurate search criteria, and precise selection and evaluation of methodological quality for included studies, strengthen this study. Our study has no funder, no conflict of interest, and followed an established PROSPERO protocol (ID: CRD42021279106).



# Resources. Day 3

## Neuroimaging and Dementias

**36**

### **Diagnostic Accuracy of MRI Techniques for Treatment Response Evaluation in Patients with Brain Metastasis: a Systematic Review and Meta-Analysis**

*Teunissen WHT, Govaerts CW, Kramer MCA, Labrecque JA, Smits M, Dirven L, van der Hoorn A. Radiother Oncol. 2022 Dec;177:121-133. doi: 10.1016/j.radonc.2022.10.026. Epub 2022 Oct 28. PMID: 36377093.*

#### Abstract

Background: Treatment response assessment in patients with brain metastasis uses contrast enhanced T1-weighted MRI. Advanced MRI techniques have been studied, but the diagnostic accuracy is not well known. Therefore, we performed a metaanalysis to assess the diagnostic accuracy of the currently available MRI techniques for treatment response.

Conclusion: A combination of techniques shows the highest diagnostic accuracy differentiating tumor progression from treatment induced abnormalities. External validation of imaging results is important to better define the reliability of imaging results with the different techniques.

**37**

### **Can Magnetic Resonance Imaging Enhance the Assessment of Potential New Treatments for Cognitive Impairment in Mood Disorders? A Systematic Review and Position Paper by the International Society for Bipolar Disorders Targeting Cognition Task Force**

*Miskowiak KW, Yalin N, Seeberg I, Burdick KE, Balanzá-Martínez V, Bonnín CDM, Bowie CR, Carvalho AF, Dols A, Douglas K, Gallagher P, Hasler G, Kessing LV, Lafer B, Lewandowski KE, López-Jaramillo C, Martínez-Aran A, McIntyre RS, Porter RJ, Purdon SE, Schaffer A, Sumiyoshi T, Torres IJ, Van Rheenen TE, Yatham LN, Young AH, Vieta E, Stokes PRA. Bipolar Disord. 2022 Sep;24(6):615-636. doi: 10.1111/bdi.13247. Epub 2022 Sep 22. PMID: 35950925. Review.*

#### Abstract

Background: Developing treatments for cognitive impairment is key to improving the functioning of people with mood disorders. Neuroimaging may assist in identifying brain-based efficacy markers. This systematic review and position paper by the International Society for Bipolar Disorders Targeting Cognition Task Force examines the evidence from neuroimaging studies of pro-cognitive interventions.

Conclusions: Modulation of CCN and DMN activity is a putative efficacy biomarker. Methodological recommendations are to pre-declare intended analyses and use task-based fMRI, paradigms probing the CCN, longitudinal assessments, mock scanning, and out-of-scanner tests.



**IAEA**

International Atomic Energy Agency  
Atoms for Peace and Development

# Resources. Day 3

Neuroimaging and Dementias

## **38** Machine Learning Imaging Applications in the Differentiation of True Tumour Progression from Treatment-Related Effects in Brain Tumours: a Systematic Review and Meta-Analysis

*Bhandari A, Marwah R, Smith J, Nguyen D, Bhatti A, Lim CP, Lasocki A. J Med Imaging Radiat Oncol. 2022 Sep;66(6):781-797. doi: 10.1111/1754-9485.13436. Epub 2022 May 22. PMID: 35599360. Review.*

### Abstract

**Introduction:** Chemotherapy and radiotherapy can produce treatment-related effects, which may mimic tumour progression. Advances in Artificial Intelligence (AI) offer the potential to provide a more consistent approach of diagnosis with improved accuracy. The aim of this study was to determine the efficacy of machine learning models to differentiate treatment-related effects (TRE), consisting of pseudoprogression (PsP) and radiation necrosis (RN), and true tumour progression (TTP).

**Conclusion:** TRE can be distinguished from TTP with good performance using machine learning-based imaging models. There remain issues with the quality of articles and the integration of models into clinical practice. Future studies should focus on the external validation of models and utilize standardized criteria such as CLAIM to allow for consistency in reporting.

## **39** Systematic Review and Meta-Analysis of Diagnostic Test Accuracy (DTA) Studies: the Role of Cerebral Perfusion Imaging in Prognosis Evaluation of Mild Cognitive Impairment

*Zhu L, Zhao W, Chen J, Li G, Qu J. Ann Palliat Med. 2022 Feb;11(2):673-683. doi: 10.21037/apm-21-3916. PMID: 35249345.*

### Abstract

**Background:** The application value of cerebral perfusion imaging, such as fluorodeoxyglucose-positron-emission computed tomography (FDG-PET), single-photon emission computed tomography (SPECT), and structural magnetic resonance imaging (MRI), in the prognostic assessment of mild cognitive impairment (MCI) remains unclear. Thus, it was the focus of this meta-analysis, which aimed to provide a theoretical basis for early diagnosis of neurological diseases.

