Title	Reference	Synopsis	Year	Keywords
Fortuitous lymph node visualization after interstitial injection of Tc-99m-MDP	Penney, HF and Styles, CB (1982). "Fortuitous lymph node visualization after interstitial injection of Tc-99m-MDP." Clin Nucl Med 7(2): 84-85.	Right axillary lymph node displayed abnormal uptake after partial interstitial injection of Tc99m. Repeat scan performed seven weeks later showed no abnormalities in the right axilla. Lymph node visualization was due to interstitial nature of injection.	1982	Diagnostic Image Interpretation
Serendipitous lymph node visualization during bone imaging	Vieras, F (1986). "Serendipitous lymph node visualization during bone imaging." Clin Nucl Med 11(6): 434.	Case report: Tc99m uptake by the right axillary lymph nodes occurred due to extravasation during bone imaging. Patient had no clinical evidence of lymphatic abnormalities leading to this type of finding may be a source of erroneous interpretation (i.e. mimic rib lesions).	1986	Diagnostic Image Interpretation Misdiagnosis
99mTc-MDP uptake by lymph nodes following tracer infiltration: clinical and laboratory evaluation	Wallis, JW, Fisher, S and Wahl, RL (1987). "99mTc-MDP uptake by lymph nodes following tracer infiltration: clinical and laboratory evaluation." Nucl Med Commun 8(5): 357-363.	Visualization of normal lymph nodes ipsilateral and proximal to an extravasated injection of Tc99m is not uncommon in patients. The uptake by the lymph nodes will dramatically increase with extravasation. Physician should be aware of the infiltration to avoid confusion with other pathologic forms of soft tissue uptake and to aid in scan interpretation.	1987	Diagnostic Image Interpretation Misdiagnosis
The Infiltrated Radiopharmaceutical Injection: Risk Considerations	Hoop, B (1991). "The Inifitrated Radiopharmaceutical Injection: Risk Considerations." J Nucl Med 32(5): 890-891.	The author summarizes reports from other papers of harm done by infiltrations and goes on to discuss the risk of such procedures. He says that the potential of significant radiation injury clearly calls for more extensive considerations of the risk involved. He also calls for monitoring of injections as a way to confirming a good injection as well as knowing when to implement mitigating actions.	1991	Risk Monitoring Mitigation
Radiation injury from interstitial injection of iodine-131-iodocholesterol	Breen, SL and Driedger, AA (1991). "Radiation injury from interstitial injection of iodine-131-iodocholesterol." J Nucl Med 32(5): 892.	A 44-yr old man was investigated for recurrent Cushing's disease with injection of 34-MBq of 131-I-iodocholesterol over a 5-min interval. At the conclusion of the injection, the patient volunteered that the injection had been the least painful i.v. entry he had experienced. After 7 days, imaging of the injection site showed essentially complete retention of the radiopharmaceutical at the site. After 20 days, the patient had a tender pruritic and erythematous patch at the injection site measuring approximately 2 cm x 1 cm. Using interstitial volumes with thicknesses of 0.5 cm and 1 cm, the dose to the skin was calculated as 490 Gy and 245 Gy, respectively. This experience demonstrates a deterministic radiation injury from a diagnostic dose of 131-I-iodocholesterol.	1991	Diagnostic Injury
Incidental Lymph Node Visualization On Bone Scan Due To Subcutaneous Infiltration Of Tc-99m MDP - A Potential For False Positive Interpretation	Dogan, AS and Rezai, K (1993). "Incidental lymph node visualization on bone scan due to subcutaneous infiltration of Tc-99m MDP. A potential for false positive interpretation." Clin Nucl Med 18(3): 208-209.	Case report: TC99m MDP was present in axillary lymph nodes due to extravasation. Patient required repeat imaging to evaluate lymph node uptake. Follow-up scan showed no signs of tracer uptake in the same region. Take away lesson is soft tissue localization of radiotracer on bone scintigraphy may result in false-positive interpretations, if the activity overlies a bony structure.	1993	Diagnostic Image Interpretation Additional Imaging
Extraosseous Tc-99m MDP uptake: a pathophysiologic approach	Peller, PJ, Ho, VB and Kransdorf, MJ (1993). "Extraosseous Tc-99m MDP uptake: a pathophysiologic approach." Radiographics 13(4): 715-734.	Significant subcutaneous infiltration of Tc99m in the antecubital fossa can lead to axillary node visualization as the extravasated radiopharmaceutical is partially cleared through the lymph vessels.	1993	Diagnostic Image Interpretation

Title	Reference	Synopsis	Year	Keywords
Axillary lymph node uptake of technetium-99m-MDP	Ongseng, F, Goldfarb, CR and Finestone, H (1995). "Axillary lymph node uptake of technetium-99m-MDP." J Nucl Med 36(10): 1797-1799.	Ipsilateral axillary lymph node visualization on PET can occur due to extravasation of Tc99m. In a study of subjects, 4 of the patients were required to have repeat scans due to extravasation.	1995	Diagnostic Image Interpretation Additional Imaging
Complications of venous access ports in 132 patients with disseminated testicular cancer treated with polychemotherapy	Lemmers NW, Gels ME, Sleijfer DT, Plukker JT, van der Graaf WT, de Langen ZJ, Droste JH, Koops HS, Hoekstra HJ. Complications of venous access ports in 132 patients with disseminated testicular cancer treated with polychemotherapy. J Clin Oncol 14: 2916-22; 1996.	Chemotherapy infiltration rates in the 1980s and 1990s ranged from 3-6%.	1995	Frequency Chemotherapy
Bone scan injection artifacts	Andrich, MP and Chen, CC (1996). "Bone scan injection artifacts." Clin Nucl Med 21(3): 260-262.	Case reports: extravasation of Tc99m into soft tissues may lead to unusual artifacts in an adjacent bone proximal to the administration site.	1996	Diagnostic Image Interpretation
Lymph node visualization in the elbow region	Shih, WJ, Wierzbinski, B and Magoun, S (1996). "Lymph node visualization in the elbow region." J Nucl Med 37(11): 1913.	Case report: extravasation of radiopharmaceutical around the dorsal wrist leads to superficial lymphatic drainage to the lymph node near the elbow. May lead to misinterpretation as a lesion.	1996	Diagnostic Image Interpretation Misdiagnosis
False-positive renal study with Tc-99m DTPA caused by infiltration of dose	Slavin, JD, Jr., Jung, WK and Spencer, RP (1996). "False-positive renal study with Tc-99m DTPA caused by infiltration of dose." Clin Nucl Med 21(12): 978-980.	Case report: extravasation of Tc99m DTPA produced a false-positive for renal dysfunction. Subsequent re-imaging after a short timeframe resulted in reduced activity.	1996	Diagnostic Image Interpretation Misdiagnosis
Axillary lymph node uptake of Tc-99m MIBI resulting from extravasation should not be misinterpreted as metastasis	Shih, WJ, Han, JK, Coupal, J, Wierzbinski, B, Magoun, S and Gross, K (1999). "Axillary lymph node uptake of Tc-99m MIBI resulting from extravasation should not be misinterpreted as metastasis." Ann Nucl Med 13(4): 269-271.	Case report: Axillary uptake in the extravasation of Tc99m should be carefully distinguished from lymphatic metastasis as this can lead to misinterpretation of the image.	1999	Diagnostic Image Interpretation Misdiagnosis
Visualization in the ipsilateral lymph nodes secondary to extravasation of a bone-imaging agent in the left hand: a case report	Shih, WJ, Collins, J and Kiefer, V (2001). "Visualization in the ipsilateral lymph nodes secondary to extravasation of a bone-imaging agent in the left hand: a case report." J Nucl Med Technol 29(3): 154-155.	Case report: extravasation of Tc99m can result in false-positive lesions of the lymph nodes in the wrist, elbow, and axillary regions.	2001	Diagnostic Image Interpretation Misdiagnosis
Inadvertent 2-deoxy-2-[18F]fluoro-D-glucose lymphoscintigraphy: a potential pitfall characterized by hybrid PET-CT	Pitman, AG, Binns, DS, Ciavarella, F and Hicks, RJ (2002). "Inadvertent 2-deoxy-2-[18F]fluoro-D-glucose lymphoscintigraphy: a potential pitfall characterized by hybrid PET-CT." Mol Imaging Biol 4(4): 276-278.	When extravasated, FDG outlines draining lymphatics and accumulates in regional lymph nodes. This may result in a false positive diagnosis if the reporting physician is not aware of the extravasation and pitfall of the scan. Additionally, if the lymph nodes draining the injection site are possible regional lymph nodes for the primary tumor, then the study is potentially compromised with regards to staging and would require repeating.	2002	Diagnostic Image Interpretation Misdiagnosis

