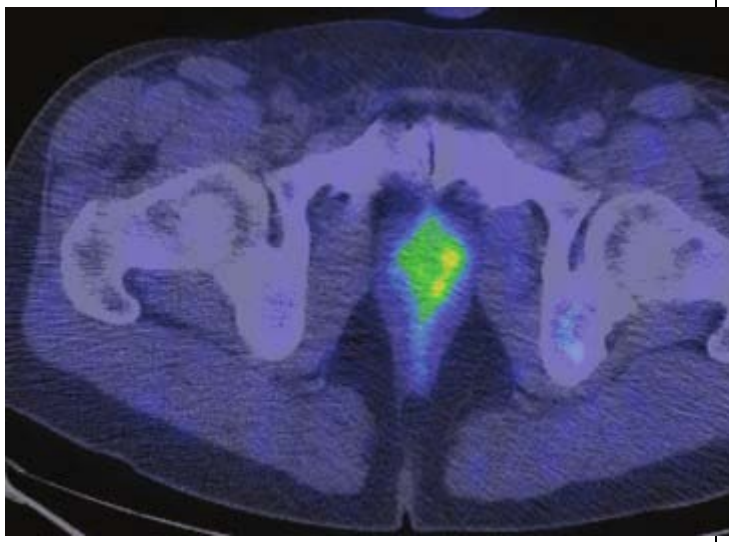
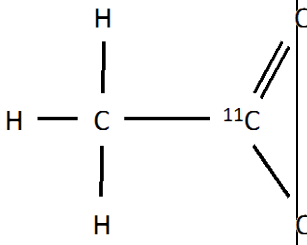
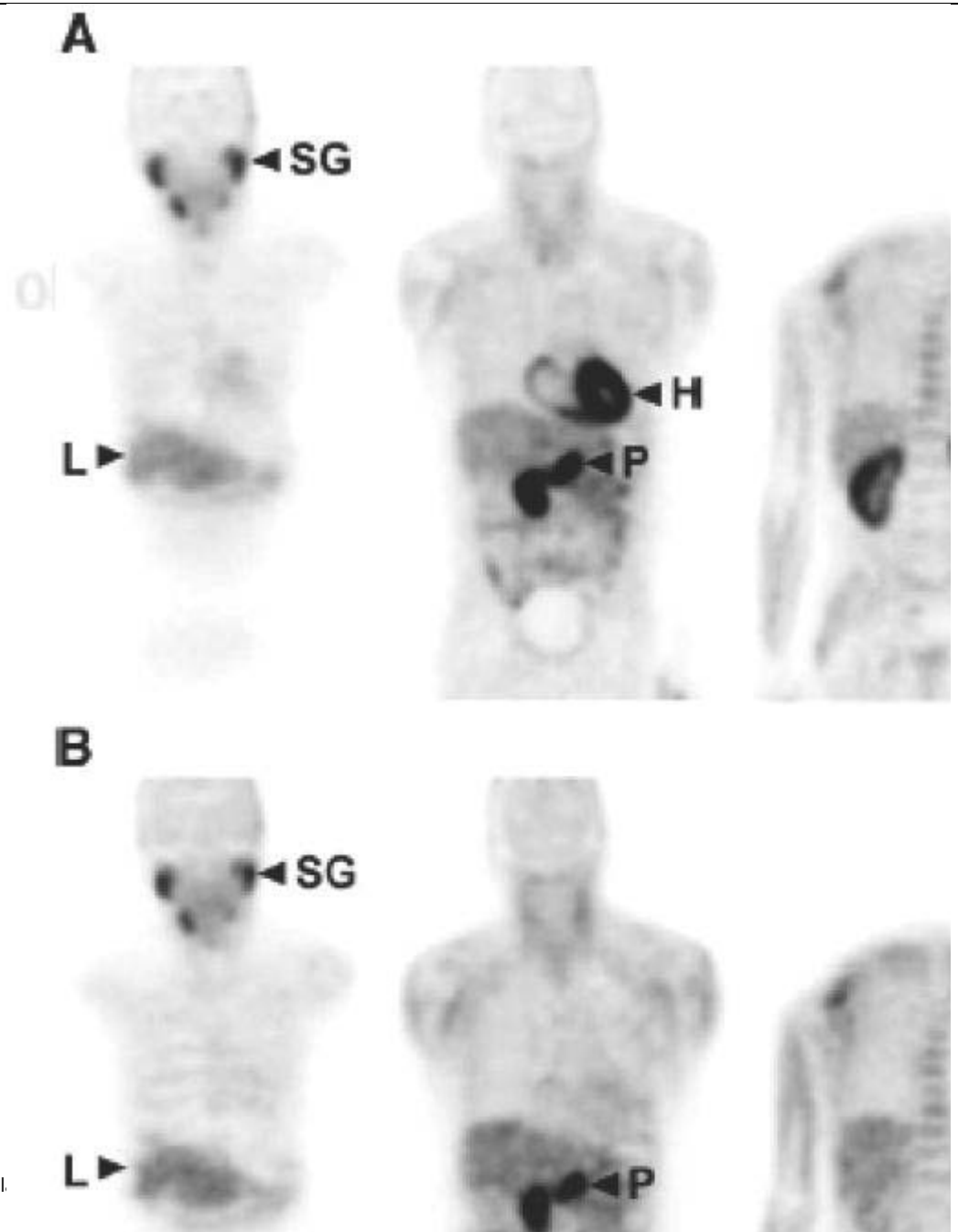
C-11 ACETATE