**Discussion:** Cerebral perfusion imaging has good prognostic value for patients with MCI, and FDG-PET imaging has better predictive ability of the prognosis for patients with MCI.

## **40** Diagnostic Yield of Diffusion-Weighted Brain Magnetic Resonance Imaging in Patients with Transient Global Amnesia: a Systematic Review and Meta-Analysis

*Lim SJ, Kim M, Suh CH, Kim SY, Shim WH, Kim SJ. Korean J Radiol. 2021 Oct;22(10):1680-1689. doi: 10.3348/kjr.2020.1462. Epub 2021 Jul 14. PMID: 34269537.*

### Abstract

**Objective:** To investigate the diagnostic yield of diffusion-weighted imaging (DWI) in patients with transient global amnesia (TGA) and identify significant parameters affecting diagnostic yield.

**Conclusion:** The pooled diagnostic yield of DWI in TGA patients was 39%. DWI obtained with a slice thickness  $\leq 3$  mm or an interval between symptom onset and DWI of  $> 24$  to 96 hours could increase the diagnostic yield.



**IAEA**

International Atomic Energy Agency  
Atoms for Peace and Development

# Resources. Day 3

Neuroimaging and Dementias

## **41** The Applications of Focused Ultrasound (FUS) in Alzheimer's Disease Treatment: a Systematic Review on Both Animal and Human Studies

*Liu X, Naomi SSM, Sharon WL, Russell EJ. Aging Dis. 2021 Dec 1;12(8):1977-2002. doi: 10.14336/AD.2021.0510. eCollection 2021 Dec. PMID: 34881081. Review.*

### Abstract

Alzheimer's disease (AD) affects the basic ability to function and has imposed an immense burden on the community and health care system. Focused ultrasound (FUS) has recently been proposed as a novel noninvasive therapeutic approach for AD. However, systematic reviews on the FUS application in AD treatment have not been forthcoming. We followed the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) criteria to summarize the techniques associated with safety and efficacy, as well as possible underlying mechanisms of FUS effects on AD in animal and human studies. Animal studies demonstrated FUS with microbubbles (FUS-MB) induced blood-brain-barrier (BBB) opening that could facilitate various therapeutic agents entering the brain. Repeated FUS-MB and FUS stimulation can relieve AD pathology and improve cognitive and memory function. Human studies showed repeated FUS-MB are well tolerated with few adverse events and FUS stimulation could enhance local perfusion and neural function, which correlated with cognitive improvement. We conclude that FUS is a feasible and safe therapeutic and drug delivery strategy for AD. However, FUS treatment on humans is still in the early stages and requires further optimization and standardization.

## **42** Technical and Clinical Validation of Commercial Automated Volumetric MRI Tools for Dementia Diagnosis - a Systematic Review

*Pemberton HG, Zaki LAM, Goodkin O, Das RK, Steketee RME, Barkhof F, Vernooij MW. Neuroradiology. 2021 Nov;63(11):1773-1789. doi: 10.1007/s00234-021-02746-3. Epub 2021 Sep 3. PMID: 34476511. Review*

### Abstract

Developments in neuroradiological MRI analysis offer promise in enhancing objectivity and consistency in dementia diagnosis through the use of quantitative volumetric reporting tools (QReports). Translation into clinical settings should follow a structured framework of development, including technical and clinical validation steps. However, published technical and clinical validation of the available commercial/proprietary tools is not always easy to find and pathways for successful integration into the clinical workflow are varied. The quantitative neuroradiology initiative (QNI) framework highlights six necessary steps for the development, validation and integration of quantitative tools in the clinic. In this paper, we reviewed the published evidence regarding regulatory-approved QReports for use in the memory clinic and to what extent this evidence fulfils the steps of the QNI framework. We summarize unbiased technical details of available products in order to increase the transparency of evidence and present the range of reporting tools on the market. Our intention is to assist neuroradiologists in making informed decisions regarding the adoption of these methods in the clinic. For the 17 products identified, 11 companies have published some form of technical validation on their methods, but only 4 have published clinical validation of their QReports in a dementia population. Upon systematically reviewing the published evidence for regulatory-approved QReports in dementia, we concluded that there is a significant evidence gap in the literature regarding clinical validation, workflow integration and in-use evaluation of these tools in dementia MRI diagnosis.



**IAEA**

International Atomic Energy Agency  
Atoms for Peace and Development

# Resources. Day 3

Neuroimaging and Dementias

**43**

## **Effects of Chronic Pain Treatment on Altered Functional and Metabolic Activities in the Brain: a Systematic Review and Meta-Analysis of Functional Neuroimaging Studies**

Kim D, Chae Y, Park HJ, Lee IS. *Front Neurosci.* 2021 Jul 5;15:684926. doi: 10.3389/fnins.2021.684926. eCollection 2021. PMID: 34290582.