Title	Reference	Synopsis	Year	Keywords
Potential false-positive FDG PET imaging caused by subcutaneous radiotracer infiltration	Chiang, SB, Rebenstock, A, Guan, L, Burns, J, Alavi, A and Zhuang, H (2003). "Potential false-positive FDG PET imaging caused by subcutaneous radiotracer infiltration." Clin Nucl Med 28(9): 786-788.	Case report: extravasation in the right antecubital fossa led to the suggestion of recurrent malignancy for non-Hodgkin lymphoma. Due to the possibility of subcutaneous infiltration, patient was subjected to a follow-up scan. Images did not demonstrate abnormal activity, which confirmed that the previous findings on the PET/CT were caused by subcutaneous extravasation.	2003	Diagnostic Image Interpretation Misdiagnosis Additional Imaging
Lymphatic Tc-99m DMSA localization after partial-dose extravasation	Stauss, J, Treves, ST and Connolly, LP (2003). "Lymphatic Tc-99m DMSA localization after partial-dose extravasation." Clin Nucl Med 28(7): 618-619.	Case report: extravasation of Tc99m DMSA may result in lymphatic absorption and focal nodal localization with skeletal radiopharmaceuticals. Experienced practitioners estimate that partial-dose extravasation occurs in approximately 8% of children undergoing nuclear medicine studies.	2003	Diagnostic Image Interpretation Frequency
Guidelines for the measurement of glomerular filtration rate using plasma sampling	Fleming, JS, Zivanovic, MA, Blake, GM, Burniston, M, Cosgriff, PS and British Nuclear Medicine, S (2004). "Guidelines for the measurement of glomerular filtration rate using plasma sampling." Nucl Med Commun 25(8): 759-769.	GFR studies utilize very low levels of radioactivity. Extravasation of the radiopharmaceutical will invalidate test results. Quality control for extravasation should be conducted via a radiation monitor.	2004	Diagnostic Misdiagnosis
Technical errors in planar bone scanning	Naddaf, SY, Collier, BD, Elgazzar, AH and Khalil, MM (2004). "Technical errors in planar bone scanning." J Nucl Med Technol 32(3): 148-153.	Compton scatter from activity caused by an extravasated radiopharmaceutical may cause confusion and inaccurate diagnoses.	2004	Diagnostic Image Interpretation Misdiagnosis
Preparation and Dispensing Problems Associated With Technetium Tc-99m Radiopharmaceuticals	Ponto, JA. (2004). "Preparation and Dispensing Problems Associated with Technetium Tc-99m Radiopharmaceuticals." Correspondence Continuing Education Courses for Nuclear Pharmacists and Nuclear Medicine Professionals Volume 11, lesson 1. Retrieved 3-22-2021, from https://pharmacyce.unm.edu/nuclear_program/freelessonfiles/Vol11Lesson1.pdf	In multi-gated acquisition (MUGA) studies used to assess the impact of a patient's chemotherapy treatment on myocardial function, an extravasation can result in suboptimal radiolabeling of blood cells with corresponding increased amounts of residual, unreacted free pertechnetate and lead to inappropriate cessation of chemotherapy treatment.	2004	Diagnostic Image Interpretation Misdiagnosis
Focal lung uptake of 18F-fluorodeoxyglucose (18F-FDG) without computed tomography findings	Farsad, M, Ambrosini, V, Nanni, C, Castellucci, P, Boschi, S, Rubello, D, Fabbri, M, Franchi, R and Fanti, S (2005). "Focal lung uptake of 18F-fluorodeoxyglucose (18F-FDG) without computed tomography findings." Nucl Med Commun 26(9): 827-830.	Case reports: paravenous administration of radiopharmaceuticals (FDG-18) may result in hot clots (lung micro embolism).	2005	Diagnostic Image Interpretation Misdiagnosis
Use of PET for monitoring cancer therapy and for predicting outcome	Weber, WA (2005). "Use of PET for monitoring cancer therapy and for predicting outcome." J Nucl Med 46(6): 983-995.	SUV is most commonly used parameter for assessing tumor glucose use. Because SUV measurements can be integrated relatively easily into routine PET acquisition protocols, at present SUV represents the parameter that is most clinically useful for monitoring tumor response. However, common issues related to erroneous SUV measurement includes extravasation of the radiopharmaceutical.	2005	SUV

Title	Reference	Synopsis	Year	Keywords
Normal variants and pitfalls in whole-body PET imaging with 18F FDG	Bogsrud, TV and Lowe, VJ (2006). "Normal variants and pitfalls in whole-body PET imaging with 18F FDG." Applied Radiology 35(6): 16-30.	Article insinuates that re-imaging may occur in dose infiltrations due to the infiltrate producing false positives/negatives due to artifacts or hot clots.	2006	Additional Imaging Misdiagnosis
PET evaluation of lung cancer	Bunyaviroch, T and Coleman, RE (2006). "PET evaluation of lung cancer." J Nucl Med 47(3): 451-469.	Paravenous FDG injection is a common source of error in measurement of SUV. This results in incorrect low SUV calculations because the area under the time-activity curve is smaller.	2006	Diagnostic SUV
Artifacts and pitfalls in myocardial perfusion imaging	Burrell, S and MacDonald, A (2006). "Artifacts and pitfalls in myocardial perfusion imaging." J Nucl Med Technol 34(4): 193-211; quiz 212-194.	A potential cause of myocardial perfusion imaging artifacts is the technologist. Errors in processing, injection administration, gating, attenuation, and quality control can all be contributing factors.	2006	Diagnostic Image Interpretation
Impact of FDG extravasation on SUV measurements in clinical PET/CT. Should we routinely scan the injection site?	Hall, N, Zhang, J, Reid, R, Hurley, D and Knopp, M (2006). "Impact of FDG extravasation on SUV measurements in clinical PET/CT. Should we routinely scan the injection site?" J Nucl Med 47(suppl 1): 115P.	Total of 190 PET/CT studies reviewed with 39 (21%) having visible focus of FDG activity at the injection site. Of the 39 patients, 36 had extravasated activity totaling less than 1% or less of the total injected dose and 3 patients had activity greater than 1% of the injected dose. Conclusion reached is if significant extravasation occurs it can have large impact on SUV values and may warrant routine acquisition of injection site data. This study did not take into consideration the biological clearance of the extravasation during uptake period, and as a result may underestimate the percent of severe extravasations.	2006	Diagnostic Frequency
Extravazation of therapeutic yttrium-90-ibritumomab tiuxetan (zevalin): a case report	Williams, G, Palmer, MR, Parker, JA and Joyce, R (2006). "Extravazation of therapeutic yttrium-90-ibritumomab tiuxetan (zevalin): a case report." Cancer Biother Radiopharm 21(2): 101-105.	Extravasation of Y-90 can cause serious damage and potential tissue necrosis. Steps should be taken to address the occurrence of extravasation and to prevent the re-occurrence of extravasation.	2006	Therapeutic Injury
FDG Dose Extravasation in PET/CT: Frequency and Impact on SUV Measurements (Oral Presentation)	Teymouri, C, Botkin, C and Osman, M (2007). " FDG Dose Extravasation in PET/CT: Frequency and Impact on SUV Measurements" Journal of Nuclear Medicine 48 (supplement 2): 475P.	Retrospective study of 398 whole body FDG-PET/CT scans (including extremities). Of the 398 scans reviewed, 46 (11.5%) had extravasations. Conclusions reached is that dose extravasation is commonly encountered with PET/CT but underreported due to omitting injection site from FOV. Extravasation can lead to underestimation of SUV max by average of 36.5% in the liver and 35.3% in the mediastinum. Extravasation should be reported to avoid false interpretations of PET/CT exams.	2007	Diagnostic Frequency SUV
Frequency, management, and outcome of extravasation of nonionic iodinated contrast medium in 69,657 intravenous injections.	Wang CL, Cohan RH, Ellis JH, Adusumilli S, Dunnick NR. Frequency, management, and outcome of extravasation of nonionic iodinated contrast medium in 69,657 intravenous injections. Radiology 243: 80-7; 2007.	CT nonionic iodinated contrast medium infiltration rates from 1991-2007 were 0.45%.	2007	Frequency Contrast CT

Title	Reference	Synopsis	Year	Keywords
The Role of PET/CT in Radiation Treatment Planning for Cancer Patient Treatment	The Role of PET/CT in Radiation Treatment Planning for Cancer Patient Treatment (2008). Vienna, Austria, International Atomic Energy Agency.	Guide for accurate imaging as part of the treatment process for most malignancies managed with radiation therapy. Guide accentuates defining the gross tumor volume (GTV) as the single most important step in planning treatment; subsequent steps depend on it. Extravasation will lead to incorrect treatment plans making the entire process futile.	2008	SUV
Paravenous activity in PET/CT – Influence on SUV and correction	Fernolendt, H, Bundschuh, R, Winter, A, Scheidhauer, K and Schwaiger, M (2008). "Paravenous activity in PET/CT – Influence on SUV and correction." Journal of Nuclear Medicine 49(supplement 1): 416P.	Paravenous administration activity can induce errors in SUV calculation. If activity deposits at the administration site are present, the amount should be measured. If more than 1% of activity remains at the administration site, corrections should be made for appropriate SUV values.	2008	Diagnostic SUV
Extravasation of yttrium-90 ibritumomab tiuxetan: a case study	Siebeneck, BM (2008). "Extravasation of yttrium-90 ibritumomab tiuxetan: a case study." Clin J Oncol Nurs 12(2): 275-278.	Yttrium-90 (Y-90) may act as a vesicant, potentially causing severe tissue damage if extravasation occurs. Patients administered Y-90 may not show signs or symptoms of extravasation until weeks or months after the IV injection.	2008	Therapeutic Injury Latent Effects
Standards for PET image acquisition and quantitative data analysis	Boellaard, R (2009). "Standards for PET image acquisition and quantitative data analysis." J Nucl Med 50 Suppl 1(Suppl 1): 11S-20S.	Multiple factors affect 18F-FDG quantification with paravenous administration of the dose included since the rate and quantity of FDG delivery are reduced, resulting in incorrect SUV calculations. The SUV range may be affected from 0-50% (unpublished data). Because the net amount of administered dose is directly used in the SUV calculation, the exact FDG dose given to the patient must be known.	2009	SUV
SUV: Advancing Comparability and Accuracy	Kelly, M. (September 2009). "SUV: Advancing Comparability and Accuracy." Retrieved 3-22-2021, from https://www.mpcphysics.com/documents/SUV_Whitepaper_Final_11.17.09_59807428_2.pdf.	Paravenous administration of the dose injection will result in underestimation of SUV.	2009	SUV
Technetium and blood extravasation before gammagraphy: a case report	Vano-Galvan, S, Rodriguez-Rey, C, Vano-Galvan, E and Jaen, P (2009). "Technetium and blood extravasation before gammagraphy: a case report." Cases J 2(1): 141.	Case report: extravasation of Tc99m-pertechnetate resulted in a black/purple colored lesion. Extravasation may result in imaging artifacts and the imaging procedure should be repeated. Symptoms may appear after several days or weeks. Authors incorrectly concluded that radiation injury symptoms could arise immediately. Additionally, authors incorrectly concluded that "patients and physicians must be reassured because of the non-vesicant property of technetium." This indicates that the authors are unaware that technetium can produced tissue injury as a result of ionizing radiation.	2009	Diagnostic Image Interpretation
Contamination in 18F-FDG PET/CT: An initial experience	Bains, A, Botkin, C, Oliver, D, Nguyen, N and Osman, M (2009). "Contamination in 18F-FDG PET/CT: an initial experience." J Nucl Med 50(supplement 2): 2222.	11% of studied patients had FDG extravasation (92% of 12%). Efforts should be made to minimize the occurrence of radiopharmaceutical extravasations to avoid false positive interpretation of the exam.	2009	Diagnostic Image Interpretation Misdiagnosis