C-11 Acetate

SOCIETY OF NUCLEAR MEDICINE AND MOLECULAR IMAGING

Radiopharmaceutical Name	^{11}C-Acetate	
Radiopharmaceutical Image	**Normal Biodistribution**	**Radiopharmaceutical Structure**
		


A
SG
L
H
P
B
SG
L
P

Radionuclide	^{11}C Half-life 20.334 minutes
Molecular Formula and Weight	$CH_3[^{11}C]O_2^-$
General Tracer Class	Diagnostic PET radiopharmaceutical.
Target	Cancer cells, myocardium
Molecular Process Imaged	^{11}C-Acetate is used as a PET radiotracer for imaging cancer cells via incorporation into intracellular phosphatidylcholine membrane microdomains in cancer cells. ^{11}C-Acetate is also used for studying myocardial oxidative metabolism and regional myocardial blood flow.
Mechanism for in vivo retention	The main mechanism for in vivo retention is conversion of acetate by acetyl-CoA synthetase in either the cytosol and/or mitochondria to acetyl-CoA. Acetyl-CoA is then converted by fatty acid synthetase into fatty acids and incorporated into the intracellular phosphatidylcholine membrane microdomains (dominant pathway in cancer cells) or alternatively oxidized through the tricarboxylic acid cycle in mitochondria to carbon dioxide and water (dominant pathway in normal myocardium).
Metabolism	^{11}C-Acetate is typically incorporated into the cellular membrane in proportion to the cellular proliferation rate or alternatively oxidized to carbon dioxide and water. ^{11}C-Acetate may also be converted into amino acids.
Radiosynthesis	^{11}C-Acetate has a short half-life and is usually produced on-site. ^{11}C-Acetate can be produced by reaction of methylmagnesium bromide or chloride and ^{11}C-carbon dioxide giving a radiochemical yield of 72 ± 12% in 20 minutes with high specific activity (>18.5 GBq/µmol, 0.5 Ci/µmol) and radiochemical purity > 95%. After reaction, it can be hydrolized with water or aqueous acid. There are several automated systems provided radiochemical yields of 60 - 80% and radiochemical purity of 99% in 15 - 23 minutes. It is stable at pH between 4.5 and 8.5 for up to 2 hrs at room temperature. Pike V.W., Eakins M.N., Allan R.M., Selwyn A.P. Preparation of [1-11C]acetate--an agent for the study of myocardial metabolism by positron emission tomography. Int J Appl Radiat Isot. 1982;**33**(7):505–12. Kruijer P.S., Ter Linden T., Mooij R., Visser F.C., Herscheid J.D.M. A practical method for the preparation of [11C]acetate. Appl. Radiat. Isot. 1995;**46**:317–321.

