

Ran Klein, PhD

Imaging Physicist

The Ottawa Hospital, Department of Nuclear Medicine
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Department/School: Medicine

January 2022

Curriculum Vitae

NAME:

KLEIN, Ran

Imaging Physicist, Department of Nuclear Medicine, The Ottawa Hospital, Ottawa, Ontario

DEGREES: designation, institution, department, year

Ph.D., Electrical Engineering, University of Ottawa, 2010

M.A.Sc., Electrical Engineering, University of Ottawa, 2005

B.A.Sc., Computer Engineering, University of Ottawa, 2003

EMPLOYMENT HISTORY:

- 2021- Associate Professor, Department of Medicine,
Faculty of Medicine, University of Ottawa
- 2020 - Ottawa DOM, Project Implementation Manager for Artificial
Intelligence and Digital Health Initiative
- 2016- Adjunct Research Professor, Department of Physics, Carleton
University
- 2015-2021 Assistant Professor, Department of Medicine,
Faculty of Medicine, University of Ottawa
- 2014- Imaging Physicist, Department of Nuclear Medicine, The Ottawa
Hospital
- Clinician Investigator in the Clinical Epidemiology Program
(CEP) at the Ottawa Hospital Research Institute (OHRI)
- 2012-15 Adjunct Professor, Department of Medicine,
Faculty of Medicine, University of Ottawa
- 2011-14 Associate Scientist, Cardiac Imaging, University of Ottawa Heart
Institute
- Principle Investigator
 - Manager, Cardiac Imaging Core Lab
 - Co-director, Cardiac Imaging Fellows Training
- 2011- Adjunct Research Professor, Department of Systems and Computer
Engineering,
Faculty of Engineering, Carleton University
- 2012 Consultant - Cardiac PET/CT Scientist & System Development
FMI Medical Systems, Inc.
- 2010-11 Research Associate, Cardiac PET Centre
University of Ottawa Heart Institute

2002-10	- Manager, Cardiac Imaging Core Lab Research Assistant, Cardiac PET Centre University of Ottawa Heart Institute
Sep-Dec 2003	Teaching Assistant
Sep-Dec 2004	University of Ottawa
Jan-May 2002	Programmable Logic Controller Application Developer (Co-op) LEAD Controls, Rosh Ha-ayin, Israel
Sept-Dec 2001	Research Assistant, Cardiac PET Centre University of Ottawa Heart Institute
Apr-Aug 2001	Research Assistant (Co-op), Cardiac PET Centre University of Ottawa Heart Institute
Apr-Aug 2000	Field Engineer ADC Teledata, Herzeliya, Israel
1998-99	Field Engineer ADC Teledata, Herzeliya, Israel
1994-98	Commander and Instructor (First-Sergeant) Israeli Air Force
1995-99	Computer Solutions Development and Support Self Employed
1995	Programmer Yani Electrical Engineering, Israel
1994	Development Quality Assurance Dimyon Multimedia, Ramat-Asharon, Israel

ACADEMIC HONOURS:

2019	PhD Scientist Award, Department of Medicine, university of Ottawa.
2019	Certificate of Merit (runner-up), Undergrad, Graduate and Postgrad category, Radiology Research Day, The Ottawa Hospital H Juma*, Zuckier L, Klein R , <i>An integrated software tool for synthesis of lesions in patient PET and CT studies</i>
2019	Clinical Sciences Long Oral Winner Graduate Level & Higher, Department of medicine, University of Ottawa Manwell S*, Klein R , Xu T, deKemp R, <i>Whole-body motion correction in cardiac PET/CT using positron emission tracking: a phantom validation study</i>
2018	Best Technical Imaging Paper in the Journal of Nuclear Cardiology Award, American Society of Nuclear Cardiology Klein R , Ocneanu A*, et al. Consistent tracer administration profile improves test–retest repeatability of myocardial blood flow quantification with ⁸² Rb dynamic PET imaging. <i>J Nuc Cardiol</i> 2018; 25, 1532-6551.
2017	Institute of Electrical and Electronics Engineering (IEEE) Senior Member
2015	Polk Research Award, Best Basic Science Poster Presentation, University of Ottawa Heart Institute Research Day