Title	Reference	Synopsis	Year	Keywords
Altered biodistribution of radiopharmaceuticals: role of radiochemical/pharmaceutical purity, physiological, and pharmacologic factors	Vallabhajosula, S, Killeen, RP and Osborne, JR (2010). "Altered biodistribution of radiopharmaceuticals: role of radiochemical/pharmaceutical purity, physiological, and pharmacologic factors." Semin Nucl Med 40(4): 220-241.	Common problems associated with radiopharmaceuticals is an unanticipated or altered biodistribution. This can result from dose infiltration, which may cause significant artifacts and compromise the utility and/or accuracy of nuclear medicine studies.	2010	Diagnostic Image Interpretation Misdiagnosis
Extravasation of a therapeutic dose of 131I-metaiodobenzylguanidine: prevention, dosimetry, and mitigation	Bonta, DV, Halkar, RK and Alazraki, N (2011). "Extravasation of a therapeutic dose of 131I-metaiodobenzylguanidine: prevention, dosimetry, and mitigation." J Nucl Med 52(9): 1418-1422.	After the extravasation of a therapeutic dose of 131I-metaiodobenzylguanidine that produced a radiation burn to a patient's forearm, we instituted a catheter placement verification protocol. Methods: Before therapy infusion, proper placement is verified by administering 37 MBq of 99mTc-pertechnetate through the catheter, and monitoring activity at the administration site and on the contralateral extremity. A dosimetric model describing both high-rate and low-rate dose components was developed and predicted that the basal epidermal layer received a radiation dose consistent with the observed moist desquamation radiation skin toxicity. Results: No extravasation incidents have occurred since the verification procedure was instituted. Conclusion: To protect against radiation injury from extravasation of therapeutic radionuclides, test administration of a small 99mTc dose with probe monitoring of comparable sites in both upper extremities appears to be an effective preventive measure.	2011	Therapeutic Injury
Recognition of dose infiltration on pulmonary ventilation-perfusion scintigraphy	Goel, S, Bhargava, P and Depuey, EG (2011). "Recognition of dose infiltration on pulmonary ventilation-perfusion scintigraphy." Radiol Case Rep 6(4): 562.	Case report: dose extravasation of Tc99m MAA can cause uneven distribution of the radioactivity in the vascular bed and can significantly lower the amount of radioactivity reaching the lungs. This can cause inaccuracy and misinterpretation of the images of a ventilation-perfusion scan.	2011	Diagnostic Image Interpretation Misdiagnosis
Causes and Imaging Features of False Positives and False Negatives on (18)F-PET/CT in Oncologic Imaging	Long, NM and Smith, CS (2011). "Causes and imaging features of false positives and false negatives on F-PET/CT in oncologic imaging." Insights Imaging 2(6): 679-698.	Injection of radioactive clot following blood withdrawal into the syringe during FDG administration can result in pulmonary hotspots. Additionally, extravasation can result in subcutaneous tracking of FDG along lymphatic channels in the arm resulting in uptake in axillary nodes.	2011	Diagnostic Image Interpretation
New axillary lymph nodal F-18 fluoro-deoxy glucose uptake in an interim positron emission tomography scan - not always a sign of disease progression	Manohar, K, Agrawal, K, Bhattacharya, A and Mittal, BR (2011). "New axillary lymph nodal F-18 fluoro-deoxy glucose uptake in an interim positron emission tomography scan - not always a sign of disease progression." Indian J Nucl Med 26(4): 192-193.	FDG may accumulate in non-malignant conditions causing potential pitfalls leading to false-positive interpretations, resulting in unnecessary invasive procedures.	2011	Diagnostic Image Interpretation Misdiagnosis

Title	Reference	Synopsis	Year	Keywords
Inadvertent intraarterial injection of (1)(8)F-FDG: a case report and literature review of hot forearm and hot hand signs	Zhu, Z, Doss, M, Tan, H, Feigenberg, S and Yu, JQ (2011). "Inadvertent intraarterial injection of (1)(8)F-FDG: a case report and literature review of hot forearm and hot hand signs." J Nucl Med Technol 39(4): 249-251.	Unintentional intraarterial injection of radiotracers may cause artifacts leading to difficulties in accurately interpreting PET/CT images. We report a case of a 73-y-old man with a history of metastatic colon cancer who underwent a PET/CT scan for restaging. In the PET scan, there was intense and diffuse distribution of 18F-FDG in his left forearm and hand. This is a classic sign of an accidental intraarterial injection of 18F-FDG in the antecubital region. Similar phenomena after inadvertent intraarterial injection of other radiotracers are reviewed. The associated risk factors, preventive measures, and radiation dose to the arm are discussed.	2011	Diagnostic
FDG Dose Extravasations in PET/CT: Frequency and Impact on SUV Measurements	Osman, MM, Muzaffar, R, Altinyay, ME and Teymouri, C (2011). "FDG Dose Extravasations in PET/CT: Frequency and Impact on SUV Measurements." Front Oncol 1: 41.	Radiopharmaceutical dose extravasations are commonly encountered (10.5%) in PET/CT. However, it is underreported by at least 31% due to omitting injection site from the FOV. When present, extravasations may lead to underestimation of SUVmax.	2011	Diagnostic Frequency SUV
FDG injection site extravasation: potential pitfall of misinterpretation and missing metastases	Sonoda, LI, Ghosh-Ray, S, Sanghera, B, Dickson, J and Wong, WL (2012). "FDG injection site extravasation: potential pitfall of misinterpretation and missing metastases." Clin Nucl Med 37(11): 1115-1116.	Case image report: extravasation in the left antecubital fossa could have led to a significant difference in patient management and treatment if the images were not interpreted carefully.	2012	Diagnostic Image Interpretation Misdiagnosis
Extravasation of 90Y-Dotatoc: case report and discussion of potential effects, remedies and precautions in PRRT	Terwinghe, C, Binnebeek, SV, Bergans, N, Haustermans, K, Van Custem, E, Verbruggen, A, Deroose, CM, Vanbilloen, B, Baeste, K, Koole, M, Verslype, C, Clement, PM and Mortelmans, L (2012). "Extravasation of 90Y-Dotatoc: case report and discussion of potential effects, remedies and precautions in PRRT." European Journal Of Nuclear Medicine And Molecular Imaging 39: S205.	Extravasation with 90Y can cause a lot of tissue damage depending on the local retention of the radiopharmaceutical. If monitoring for extravasation occurs, it can be properly managed and resolved without any local signs or symptoms.	2012	Therapeutic Injury Monitoring

Title	Reference	Synopsis	Year	Keywords
Extravasation of radiopharmaceuticals: preventive measures and management recommended by SoFRa (Societe Francaise de Radiopharmacie)	Barre, E, Nguyen, ML, Bruel, D, Fournel, C, Hosten, B, Lao, S, Vercellino, L and Rizzo-Padoin, N (2013). " Extravasation of radiopharmaceuticals: preventive measures and management recommended by SoFRa (Societe Francaise de Radiopharmacie)" Ann Pharm Fr 71(4): 216-224.	Radiopharmaceuticals extravasation is rare but may have serious clinical issues. Because no specific recommendations are being proposed to date, the goals of our working group created within the French Society of Radiopharmacy are to determine preventive measures and to establish a pragmatic management of extravasation of these drugs. Our preventive measures are to recognize the symptoms (erythema, venous discoloration, swelling), to know the risk factors (which are related to radiopharmaceutical, patient, site of injection, injection technique) and severity (from erythema to skin necrosis, depending on the radionuclide) and how to avoid them (training and awareness of staff, choice of injection site, route of drug administration test, use of a catheter for administration of therapeutic radiopharmaceuticals).Management should be immediate. It can be facilitated by a specific emergency kit. General measures recommended are the immediate cessation of injection, aspiration of fluid extravasation, delimitation of the extravasated area with an indelible pen, informing the doctor. Specific measures taking into account the radiotoxicity of the radionuclide and the type of radiopharmaceutical were also established. The patient should be informed by the doctor about the risks and how to take care of. Traceability of the incident must be ensured. A multidisciplinary approach is essential to manage the extravasation as early and effectively as possible.	2013	Contributing Factors Prevention Mitigation
Fluorodeoxyglucose uptake in absence of CT abnormality on PET-CT: What is it?	Liu, Y (2013). "Fluorodeoxyglucose uptake in absence of CT abnormality on PET-CT: What is it?" World J Radiol 5(12): 460-467.	Focal FDG accumulation in lung parenchyma without abnormal CT findings share a common characteristic with partial paravenous injection of radiotracer. The damage to the vein due to extravasation causes the formation of blood clots at the site of injury, which in turn detach from the vein, enter the small pulmonary vasculature and are seen as hot spots in the distal lung.	2013	Diagnostic Image Interpretation
Assessment of glomerular filtration rate measurement with plasma sampling: a technical review	Murray, AW, Barnfield, MC, Waller, ML, Telford, T and Peters, AM (2013). "Assessment of glomerular filtration rate measurement with plasma sampling: a technical review." J Nucl Med Technol 41(2): 67-75.	Extravasation should be avoided in glomerular filtration rate assessments since they will invalidate a study or cause inaccurate glomerular filtration rate measurements.	2013	Diagnostic Misdiagnosis
A false-positive finding in therapeutic evaluation: hypermetabolic axillary lymph node in a lymphoma patient following FDG extravasation	Wagner, T, Brucher, N, Julian, A and Hitzel, A (2011). "A false-positive finding in therapeutic evaluation: hypermetabolic axillary lymph node in a lymphoma patient following FDG extravasation." Nucl Med Rev Cent East Eur 14(2): 109-111.	Case report: false-positive finding in the right axillary lymph node due to radiopharmaceutical extravasation.	2013	Diagnostic Image Interpretation Misdiagnosis
Accuracy of positron emission tomography may be improved when combined with postcontrast high-resolution computed tomography scan	Giron, J, Lacout, A and Marcy, PY (2015). "Accuracy of positron emission tomography may be improved when combined with postcontrast high-resolution computed tomography scan: In Regard to Pepek et al." Pract Radiat Oncol 5(5): e549-e550.	PET helps in accurate staging of hilar lymph nodes of the lungs, but extravasation of FDG may lead to false-positive hot spots.	2014	Diagnostic Image Interpretation Misdiagnosis