	Moerlein S.M., Gaehle G.G., Welch M.J. Robotic preparation of Sodium Acetate C 11 Injection for use in clinical PET. Nucl Med Biol. 2002;**29**(5):613–21. Roeda D., Dolle F., Crouzel C. An improvement of 11C acetate synthesis--non-radioactive contaminants by irradiation-induced species emanating from the 11C carbon dioxide production target. Appl Radiat Isot. 2002;**57**(6):857–60. Saha, G.B. Fundamentals of Nuclear Pharmacy, 5th edition. Springer. 383 pages, 2004.
Availability	^{11}C-acetate has a short half-life and typically requires the use of an on-site cyclotron.
Status with USP / EuPh	Investigational
Recommended Activity and Allowable mass	740 - 1480 MBq (20 - 40 mCi)
Dosimetry	It is estimated that following the administration of 525 MBq (14.2 mCi) ^{11}C-acetate iv, the organs receiving the highest absorbed dose are the pancreas (0.017 mGy/MBq or 62.9 mrad/mCi), bowel (0.011 mGy/MBq or 40.7 mrad/mCi), kidneys (0.0092 mGy/MBq or 34.0 mrad/mCi), and spleen (0.0092 mGy/MBq or 34.0 mrad/mCi) and the effective dose equivalent is 0.0062 mSv/MBq (22.9 mrem/mCi). Seltzer M.A., Jahan S.A., Sparks R., Stout D.B., Satyamurthy N., Dahlbom M., Phelps M.E., Barrio J.R. Radiation dose estimates in humans for (11)C-acetate whole-body PET. J Nucl Med. 2004;**45**(7):1233–6.
Pharmacology and Toxicology	C-11 acetate is taken up in proportion to fatty acid synthesis. It is also taken up proportionally to myocardial blood flow, and therefore myocardial oxygen consumption. In rodents, there is clearance from all organs except the pancreas within one hour. Tumor uptake was clearly visible in 30 minutes. In humans, more than 80% of tracer is cleared from normal tissues within 20 minutes. It is taken up in cancer within the prostate and prostate cancer metastases, however, it has been reported that increased uptake can be seen in hyperplastic and benign prostate tissues. No urinary excretion is seen. No toxic effects have been demonstrated.
Current Clinical Trials	The NIH clinical trials registry (www.clinicaltrials.gov) should be consulted for a list of current trials. As of early 2014, the site lists 16 active or completed clinical trials related to ^{11}C-Acetate. Of these, 4 were recruiting subjects.
Reference Site / Person	http://www.ncbi.nlm.nih.gov/books/NBK23334/#Acetate11C.REF.20
Imaging Protocol	740 MBq to 1480 MBq administered intravenously

	Imaging performed 10-15 minutes after injection (prostate cancer) Imaging performed immediately (heart studies) Haseebuddin M, Dehdashti F, Siegel BA, et al. ^{11}C-acetate PET/CT before radical prostatectomy: nodal staging and treatment failure prediction. J Nucl Med 2013; 54:699–706 Grassi I, Nanni C, Allegri V, et al. The clinical use of PET with (^{11})C-acetate. Am J Nucl Med Mol Imaging. 2012;2(1):33-47.
Human Imaging Experience	^{11}C-Acetate PET has been used for evaluation of malignancy, most notably in prostate cancer. Yu EY, Muzi M, Hackenbracht JA, Rezvani BB, Link JM, Montgomery RB, Higano CS, Eary JF, Mankoff DA. C11-acetate and F-18 FDG PET for men with prostate cancer bone metastases: relative findings and response to therapy. Clin Nucl Med. 2011 Mar;36(3):192-8. Czernin J, Benz M, Allen-Auerbach M. PET Imaging of prostate cancer using 11C-Acetate. PET Clinics April, 2009; 4(2): 163-172. ^{11}C-Acetate PET has also been used for the evaluation of myocardial oxygen consumption/ myocardial infarction. Wong YY, Raijmakers P, van Campen J, van der Laarse WJ, Knaapen P, Lubberink M, Ruiter G, Vonk Noordegraaf A, Lammertsma AA. 11C-Acetate clearance as an index of oxygen consumption of the right myocardium in idiopathic pulmonary arterial hypertension: a validation study using 15O-labeled tracers and PET. J Nucl Med. 2013 Aug;54(8):1258-62. Other references include: Grassi I, Nanni C, Allegri V, Morigi JJ, Montini GC, Castellucci P, Fanti S. The clinical use of PET with (11)C-acetate. Am J Nucl Med Mol Imaging. 2012;2(1):33-47.

SNMMI would like to acknowledge Katherine Zukotynski, MD and Bennett Greenspan, MD for their contributions to developing this content.