### Abstract

Previous studies have identified altered brain changes in chronic pain patients, however, it remains unclear whether these changes are reversible. We summarized the neural and molecular changes in patients with chronic pain and employed a meta-analysis approach to quantify the changes. We included 75 studies and 11 of these 75 studies were included in the activation likelihood estimation (ALE) analysis. In the 62 functional magnetic resonance imaging (fMRI) studies, the primary somatosensory and motor cortex (SI and MI), thalamus, insula, and anterior cingulate cortex (ACC) showed significantly decreased activity after the treatments compared to baseline. In the 13 positron emission tomography (PET) studies, the SI, MI, thalamus, and insula showed significantly increased glucose uptake, blood flow, and opioid-receptor binding potentials after the treatments compared to baseline. A meta-analysis of fMRI studies in patients with chronic pain, during pain-related tasks, showed a significant deactivation likelihood cluster in the left medial posterior thalamus. Further studies are warranted to understand brain reorganization in patients with chronic pain compared to the normal state, in terms of its relationship with symptom reduction and baseline conditions.

**44**

## **Prenatal Ultrasound Diagnosis of Biometric changes in the Brain of Growth Restricted Fetuses. A Systematic Review of Literature**

Silva PIP, Perez M. *Rev Bras Ginecol Obstet.* 2021 Jul;43(7):545-559. doi: 10.1055/s-0041-1730290. Epub 2021 Aug 30. PMID: 34461665.

### Abstract

Fetal growth restriction (FGR) occurs when the fetus does not reach its intrauterine potential for growth and development as a result of compromise in placental function. It is a condition that affects 5 to 10% of pregnancies and is the second most common cause of perinatal morbidity and mortality. Children born with FGR are at risk of impaired neurological and cognitive development and cardiovascular or endocrine diseases in adulthood. The purpose of the present revision is to perform a literature search for evidence on the detection and assessment by ultrasound of brain injury linked to FGR during fetal life. Using a systematic approach and quantitative evaluation as study methodology, we reviewed ultrasound studies of the fetal brain structure of growth-restricted fetuses with objective quality measures. A total of eight studies were identified. High quality studies were identified for measurement of brain volumes; corpus callosum; brain fissure depth measurements, and cavum septi pellucidi width measurement. A low-quality study was available for transverse cerebellar diameter measurement in FGR. Further prospective randomized studies are needed to understand the changes that occur in the brain of fetuses with restricted growth, as well as their correlation with the changes in cognitive development observed.



**IAEA**

International Atomic Energy Agency  
Atoms for Peace and Development

# Resources. Day 3

Neuroimaging and Dementias

45

## Defining Functional Brain Networks Underlying Obsessive-Compulsive Disorder (OCD) Using Treatment-Induced Neuroimaging Changes: a Systematic Review of The Literature

Bijanki KR, Pathak YJ, Najera RA, Storch EA, Goodman WK, Simpson HB, Sheth SA. *J Neurol Neurosurg Psychiatry*. 2021 Jul;92(7):776-786. doi: 10.1136/jnnp-2020-324478. Epub 2021 Apr 27. PMID: 33906936.

### Abstract

Approximately 2%-3% of the population suffers from obsessive-compulsive disorder (OCD). Several brain regions have been implicated in the pathophysiology of OCD, but their various contributions remain unclear. We examined changes in structural and functional neuroimaging before and after a variety of therapeutic interventions as an index into identifying the underlying networks involved. We identified 64 studies from 1990 to 2020 comparing pretreatment and post-treatment imaging of patients with OCD, including metabolic and perfusion, neurochemical, structural, functional and connectivity-based modalities. Treatment class included pharmacotherapy, cognitive-behavioural therapy/exposure and response prevention, stereotactic lesions, deep brain stimulation and transcranial magnetic stimulation. Changes in several brain regions are consistent and correspond with treatment response despite the heterogeneity in treatments and neuroimaging modalities. Most notable are decreases in metabolism and perfusion of the caudate, anterior cingulate cortex, thalamus and regions of prefrontal cortex (PFC) including the orbitofrontal cortex (OFC), dorsolateral PFC (DLPFC), ventromedial PFC (VMPFC) and ventrolateral PFC (VLPFC). Modulating activity within regions of the cortico-striato-thalamo-cortical system may be a common therapeutic mechanism across treatments. We identify future needs and current knowledge gaps that can be mitigated by implementing integrative methods. Future studies should incorporate a systematic, analytical approach to testing objective correlates of treatment response to better understand neurophysiological mechanisms of dysfunction.