Title	Reference	Synopsis	Year	Keywords
Hot-clot artifacts in the lung parenchyma on F-18 fluorodeoxyglucose positron emission tomography/CT due to faulty injection techniques: two case reports	Ozdemir, E, Poyraz, NY, Keskin, M, Kandemir, Z and Turkolmez, S (2014). "Hot-clot artifacts in the lung parenchyma on F-18 fluorodeoxyglucose positron emission tomography/CT due to faulty injection techniques: two case reports." Korean J Radiol 15(4): 530-533.	Two case reports detail that paravenous injection may lead to hot-clot artifacts in the lung parenchyma that may result in false positives and/or additional imaging procedures for the patient.	2014	Diagnostic Image Interpretation Misdiagnosis
PET/CT Atlas on Quality Control and Image Artefacts	PET/CT Atlas on Quality Control and Image Artefacts (2014). Vienna, Austria, International Atomic Energy Agency, Division of Human Health.	Case report: PET images depicted infiltration resulting in neck lesion SUV underestimation. Recommended guidance is to image patients from top of the head to visualize possible infiltration, but this technique should be balanced against additional CT radiation exposure.	2014	Diagnostic Image Interpretation Misdiagnosis SUV
Non-invasive input function measurement using a modular detector device.	Acuff, S and Osborne, D (2015). "Non-invasive input function measurement using a modular detector device." J Nucl Med 56(supplement 3 2624).	Presented a device from Lucerno Dynamics that shows potential for use as a non-invasive method for determining arterial input functions for dynamics PET studies. The system may also obviate the need for "on the bed" injections and long 1-hour acquisitions to obtain image derived input functions.	2015	Lara Blood Input Function
FDG PET/CT: EANM procedure guidelines for tumour imaging: version 2.0	Boellaard, R, Delgado-Bolton, R, Oyen, WJ, Giammarile, F, Tatsch, K, Eschner, W, Verzijlbergen, FJ, Barrington, SF, Pike, LC, Weber, WA, Stroobants, S, Delbeke, D, Donohoe, KJ, Holbrook, S, Graham, MM, Testanera, G, Hoekstra, OS, Zijlstra, J, Visser, E, Hoekstra, CJ, Pruim, J, Willemsen, A, Arends, B, Kotzerke, J, Bockisch, A, Beyer, T, Chiti, A, Krause, BJ and European Association of Nuclear, M (2015). "FDG PET/CT: EANM procedure guidelines for tumour imaging: version 2.0." Eur J Nucl Med Mol Imaging 42(2): 328-354.	Extravasation of the radiopharmaceutical administration warrants imaging of the administration area. Extravasation should be reported to the imaging physician since the content of the images affect patient management and clinical outcomes.	2015	Diagnostic Image Interpretation Misdiagnosis
Intravenous contrast extravasation during CT: a national data registry and practice quality improvement initiative	Dykes TM, Bhargavan-Chatfield M, Dyer RB. Intravenous contrast extravasation during ct: A national data registry and practice quality improvement initiative. J Am Coll Radiol 12: 183-91; 2015.	In 2015, a National Data Registry and Practice Quality Improvement Initiative involving 454,497 CT scans showed that rates had improved to 0.24%	2015	Frequency Contrast CT
Effect of (18)F-fluorodeoxyglucose extravasation on time taken for tumoral uptake to reach a plateau: animal and clinical PET analyses	Lee, JJ, Chung, JH and Kim, SY (2016). "Effect of (18)F-fluorodeoxyglucose extravasation on time taken for tumoral uptake to reach a plateau: animal and clinical PET analyses." Ann Nucl Med 30(8): 525-533.	The concept in the paper might be confusing. The authors found that extravasation statistically lowered the SUV measurements. Additionally, the authors believed that there wasn't any correlation between extravasation and the duration required for the tumor uptake to reach a "plateau". In fact, it doesn't matter if it plateaus or not if it's at the wrong amplitude	2016	Diagnostic SUV

Title	Reference	Synopsis	Year	Keywords
SNMMI procedure standard/EANM practice guideline for amyloid PET imaging of the brain 1.0	Minoshima, S, Drzezga, AE, Barthel, H, Bohnen, N, Djekidel, M, Lewis, DH, Mathis, CA, McConathy, J, Nordberg, A, Sabri, O, Seibyl, JP, Stokes, MK and Van Laere, K (2016). "SNMMI Procedure Standard/EANM Practice Guideline for Amyloid PET Imaging of the Brain 1.0." J Nucl Med 57(8): 1316-1322.	Administration site should be routinely inspected for dose infiltration. Quotes: "Any difficulty with radiotracer injection (particularly infiltration) should be documented." "The injection site should be imaged to ensure absence of dose infiltration either systematically or when a study appears noisy/shows an unexpectedly poor count rate."	2016	Diagnostic Monitoring
A Novel method for Whole-body dynamic imaging using Continuous Bed Motion PET/CT with non-invasive estimation of arterial input function using an external radiation detector device.	Osborne, D and Acuff, S (2016). "A Novel method for Whole-body dynamic imaging using Continuous Bed Motion PET/CT with non-invasive estimation of arterial input function using an external radiation detector device." J Nucl Med 57(supplement 2 372).	The technique described enables routine use of whole-body dynamic imaging requiring only 15 minutes of PET scanner time. This technique also uses a novel method for estimation of arterial input functions for use in quantitative modeling. Further development of this technique may result in routine use of dynamic PET imaging to obtain improved quantitative imaging and more robust data comparison between patients.	2016	Lara Blood Input Function
Towards real-time topical detection and characterization of FDG dose infiltration prior to PET imaging.	Williams, JM, Arlinghaus, LR, Rani, SD, Shone, MD, Abramson, VG, Pendyala, P, Chakravarthy, AB, Gorge, WJ, Knowland, JG, Lattanze, RK, Perrin, SR, Scarantino, CW, Townsend, DW, Abramson, RG and Yankeelov, TE (2016). "Towards real-time topical detection and characterization of FDG dose infiltration prior to PET imaging." Eur J Nucl Med Mol Imaging 43(13): 2374-2380.	Topical sensors applied near the injection site provide dynamic information from the time of FDG administration through the uptake period and may be useful in detecting infiltrations regardless of PET image field of view. This dynamic information may also complement the static PET image to better characterize the true extent of infiltrations.	2016	Lara
Frequency of Interstitial Radiotracer Injection for Patients Undergoing Bone Scan	McIntosh, C and Abele, J (2016). Frequency of Interstitial Radiotracer Injection for Patients Undergoing Bone Scan. The Canadian Association of Radiologists. Montreal, Quebec.	All nine nuclear medicine sites (three hospitals and six centers) in Edmonton, Alberta contributed to a quality improvement project involving 450 Tc-99m MDP SPECT bone scans. They reported 79 infiltrations (17.5%). The centers' infiltration rates ranged from 0-44%.	2016	Diagnostic Frequency
Chemotherapy Extravasation: Establishing a National Benchmark for Incidence Among Cancer Centers	Jackson-Rose J, Del Monte J, Groman A, Dial LS, Atwell L, Graham J, O'Neil Semler R, O'Sullivan M, Truini-Pittman L, Cunningham TA, Roman-Fischetti L, Costantinou E, Rimkus C, Banavage AJ, Dietz B, Colussi CJ, Catania K, Wasko M, Schreffler KA, West C, Siefert ML, Rice RD. Chemotherapy extravasation: Establishing a national benchmark for incidence among cancer centers. Clin J Oncol Nurs 21: 438-445; 2017.	A recent attempt to create a national benchmark of the chemotherapy infiltration rate assessed 739,832 patients. Peripheral IV and central venous access device infiltration rates were estimated to be 0.18% and 0.01% respectively.	2017	Frequency Chemotherapy
QIBA Profile: Quantifying Dopamine Transporters with 123-Iodine Labeled Ioflupane in Neurodegenerative Diseases, Stage 2: Consensus	QIBA Profile: Quantifying Dopamine Transporters with 123-Iodine Labeled Ioflupane in Neurodegenerative Diseases, Stage 2: Consensus. (2019). Quantitative Imaging Biomarker Alliance.	Several radiopharmaceuticals can quantify and help distinguish between neurodegenerative causes in Parkinson's disease and Diffuse Lewy Body Dementia. However, a caveat with regards to such nuclear medicine studies includes administration of the radiopharmaceutical, which cannot be compromised by extravasation.	2019	Diagnostic