- Ocneanu A, deKemp RA, Adler A, Beanlands SB, **Klein R**,
Reproducible Tracer Injection Profile Improves the Test-Retest Repeatability of Myocardial Blood Flow Quantification with 82Rb PET
- 2011-2012 Best Technical Imaging Paper in the Journal of Nuclear Cardiology Award, American Society of Nuclear Cardiology
Katoh C, Yoshinaga K, Klein R, et al. Quantification of Regional Myocardial Blood Flow Estimation with Three-dimensional Dynamic Rubidium-82 PET and modified spillover correction Model. J. Nucl. Cardiol., 2012;19:763-74.
- 2012 Siemens Outstanding Academic Research (SOAR) Award
Coulden R, Klein R, Sonnex, Butler C, Time-resolved quantitative CT myocardial perfusion compared with quantitative 82Rubidium-PET: a pilot study. Soc. Of Cardiovascular Computed Tomography Annual Meeting, Baltimore, MD, 2012
- 2009-2010 Best Technical Imaging Paper in the Journal of Nuclear Cardiology Award, American Society of Nuclear Cardiology
Klein R, Renaud JM, Ziadi MC, et al., Intra- and inter-operator repeatability of myocardial blood flow and myocardial flow reserve measurements using Rubidium-82 PET and a highly automated analysis program. J. Nucl. Cardiol., 2010;17(4):600-616.
- 2009 Polk Research Award, Best Clinical Science Poster Presentation, University of Ottawa Heart Institute Research Day
- 2009 Outstanding Research Award, Molecular Function and Imaging Annual Symposium, \$500
- 2008-2009 Heart and Stroke Doctoral Scholarship, \$21,000/year
- 2008 JSPS Summer in Japan, Research Exchange Program, ~\$10,000
- 2005-2008 NSERC Canadian Graduate Scholarship (CGS-D), \$35,000/year
- 2004-2005 Ontario Graduate Scholarship, \$15 000/year
– declined in favour of NSERC PGS-M
- 2006-2009 University of Ottawa Excellence Scholarship, Full tuition coverage
- 2005-2006 University of Ottawa Admission Scholarship, Full tuition coverage
- 2004-2005 NSERC Postgraduate Scholarship (PGS-M), \$17,300/year
- 2004-2005 University of Ottawa Excellence Scholarship, Full tuition coverage
- 2003-2004 University of Ottawa Admission Scholarship, Full tuition coverage
- 2000-2003 Dean's Honour List, University of Ottawa
- 1999-2003 Nortel Networks Scholarship, \$ 2,500/year
- 1999 University of Ottawa Admission Scholarship, \$1,000

PROFESSIONAL TRAINING:

- 2021 Essentials of Academic Leadership Phase II (40 hours)
- 2021 Introduction to Quality Improvement in Healthcare (7.5 hours)
- 2019 Essentials of Academic Leadership Phase I – Basic Science (32.5 hours)

2016, Nov 17-18 Medical Emergency Treatment of Exposure to Radiation (METER),
Health Canada (14 hours)

SCHOLARLY AND PROFESSION ACTIVITIES: past 7 years only (eg. executive and editorial positions but not memberships in societies; invited presentations at national or international conferences. Do not list manuscript and grant application reviews)

Executive Committee

International

2021 Society of Nuclear Medicine and Molecular Imaging – Physics,
Instrumentation and Data Science Council (PIDSC), Board of
Directors Member

2020- Society of Nuclear Medicine and Molecular Imaging – Procedure
Standards and Guidance Document Oversight Committee

2020 Society of Nuclear Medicine and Molecular Imaging – Physics,
Instrumentation and Data Science Council (PIDSC)
- Remote Viewing Guidance

2019- American Society of Nuclear Cardiology, H. William Strauss Best
Technical Research Award, Committee Member

2018 Targeted Alpha Therapy, Conference Clinical Committee Member

National

2017-2021 Canadian Organization of Medical Physicists, Scientific Advisory,
Member

Local

2016- Cancer Care Ontario, Lung PET, Community of Practice Member

2014- Ottawa Medical Physics Institute, Communications Officer

Editorial Board

2017- Annals of Nuclear Cardiology

Reviewer

2019- IEEE - Transactions on Radiation and Plasma Medical Sciences

2018- Clinical Oncology

2018- Journal of Medical Imaging and Radiation Sciences

2016- Annals of Nuclear Cardiology

2015- Natural Sciences and Engineering Research Council of Canada
(NSERC) grant review

2013- Medical Physics

2013- Journal of Cardiology and Vascular Medicine

2011- International Journal of Cardiovascular Imaging

2010- Journal of Nuclear Cardiology

Professional Membership

Institute of Electrical and Electronics Engineers, Senior member (2017)
 Society of Nuclear Medicine (2010)
 Canadian Organization of Medical Physics (2016)