Title	Reference	Synopsis	Year	Keywords
Focal Cutaneous Squamous Cell Carcinoma Following Radium-223 Extravasation	Benjegerdes, KE, Brown, SC and Housewright, CD (2017). "Focal cutaneous squamous cell carcinoma following radium-223 extravasation." Proc (Bayl Univ Med Cent) 30(1): 78-79.	Long-term sequelae due to extravasation of intravenous radioisotopes resulting in radiation injuries are rarely reported. As the use of radioactive isotopes for the treatment of osteoblastic metastases increases, information regarding the prevention, treatment, and long-term monitoring of suspected extravasation injury will become increasingly important. We present a patient with no previous history of skin cancer who developed an aggressive cutaneous squamous cell carcinoma at the site of prior radium-223 extravasation. We recommend that patients who experience extravasation of therapeutic radioisotopes be monitored by dermatologists for long-term sequelae. Cutaneous squamous cell carcinoma should be recognized as a rare but potential adverse event following cutaneous extravasation of radium-223 and is likely a side effect that is severely underreported.	2017	Therapeutic Stochastic Harm
False-positive stress PET-CT imaging in a patient with interstitial injection	Erthal, L, Erthal, F, Beanlands, RSB, Ruddy, TD, deKemp, RA and Dwivedi, G (2017). "False-positive stress PET-CT imaging in a patient with interstitial injection." J Nucl Cardiol 24(4): 1447-1450.	Case report: physicians should be cognizant of the presence of artifacts as it can lead to misinterpretation of a PET study. Artifacts may be caused by substantial radiopharmaceutical activity outside of the FOV.	2017	Diagnostic Image Interpretation Misdiagnosis
Novel method to detect and characterize (18)F-FDG infiltration at the injection site: a single-institution experience.	Muzaffar, R, Frye, SA, McMunn, A, Ryan, K, Lattanze, R and Osman, MM (2017). "Novel Method to Detect and Characterize (18)F-FDG Infiltration at the Injection Site: A Single-Institution Experience." J Nucl Med Technol 45(4): 267-271.	The device provides valuable quality control information for each subject. Time-activity curves can further characterize visible infiltration. Even when the injection site was out of the field of view, the time-activity curves could still detect and characterize infiltration. Our initial experience showed that the quality assurance information obtained from the device helped reduce the rate and severity of infiltration. The device revealed site-specific contributing factors that helped nuclear medicine physicians and technologists customize their quality improvement efforts to these site-specific issues. Reducing infiltration can improve image quality and SUV quantification, as well as the ability to minimize variability in a site's PET/CT results.	2017	Lara Frequency Contributing Factors Prevention Image Interpretation
Prolonged Venous Stasis: Invisible Intravenous FDG Infiltrations and Potential Negative Implications in PET/CT Examination.	Osman, M, Townsend, D, Frye, SA, Lattanze, RK and Muzaffar, R (2017). "Prolonged Venous Stasis: Invisible Intravenous FDG Infiltrations and Potential Negative Implications in PET/CT Examination." JNM 58(Supplement 1).	Dynamic images support sensor TACs as a means to identify presence of radiotracer at the injection site. Both dynamic images and TACs captured venous stasis that resolved during the standard uptake period. Since a standard PET image cannot routinely assess the quality of the injection9, and long-lasting stasis impacts studies in the same manner as infiltrations, the device provides important QC by identifying and characterizing all invisible and visible infiltration and stasis cases. This may prove valuable by improving the injection process, quantification, and patient safety during PET/CT examination.	2017	Lara
The importance of quality control for clinical PET imaging	Schaefferkoetter, JD, Osman, M and Townsend, DW (2017). "The Importance of Quality Control for Clinical PET Imaging." J Nucl Med Technol 45(4): 265-266.	Radiotracer administration problems can never be completely eliminated, but such problems can be minimized with continuous feedback quality control and quality assurance measures.	2017	Monitoring Prevention
FDG PET/CT: artifacts and pitfalls	Simpson, DL, Bui-Mansfield, LT and Bank, KP (2017). "FDG PET/CT: Artifacts and Pitfalls." Contemporary Diagnostic Radiology 40(5): 108.	False-positive or false-negative PET/CT examination results can occur due to the presence of artifacts. Artifacts can be created by an error in the radiopharmaceutical administration process.	2017	Diagnostic Image Interpretation Misdiagnosis

Title	Reference	Synopsis	Year	Keywords
Consequences of radiopharmaceutical extravasation and therapeutic interventions: a systematic review	van der Pol, J, Voo, S, Bucerius, J and Mottaghy, FM (2017). "Consequences of radiopharmaceutical extravasation and therapeutic interventions: a systematic review." Eur J Nucl Med Mol Imaging 44(7): 1234-1243.	Diagnostic extravasations are likely underreported due to lack of regulatory requirements. Vast majority of diagnostic extravasations do not include dosimetry or patient follow-up (3,013/3,016). In addition, image quality might be significantly affected by a large extravasation leading to a lower degree of tracer uptake in the target tissue (organ) and to the potential need for a new scan. Extravasation of therapeutic radiopharmaceuticals can lead to severe soft tissue lesions. Lesions may result in surgical intervention.	2017	Literature Review Frequency
Evaluating Radiopharmaceutical Administration Quality: A Journey of Process Improvement in PET/CT	Barber, SA and Fulp, AH (2018). "Evaluating Radiopharmaceutical Administration Quality: A Journey of Process Improvement in PET/CT." Uptake 24(3).	Case studies address the efforts of two institutions that used a radiation sensor device (Lara, Lucerno Dynamics) to identify and address dose extravasation, thus improving overall patient care and outcome.	2018	Lara Prevention
Specialty Imaging: PET - Positron Emission Tomography with Correlative CT and MR	Bennett, PA, Mintz, A, Perry, B, Trout, A and Vergara-Wentland, P (2018). Specialty Imaging: PET - Positron Emission Tomography with Correlative CT and MR. Philadelphia, PA, Elsevier.	Severe dose infiltration can decrease uptake in areas of normal biodistribution, rendering the exam uninterpretable. Artifacts and pitfalls are common causes of unclear, inaccurate, and false-positive conclusions.	2018	Diagnostic Image Interpretation Misdiagnosis
Impact of an 18F-FDG PET/CT Radiotracer Injection Infiltration on Patient Management - A Case Report	Kiser, JW, Crowley, JR, Wyatt, DA and Lattanze, RK (2018). Impact of an 18F-FDG PET/CT Radiotracer Injection Infiltration on Patient Management - A Case Report. Front Med (Lausanne) 5:143.	Case report: severe infiltration in right antecubital fossa on initial scan masked metastatic cancer. Repeat scan performed resulted in finding stage 3 disease. Demonstrates that severe extravasation of the radiopharmaceutical dose degrades image quality.	2018	Lara Diagnostic Image Interpretation Misdiagnosis
Quality Improvement Using New Technology to Assess and Reduce FDG PET/CT Radiotracer Infiltrations.	Kiser, JW, Crowley, JR, Benefield, T, Lattanze, RK, Ryan, K, Knowland, J and Perrin, SR (2018). Quality Improvement Using New Technology to Assess and Reduce FDG PET/CT Radiotracer Infiltrations. American Society of Clinical Oncology (ASCO).	The quality and accuracy of the PET/CT image is important to oncologists and their patients. Our center's 13.3% infiltration rate was similar to published rates. Using new technology led to significant and sustainable improvement in PET/CT radiotracer injections with minimal patient/procedure disruptions. Since a proper injection is critical to the PET/CT image, ongoing monitoring of the injection process is essential	2018	Lara Frequency Monitoring Prevention
2018 SNMMI Highlights Lecture: General Nuclear Medicine	Jacene, HA (2018). "2018 SNMMI Highlights Lecture: General Nuclear Medicine." J Nucl Med 59(10): 7N-13N	This article presents the highlights of the 2018 SNMMI Annual Meeting and discusses the oral presentations given that reported on the Lara QI Study. Lara results were highlighted as one of the most significant presentations at the Annual Meeting.	2018	Lara Monitoring
Practical Clinical Measurement of Radiotracer Concentration in Blood: Initial Device Concept and Feasibility Testing	Knowland, J, Lattanze, R, Kingg, J and Perrin, S (2018). "Practical Clinical Measurement of Radiotracer Concentration in Blood: Initial Device Concept and Feasibility Testing." J Nucl Med Technol 46(4): 373-377.	In experiments with phantom models, the prototype provided accurate measurements of beta-emitting radiotracer concentration. The design will be refined for in vivo testing. The ability to routinely gather blood input function data would facilitate the adoption of kinetic modeling of PET data.	2018	Blood Input Function

Title	Reference	Synopsis	Year	Keywords
Usefulness of topically applied sensors to assess the quality of 18F-FDG injections and validation against dynamic positron emission tomography (PET) images.	Lattanze, RK, Osman, MM, Ryan, KA, Frye, S and Townsend, DW (2018). "Usefulness of Topically Applied Sensors to Assess the Quality of 18F-FDG Injections and Validation Against Dynamic Positron Emission Tomography (PET) Images." Front Med (Lausanne) 5: 303.	Sensor measurements can be an effective way to identify and characterize infiltrations and venous stasis. Comparable to an infiltration, venous stasis may produce spurious and clinically meaningful measurement bias and possible even scan misinterpretation. Since the quality and quantification of PET/CT studies are of clinical importance, sensor measurements acquired during the FDG uptake may prove to be a useful quality control measure to reduce infiltration rates and potentially improve patient care.	2018	Lara Monitoring
Clinical Quantification of Myocardial Blood Flow Using PET: Joint Position Paper of the SNMMI Cardiovascular Council and the ASNC	Murthy, LV, Bateman, TM, Beanlands, RS, Berman, DS, Borges-Neto, S, Chareonthaitawee, P, Cerqueira, MD, deKemp, RA, DePuey, EG, Dilsizian, V, Dorbala, S, Ficaro, EP, Garcia, EV, Gewirtz, H, Heller, GV, Lewin, HC, Malhotra, S, Ruddy, TD, Schindler, TH, Schwartz, RG, Slomka, PJ, Soman, P and Di Carli, MF (2018). " Clinical Quantification of Myocardial Blood Flow Using PET: Joint Position Paper of the SNMMI Cardiovascular Council and the ASNC" J Nuc Med 59(2): 269-297.	Extravasation or incomplete delivery of the radiopharmaceutical may result in inaccurate myocardial blood flow estimates and accuracy. Use of automatic injectors facilitates uniform radiopharmaceutical delivery and increases the reliability of quantification of myocardial blood flow.	2018	Diagnostic Image Interpretation Misdiagnosis Prevention
Measuring Differences in Y90 Delivery Techniques: A Potential Tool for Physician Training, Optimization of Technique, and Confirmation of Dose Delivery.	Osborne, D, Acuff, S, Green, C, Taylor, R, Leschak, S and Stephens, C (2018). "Measuring Differences in Y90 Delivery Techniques: A Potential Tool for Physician Training, Optimization of Technique, and Confirmation of Dose Delivery." J Nucl Med 59(Supplement 1).	Analysis of time activity curves from both detectors indicate that use of these detectors can provide specific information about a particular radioactive sphere infusion procedure. Data can be used to optimize techniques for a given Y90 therapy device or used to train radiology residents on proper technique. This method can also provide near real-time confirmation of a successful complete delivery of the desired patient dose which may also maximize therapy efficacy and improve patient outcomes.	2018	Therapeutic Monitoring
Masking effect of radiopharmaceutical dose extravasation during injection on myocardial perfusion defects during SPECT myocardial perfusion imaging: a potential source of false negative result	Qutbi, M (2018). "Masking Effect of Radiopharmaceutical Dose Extravasation During Injection on Myocardial Perfusion Defects During SPECT Myocardial Perfusion Imaging: A Potential Source of False Negative Result." Mol Imaging Radionucl Ther 27(3): 141-143.	Dose extravasation during SPECT MPI can be considered a major source of false negative results. Recommendation is to check the administration site prior to imaging to avoid incorrect interpretation.	2018	Diagnostic Image Interpretation Misdiagnosis Monitoring

Title	Reference	Synopsis	Year	Keywords
Multi-Center Assessment of Infiltration Rates in FDG-PET/CT scans: Detection, Incidence, and Contributing Factors (Oral Presentation)	Townsend, D, Benefield, T, Perrin, SR, Ryan, K, Lattanze, RK and Wong, TZ (2018). " Multi-Center Assessment of Infiltration Rates in FDG-PET/CT scans: Detection, Incidence, and Contributing Factors" J Nucl Med 59.	The range of infiltration rates across the diverse PET/CT centers in this project supports 7 previously published single-center studies involving over 2,804 patients with an average infiltration rate of 15.2% (range: 3% - 23%), and suggests infiltrations are not uncommon. Approximately 12,000 PET/CT scans are performed daily in the United States and therefore our findings suggest that each day infiltrations may be present in ~740 PET studies, of which ~200 could be compromised by moderate or severe infiltration. Since infiltrations can resolve during uptake and as the standard imaging FOV does not always capture the injection site, many infiltrations may go undetected. Infiltrations result in underestimated SUVs that can impact patient care emphasizing that it is important to monitor injection quality. Thus, identifying contributing factors associated with infiltrations may help stimulate quality improvements, reduce infiltration rates, and potentially improve patient care.	2018	Diagnostic Frequency Contributing Factors
Classification of PET/CT Injection Quality Using Deep Learning Techniques and External Radiation Detectors.	Tumpa, T, Acuff, S, Carr, C, Baxter, E and Osborne, D (2018). "Classification of PET/CT Injection Quality Using Deep Learning Techniques and External Radiation Detectors." J Nucl Med 59(Supplement 1): 33.	A combination of deep learning techniques and TACs from external sensors is a novel approach which can play a significant role in classifying infiltrated injections. With the data constraint factor, the highest accuracy achieved was in the range of 70%. However, the system could identify the good injections with 85% accuracy and with 90% accuracy when using only the original data. Future work aims at training the network with sufficient data and an improved model to achieve better accuracy.	2018	Lara Monitoring
Collection of Real-Time Data with a Modular Detector System to Assess Injection Quality.	Acuff, SN and Osborne, D (2019). "Collection of Real-Time Data with a Modular Detector System to Assess Injection Quality." J Nucl Med Technol 47(3): 255-257.	The external detector device may be used to ascertain, within only 60 s, whether an injection is sufficient.	2019	Lara Monitoring
Development of a Quantitatively-Based 18F-FDG Infiltration Classifier of Topically Applied Sensor Readings. (Oral Presentation)	Kingg, J, Perrin, S, Knowland, J, Kiser, J and Bowen, S (2019). "Development of a Quantitatively-Based 18F-FDG Infiltration Classifier of Topically Applied Sensor Readings." Journal of Nuclear Medicine 60(Supplement 1): 63.	Linear regression of topical sensor and image-derived tracer infiltration activity estimates showed high correlation, with R2=0.81. A total of 18 subject scans were cross-validated with the quantitatively-based classifier through a leave-one-out methodology. Specificity for binary infiltration classification (none and infiltrated) was 17% for the radiologist's interpretations and 58% for the new topical sensor classification. Sensitivity was 100% for both. The physician tended to label infiltrations as more severe than the classifier.	2019	Lara Classifier
Technical Note: Characterization of technology to detect residual injection site radioactivity.	Knowland, J, Lipman, S, Lattanze, R, Kingg, J, Ryan, K and Perrin, S (2019). "Technical Note: Characterization of technology to detect residual injection site radioactivity." Med Phys 46(6): 2690-2695.	The performance of the sensor was adequate for identification of excessive residual activity at an injection site. Its ability to provide feedback may be useful as a quality control measure for nuclear medicine injections.	2019	Lara
Guidance on prevention of unintended and accidental radiation exposures in nuclear medicine.	Martin, CJ, Marengo, M, Vassileva, J, Giammarile, F, Poli, GL and Marks, P (2019). "Guidance on prevention of unintended and accidental radiation exposures in nuclear medicine." J Radiol Prot 39(3): 665-695.	The paper aims to highlight errors that could occur during different phases of NM procedures in order to aid prevention of incidents. The value of periodic audit in evaluating systems in place on a regular basis is emphasized. Approaches to incident investigation and follow-up are described, and the need to ensure corrective action is taken to address any deficiencies stressed.	2019	Prevention

Title	Reference	Synopsis	Year	Keywords
Use of a PACS Integrated Injection Monitoring Device to Increase Injection Quality and Infiltration Awareness.	Osborne, D, Acuff, S, Noe, J and Fu, Y (2019). "Use of a PACS Integrated Injection Monitoring Device to Increase Injection Quality and Infiltration Awareness." JNM 60(387).	Access to injection monitoring with PACS integration can lead to significant increases in radiology reporting of injection quality both to confirm good quality, and to indicate when an injection may have been compromised.	2019	Lara Monitoring
A Retrospective Study of Physiologic Markers to Assess Radiopharmaceutical Infiltration Compared to External Injection Monitoring.	Osborne, D, Thakur, S and Acuff, SN (2019). "A Retrospective Study of Physiologic Markers to Assess Radiopharmaceutical Infiltration Compared to External Injection Monitoring." Journal of Nuclear Medicine 60(Supplement 1): 1190.	Physiologic parameters may be helpful in assessing potential infiltration, however, commonly reported areas such as the liver do not appear to have any significant correlation with injection quality making it an unreliable marker of infiltration. Other regions may be more useful, however, the overlap of values for infiltrated and non-infiltrated scans make it difficult to simply assign a threshold for rapid assessment. External injection monitoring seems to be the most reliable method for assessing PET radiopharmaceutical injection quality for individual patients.	2019	Lara Monitoring
Classification of Infiltrated Injections During PET/CT Imaging Applying Deep Learning Technique.	Tumpa, TR, Acuff, SN and Osborne, DR (2019). Classification of Infiltrated Injections During PET/CT Imaging Applying Deep Learning Technique. 2019 IEEE 31st International Conference on Tools with Artificial Intelligence (ICTAI): 1781-1785.	The objective of this work was to examine the feasibility of implementing a DL approach to PET dose injection quality monitoring.	2019	Lara Classifier
Quality Improvement Initiatives to Assess and Improve PET/CT Injection Infiltration Rates at Multiple Centers.	Wong, TZ, Benefield, T, Masters, S, Kiser, JW, Crowley, J, Osborne, D, Mawlawi, O, Barnwell, J, Gupta, P, Mintz, A, Ryan, KA, Perrin, SR, Lattanze, RK and Townsend, DW (2019). "Quality Improvement Initiatives to Assess and Improve PET/CT Injection Infiltration Rates at Multiple Centers." J Nucl Med Technol 47(4): 326-331.	A quality improvement approach with new technology can help centers measure infiltration rates, determine associative factors, implement interventions, and improve and sustain injection quality. Because PET/CT images help guide patient management, the monitoring and improvement of radiotracer injection quality are important.	2019	Lara Monitoring Contributing Factors
Injection Integrity in 2020.	Crowley, J (2020). "Injection Integrity in 2020." J Nucl Med Technol 48(1): 3-4.	Infiltrations can be reduced. Using the techniques described, our 2 departments have shown a significant reduction in infiltration rates. Our main department, with a fixed-site PET/CT scanner, began with a 13.3% infiltration rate and reduced it to under 3% for 2 consecutive years and continues to improve. The mobile PET/CT department started with a 15.5% infiltration rate, reduced it to under 5%, and has maintained it there. Nuclear medicine technologists can learn to understand how injections are impacting procedures being performed and advocate to ensure our procedures are of high quality and reproducible.	2020	Lara Frequency Prevention
Topical Sensor for the Assessment of Injection Quality for 18F-FDG, 68Ga-PSMA and 68Ga-DOTATATE Positron Emission Tomography	Currie, GM and Sanchez, S (2020). " Topical Sensor for the Assessment of Injection Quality for 18F-FDG, 68Ga-PSMA and 68Ga-DOTATATE Positron Emission Tomography" J of Medical Imaging and Radiation Sciences 51: 247-255.	Topical monitoring and characterization of PET dose administration is possible and practical with the LARA device. Extravasation and partial extravasation of PET doses are not only readily detected but they are also preventable. The LARA device can provide insights into variables that could eliminate extravasation as a cause of image quality or SUV accuracy issues.	2020	Lara Monitoring Prevention Contributing Factors

Title	Reference	Synopsis	Year	Keywords
Assessing and Reducing Positron Emission Tomography/Computed Tomography Radiotracer Infiltrations: Lessons in Quality Improvement and Sustainability.	Kiser, JW, Benefield, T, Lattanze, RK, Ryan, KA and Crowley, J (2020). "Assessing and Reducing Positron Emission Tomography/Computed Tomography Radiotracer Infiltrations: Lessons in Quality Improvement and Sustainability." JCO Oncol Pract 16(7): e636-e640.	A QIP can significantly improve and sustain injection quality; however, ongoing monitoring is needed as new technologists join the team.	2020	Lara Contributing Factors Prevention
Novel Method to Calculate Equivalent Dose to Tissue in Cases of Radiopharmaceutical Extravasation Poster Presentation.	Knowland, J and Kiser, JW (2020). Novel Method to Calculate Equivalent Dose to Tissue in Cases of Radiopharmaceutical Extravasation, a Poster Presentation. ACNM Annual Meeting.	We have described and demonstrated a novel technique for calculating equivalent dose to tissue in the case of radiopharmaceutical extravasation. The technique differs from existing techniques by accounting for the ways in which both the extravasation activity and volume change over time. Inclusion of this dynamic information may result in more accurate estimation of equivalent dose to the initially extravasated tissue volume.	2020	Lara Dosimetry
Correlation of blood pool and liver uptake values with radionuclide extravasation in FDG PET, a poster presentation.	Lawson, T and Masters, S (2020). Correlation of blood pool and liver uptake values with radionuclide extravasation in FDG PET, a Poster Presentation. ACNM Annual Meeting.	No significant correlation was found between an injection quality score utilizing a radionuclide extravasation monitoring device and uptake values in the liver or blood pool. This suggests that liver and blood pool uptake may be relatively resistant to extravasation events. At least one case report in the literature using the same extravasation monitoring device has suggested that tumor F18 FOG uptake can be affected by radionuclide extravasation (Kiser, Crowley, Wyatt, & Lattanze, 2018). Blood pool and liver values are often used as a reference value for tumor uptake, for example in the Deauville criteria. Therefore, extravasation events may affect clinical interpretation of PET imaging by disproportionately affecting tumor uptake and sparing blood pool and liver uptake.	2020	Lara SUV
Assessing and reducing PET radiotracer infiltration rates: a single center experience in injection quality monitoring methods and quality improvement.	Osborne, DR, Acuff, SN, Fang, M, Weaver, MD and Fu, Y (2020). "Assessing and reducing PET radiotracer infiltration rates: a single center experience in injection quality monitoring methods and quality improvement." BMC Med Imaging 20(1): 3.	Developing a quality improvement plan and monitoring PET injections can lead to reduced infiltration rates. No significant correlation between reference SUVs and injection score provides evidence that determination of infiltration based on PET images alone may be limited. Results also indicate that the number of infiltrated PET injections is under-reported.	2020	Lara Monitoring Contributing Factors Frequency
Detection of (18)F-FDG Dose Leakage Using a Topical Device.	Sanchez, S and Currie, GM (2020). "Detection of (18)F-FDG Dose Leakage Using a Topical Device." J Nucl Med Technol 48(3): 283-284.	PET and SUV depend on reliable pharmacokinetic modeling, part of which is predictable dose delivery. Partial extravasation of the intravenous dose administered undermines the predictability of dose delivery and, potentially, the accuracy of the SUV calculation. Use of the Lara device with topical sensors is a simple, noninvasive way to determine partial dose extravasation. As part of routine monitoring of (18)F-FDG PET administrations, an interesting case was identified that mimicked extravasation but represented dose leakage during infusion via an automatic injector. The Lara device provided a useful tool for more timely critical evaluation and problem solving, extending advantages to the patient and practice.	2020	Lara

Title	Reference	Synopsis	Year	Keywords
Extravasation of [^{177}Lu]Lu-DOTATOC: case report and discussion	Arveschoug, AK, Bekker, AC, Iversen, P, Bluhme, H, Villadsen, GE and Staanum, PF (2020). " Extravasation of [^{177}Lu]Lu-DOTATOC: case report and discussion" EJNMMI Res 10(1): 68.	In the case of extravasation of radioactive drugs used in peptide-receptor radionuclide therapy of neuroendocrine tumors, or in radionuclide therapy in general, rapid action is important to reduce or avoid complications. Dosimetry of the extravasation can help determine if a change in treatment course is necessary.	2020	Therapeutic Dosimetry
The Radiation Safety Officer as an Advocate for Patient Safety	Morgan TL. The radiation safety officer as an advocate for patient safety. Health Phys 118: 75-78; 2020. doi: 10.1097/HP.0000000000000128	The role of the radiation safety officer is to maintain radiation exposures as low as reasonably achievable. Traditionally, the focus has been on reducing or eliminating unnecessary occupational exposure to employees and ensuring exposure of visitors and members of the public is maintained below regulatory limits. Over the last three decades there has been increasing concern expressed in the medical literature on the potential risks of radiation exposure to patients undergoing diagnostic medical imaging procedures. This paper will discuss the need for advocacy and processes by which the radiation safety officer can expand the focus of a medical radiation safety program to include advocacy for applying the principles and practices of maintaining exposures as low as reasonably achievable to patients.	2020	Radiation Safety NRC RSO ALARA Dosimetry
Detection of Excess Presence of ^{99m}Tc-MDP Near Injection Site-A Case Report	Crowley, JR, Barvi, I, Greulich, D and Kiser, JW (2021). " Detection of Excess Presence of ^{99m}Tc-MDP Near Injection Site-A Case Report " Front Med (Lausanne) 8: 728542.	Nuclear medicine extravasations and prolonged venous stasis may cause poor quality and quantification errors that can affect image interpretation and patient management. Radiopharmaceutical remaining near the administration site means that some portion of the radioactivity is not circulating as required for the prescribed uptake period. This case describes how detection of excess presence of (99m)Tc-MDP near the injection site enabled the technologist to apply mitigation tactics early in the uptake process. It also suggests that detecting extravasation or stasis early in the injection process can be important for image interpretation and minimizing radiation dose to tissue.	2021	Lara Diagnostic Mitigation
Topical sensor metrics for 18F-FDG positron emission tomography dose extravasation.	Currie, GM and Sanchez, S (2021). "Topical sensor metrics for 18F-FDG positron emission tomography dose extravasation." Radiography (Lond) 27(1): 178-186.	Partial extravasation of PET doses are readily detected and differentiated using TAC metrics and these metrics could provide deeper insight into the impact of partial extravasation on image quality or quantitation. There are a number of confounders for metrics, in particular metrics reflecting absolute counts. Those metrics with strongest characterization of extravasation could improve demarcation for normal injections with established thresholds or could be predicted using a machine learning algorithm. Extravasation need not be considered virtually unavoidable, should require reporting and should demand training/education to ensure reliability of SUV, optimal image quality, improved patient outcomes and limitation of unnecessary tissue doses to patients.	2021	Lara Classification

Title	Reference	Synopsis	Year	Keywords
Patient-specific Extravasation Dosimetry Using Uptake Probe Measurements.	Osborne, D, Kiser, JW, Knowland, J, Townsend, D and Fisher, DR (2021). "Patient-specific Extravasation Dosimetry Using Uptake Probe Measurements." Health Phys 120(3): 339-343.	Extravasated injections of radiopharmaceuticals can result in unintentional doses that exceed well-established radiation protection and regulatory limits; they should be identified and characterized. An external injection monitoring system may help to promptly identify and characterize extravasations and improve dosimetry calculations. Patient-specific characterization can help clinicians determine extravasation severity and whether the patient should be followed for adverse tissue reactions that may present later in time.	2021	Lara Dosimetry
The Scientific and Clinical Case for Reviewing Diagnostic Radiopharmaceutical Extravasation Long-Standing Assumptions.	Osborne, D, Lattanze, R, Knowland, J, Bryant, TE, Barvi, I, Fu, Y and Kiser, JW (2021). "The Scientific and Clinical Case for Reviewing Diagnostic Radiopharmaceutical Extravasation Long-Standing Assumptions." Front Med (Lausanne) 8: 684157.	Our findings suggest that significant extravasations can or have caused patient harm and can irradiate patients' tissue with doses that exceed medical event reporting limits and deterministic effect thresholds. Therefore, diagnostic radiopharmaceutical injections should be monitored, and dosimetry of extravasated tissue should be performed in certain cases where thresholds are thought to have been exceeded. Process improvement efforts should be implemented to reduce the frequency of extravasation in nuclear medicine.	2021	Monitoring Dosimetry Reporting
Tissue dose estimation after extravasation of ^{177}Lu-DOTATATE	Tylski, P, Pina-Jomir, G, Bournaud-Salinas, C and Jalade, P (2021). " Tissue dose estimation after extravasation of ^{177}Lu-DOTATATE " EJNMMI Phys 8(1): 33.	Case Report: 70-year-old patient extravasated with 177Lu-DOTATATE; extravasation was identified during the infusion process and interventions occurred to promote the elimination of 177-Lu from the injection site. Using very large volume estimates, the authors calculated an absorbed dose to patient's subcutaneous tissue was b/t 2-8 Gy. Patient followed and monitored for ~3 weeks and showed no clinical signs of irradiation. Provides a good example for the need of a reference volume of tissue.	2021	Therapeutic Mitigation Dosimetry
Radiopharmaceutical Extravasation: Pragmatic Radiation Protection.	Fisher, DR and Liverett, M (2022). "Radiopharmaceutical Extravasation: Pragmatic Radiation Protection." Health Phys 122(4): 537-539.	Inadvertent injection of a radiopharmaceutical agent into a patient's arm tissue instead of into the appropriate blood vessel can cause the injection to infiltrate underlying tissue and produce a potentially substantial, localized irradiation to the patient's arm and skin tissue. When this type of misadministration occurs, called an extravasation, it should be recognized, mitigated, and monitored for patient health and safety. Immediate symptoms of radiopharmaceutical extravasation may include swelling, edema, pain, or numbness in the vicinity of the extravasation site; inflammation; and drainage from the site. Some infiltrations may go unnoticed until later. Pragmatic elements of radiation safety include imaging to assess the geometry, volume, and anatomic distribution of activity, collection of tissue count-rate data over retention times, calibration against known activity levels, and dosimetry to help clinicians determine whether an extravasation is severe and whether the patient should be followed for adverse tissue reactions.	2022	HPS
Patients for Safer Nuclear Medicine (PSNM) Supports the Development of Federal Policies That Support Safe, Transparent, and Effective Nuclear Medicine Care on Behalf of Patients throughout the U.S.	Horn, M (2022). "Patients for Safer Nuclear Medicine (PSNM) Supports the Development of Federal Policies That Support Safe, Transparent, and Effective Nuclear Medicine Care on Behalf of Patients throughout the U.S." Health Phys 122(4): 530-533.	HPS Public Comment Rebuttal	2022	HPS

Title	Reference	Synopsis	Year	Keywords
Response to the HPS Public Comments to Docket ID NRC-2020-0141	Lattanze, R (2022). "Response to the HPS Public Comments to Docket ID NRC-2020-0141." Health Phys 122(4): 526-529.	HPS Public Comment Rebuttal	2022	HPS
Practical Tools for Patient-Specific Characterization and Dosimetry of Radiopharmaceutical Extravasation	Wilson S, Osborne D, Long M, Knowland J, Fisher DR. Practical Tools for Patient-specific Characterization and Dosimetry of Radiopharmaceutical Extravasation. Health Phys. 2022;123(5):343-7.	In this work, three new extravasation characterization and dosimetry tools were developed, validated against published data, and demonstrated in a realistic clinical workflow. The tools—including a worksheet, a spreadsheet, and a web application–are free and publicly available. The authors believe that the new dosimetry tools will enable standardized clinical analyses and benefit patient care, clinical follow-up, and event reporting.	2022	Lara Dosimetry
A Request for Scientific Accountability in Public Statements.	Townsend, D, Kiser, JW, Boerma, M, Fass, D, Wilson, S and Sullivan, D (2022). "A Request for Scientific Accountability in Public Statements." Health Phys 122(4): 534-536.	HPS Public Comment Rebuttal	2022	HPS NRC
Development of a classifier for [18F]fluorodeoxyglucose extravasation severity using semi-quantitative readings from topically applied detectors	Perrin S, Kiser JW, Knowland J, Bowen SL. (2022) Development of a classifier for [18F]fluorodeoxyglucose extravasation severity using semi-quantitative readings from topically applied detectors. EJNMMI Phys.	This is a new paper that has been submitted for publication in the EJNMMI Physics journal and is under review. It details work done to develop a quantitative classifier for Lara sensor TACs.	2022	Lara Classification
Near Real-Time Y-90 Dose Infusion Monitoring and On-table Assessment of Residual Dose	Osborne D, Minwell G, Pollard B, Walker DC, Acuff S, Smith K, Stephens C. Near real-time y-90 dose infusion monitoring and on-table assessment of residual dose. Journal of Nuclear Medicine 63: 3037-3037; 2022.	The study examines the use of external radiation detectors as a way to obtain real-time assessments of the quality of a Y90 therapy infusion and to potentially obtain estimates of expected residual dose from the completed infusion prior to the patient leaving the procedure room. The study concluded that monitoring of radioembolization infusions can provide confirmation that the infusion of the patient dose was successful. Additionally, it is noted that the ability to examine the injection quality at the time of the procedure may enable real-time troubleshooting to assess any difficulties that may have occurred during the infusion.	2022	Y90 Radioembolization Monitoring

Title	Reference	Synopsis	Year	Keywords
Adverse Clinical Events at the Injection Site Are Exceedingly Rare After Reported Radiopharmaceutical Extravasation in Patients Undergoing 99mTc-MDP Whole-Body Bone Scintigraphy: A 12-Year Experience	Parihar AS, Schmidt LR, Crandall J, Dehdashti F, Wahl RL. Adverse clinical events at the injection site are exceedingly rare after reported radiopharmaceutical extravasation in patients undergoing ^{99m}Tc-MDP whole-body bone scintigraphy: A 12-year experience. Journal of Nuclear Medicine 64: 485-490; 2023.	A study from a single center indicated a less than 1% rate of extravasation. However, this estimation is incorrect as it significantly understates the actual extravasation rate. The authors based their findings not on confirmed extravasations obtained from a retrospective analysis of imaged injection sites or prospective monitoring. Instead, they only accounted for extravasations explicitly mentioned in radiology reports, leading to potential underestimation. The authors also noted physicians assessed the RPE severity by patient harm and impact to the study but did not perform dosimetry. Without adequately characterizing diagnostic RPEs it is difficult to assess the procedure impact and which patients to follow. The study's conclusion that diagnostic RPEs adverse effects are rare is not supported by the study's methods, which grossly underestimate incidence of RPEs and inadequately capture effects.	2022	Extravasation rate Frequency
Dose Estimation for Extravasation of ^{177}Lu, ^{99m}Tc, and ^{18}F	Tsorxe IY, Hayes RB. Dose Estimation for Extravasation of 177Lu, 99mTc, and 18F. Health Phys. 2023;124(3):217-20.	The authors utilized GATE Monte Carlo simulation software to determine if a radiopharmaceutical extravasation might surpass the 0.5 Sv dose equivalent threshold set by the US Nuclear Regulatory Commission for medical event reporting or the 1.0 Sv dose equivalent at which tissue damage is likely to occur. Their findings revealed that radiopharmaceutical extravasations can lead to tissue doses that exceed both the reporting limits and the levels where deterministic effects are anticipated. Consequently, radiation safety initiatives should incorporate the identification, mitigation, assessment, and documentation of significant extravasation incidents.	2023	Absorbed dose Monte Carlo
Active monitoring improves radiopharmaceutical administration quality	James R. Crowley, Iryna Barvi, Jackson W. Kiser, Front. Nucl. Med., 2023, V 3 – 2023 https://doi.org/10.3389/fnume.2023.1126029	Active monitoring and the associated display of results are critical to quality improvement efforts aimed at decreasing and maintaining low rates of radiopharmaceutical extravasation.	2023	Frontiers Special Issue Monitoring MDP QI ^{99m}Tc-MDP
Transparency – a patient-centric view on radiopharmaceutical extravasations	Kohl P. Transparency – a patient-centric view on radiopharmaceutical extravasations. Frontiers in Nuclear Medicine. 2023;3	A patient shares her perspective on the importance of informing patients when they have been extravasated, as well as the shortcomings of the Nuclear Regulatory Commission (NRC) in protecting patients.	2023	Frontiers Special Issue Patient perspective NRC
The decision to reimage following extravasation in diagnostic nuclear medicine	Jackson W. Kiser, Front. Nucl. Med., 21 April 2023Sec. Radiopharmacy and Radiochemistry Volume 3 - 2023 | https://doi.org/10.3389/fnume.2023.1171918	Nuclear medicine departments as well as the interpreting radiologist physicians should be cognizant of the possible need to repeat studies which have been affected by an extravasation. The decision to reimage is based on several factors, but chief among them should always be the clinical intent of the procedure.	2023	Frontiers Special Issue Additional Imaging

Title	Reference	Synopsis	Year	Keywords
Safety injections of nuclear medicine radiotracers: towards a new modality for a real-time detection of extravasation events and 18F-FDG SUV data correction	Mauro Iori, et.al EJNMMI Physics, (2023) 10:31, https:/doi.org/10.1186/s40658-023-00556-5	The study proposed monitoring and managing extravasations to provide an early evaluation and correction to the estimated SUV value through a SUV correction coefficient. The sensors that allowed the collection of Dosimetric data directly on patients during administration and allowed an analysis of the different behavior of DR-time curves, were used on a cohort of 70 patients undergoing 18F- FDG PET/CT examination. Four cases of extravasation were identified. The authors concluded that proposed metrics allowed to characterized the extravasation events in the first few minutes after the injection, providing an early SUV correction when necessary.	2023	SUV Monitoring Portable detectors Frequency
Extravasation of radiopharmaceuticals: Why report?	Morgan TL. Extravasation of radiopharmaceuticals: Why report? Frontiers in Nuclear Medicine 3; 2023. doi: 10.3389/fnume.2023.1148177	This perspective paper discusses extravasation in the context of medical imaging and therapy with radiopharmaceuticals. The central thesis is that these events should be reported and followed so that agreement can be reached on the definition of a “significant” event which should be classified as a medical event in accordance with US Nuclear Regulatory Commission (NRC) regulations. It also also outlines steps that can be taken to reduce the risk of extravasations.	2023	Frontiers Special Issue NRC
Multicenter Evaluation of Frequency and Impact of Activity Infiltration in PET Imaging, Including Microscale Modeling of Skin-Absorbed Dose	Sunderland JJ, Graves SA, York DM, Mundt CA, Bartel TB. Multicenter Evaluation of Frequency and Impact of Activity Infiltration in PET Imaging, Including Microscale Modeling of Skin-Absorbed Dose. J Nucl Med. 2023.	The paper attempts to minimize concerns regarding frequency and severity of radiopharmaceutical extravasations. There are, however, several problems with the work: the methods are not well described, the results contain errors, and the peer-review process appears to have lacked rigor.	2023	Monte Carlo Retrospective Study Frequency
Critique and discussion of “Multicenter evaluation of frequency and impact of activity infiltration in PET imaging, including microscale modeling of skin-absorbed dose”	Josh Knowland. Critique and discussion of “Multicenter evaluation of frequency and impact of activity infiltration in PET imaging, including microscale modeling of skin-absorbed dose”. Front. Nucl. Med., 31 July 2023 Sec. Radiopharmacy and Radiochemistry Volume 3 - 2023 | https://doi.org/10.3389/fnume.2023.1240162	In this opinion piece, the author highlights numerous issues related to the "Multicenter Evaluation of Frequency and Impact of Activity Infiltration in PET Imaging, Including Microscale Modeling of Skin-Absorbed Dose" paper. The author delves into methodological concerns, identifies errors in the paper's results, and argues that the peer-review process lacked rigor.	2023	Critique Opinion Piece Retrospective Study Frontiers Special Issue
Radiopharmaceutical extravasations: a twenty year mini-review	Dustin R.Osborne. Radiopharmaceutical extravasations: a twenty year mini-review. Front. Nucl. Med., 20 July 2023 Sec. Radiopharmacy and Radiochemistry Volume 3 - 2023 | https://doi.org/10.3389/fnume.2023.1219202	In this review, the author analyzes two decades of literature on radiopharmaceutical extravasations to summarize its history, identify trends, and spotlight research gaps. The article reveals a rise in related publications, indicating heightened awareness and its significance in patient care. Despite this, there's a lack of practical guidance for clinicians facing such events. Comprehensive research is required globally to establish best practices and understand the real clinical implications for imaging studies using radiopharmaceuticals.	2023	Literature Review History of Extravasations Key Gaps in Research Frontiers Special Issue

Title	Reference	Synopsis	Year	Keywords
Radiopharmaceutical extravasation in bone scintigraphy: a cross-sectional study	Fernandes, D., Santos, M., Pinheiro, M., Duarte, H., and Fontes, F. (2023). Radiopharmaceutical extravasation in bone scintigraphy: a cross-sectional study. Nucl Med Commun. doi: 10.1097/MNM.0000000000001738	In a study analyzing Tc-99m HMDP bone scintigraphy exams from the Portuguese Institute of Oncology of Porto, 26.5% of patients experienced radiopharmaceutical extravasation. The likelihood of extravasation was notably higher for inpatients and when the wrist was used for administration. Both visual assessments and image processing software were effective in classifying extravasation severity.	2023	Portuguese Institute of Oncology Study Tc-99m Extravasation Rate Bone Scans Extravasation Rate