Session Moderator**International**

2019 Targeted Alpha Therapy Conference, Clinical Research Day

Local

2013 Molecular Function and Imaging Annual Symposium
 2010 Molecular Function and Imaging Annual Symposium

Invited Consultation (academic and industry)

2021 National Physics Laboratory, Teddington, UK – Flow quantification phantom, image analysis software and QC.

2019, Sept 26-27 Kettering Medical Center, Dayton, Ohio, USA – Clinical implementation of myocardial blood flow on MiE HR+ PET.

2018 Expert Consultant and Medical Device Reviewer, Health Canada

2013, May 19-25 Instituto do Coração, Hospital das Clinicas, Faculdade de Medicina, Universidade de Sao Paulo (USP), Sao Paulo, Brazil – Funded by International Atomic Energy Agency (IAEA)
 Supporting Human Resource Qualification and Diffusion of Quantitative Emission Tomography to Improve Management of Patients.

2012, Dec 13-22 Université de Lausanne, Lausanne, Switzerland
 Integration of FlowQuant© into clinical routine.

2012-2013 FMI Medical Systems, Akron, OH
 Design and development of cardiac image analysis software for cardiac dedicated PET/CT system.

2008- DraxImage, Montreal, QC
 Design and evaluation of Rubidium Elution System for cardiac PET perfusion imaging.

2007 Central Research Institute for Roentgenology and Radiology, St. Petersburg, Russia
 Rubidium Elution system for cardiac PET perfusion imaging.

Education Leadership and Administration:

2014- Member, Resident Program Committee, Division of Nuclear Medicine, Department of Medicine, University of Ottawa

2011-16 Co-director, Cardiac Imaging Fellows Training, Division of Cardiology, Department of Medicine, University of Ottawa

Teaching

2013-present	PHYS 5203 – Medical Radiation Physics, Carleton University - Tour of UOHI Radiochemistry Lab and Nuclear Cardiology
2018	TMM4300B – Translational and Molecular Imaging, University of Ottawa - Nuclear Medicine - Image acquisition and reconstruction (3 hrs)
2018-present	Nuclear Medicine for Radiology Residents at the Department of Radiology, University of Ottawa (2 hrs).
2015-	Nuclear Medicine Physics for medical residents at the Nuclear Medicine Residency Program at Division of Nuclear Medicine, University of Ottawa (40 hrs).
2014-2018	BIOM5200/BMG5105/SYSC5304/ELG5127 Biomedical Image Processing Graduate Course, Biomedical Engineering, Carleton University & University of Ottawa joint program: - Computed Tomography Image Reconstruction (1.5 hrs) - Nuclear Imaging Instrumentation (4.5 hrs).
2010-2015	Co-director Cardiac Imaging Training Program for clinical fellows in Nuclear Cardiology and Cardiac CT program at the University of Ottawa Heart Institute.

Lectures**International**

1. **Klein R**, Survey Meters, American Society of Nuclear Cardiology, 80 hours Physics Course, 2021 (45 minutes)
2. **Klein R**, Personal Dosimeters, American Society of Nuclear Cardiology, 80 hours Physics Course, 2021 (1.5 hours)
3. **Klein R**, Comparison of Myocardial Blood Flow Quantification using PET with ^{82}Rb and ^{15}O -water – Summary. Nuclear Rounds, University of Hokkaido School of Medicine, 2008-08-18
4. **Klein R**, Comparison of Myocardial Blood Flow Quantification using PET with ^{82}Rb and ^{15}O -water. Nuclear Rounds, University of Hokkaido School of Medicine, 2008-07-07
5. **Klein R**, ^{82}Rb – *From Lab to Clinic – Introduction*. Nuclear Rounds, University of Hokkaido School of Medicine, 2008-06-30

Local

6. Klein R, Quantitative lung
7. **Klein R**, Squeezing medical insight out of photons – Quality Control in the Nuclear Medicine Department, OMPI Symposium, 2018-05-24
8. **Klein R**, Thibeau A, Sutherland J, *Emerging Technologies - Panel Discussion*, CAMRT Game Changers Annual Symposium, 2018-05-16
9. **Klein R**, The rise of artificial intelligence in medical imaging. And we thought an isotope shortage was disruptive? O and D Section of the OAMRS, 2018-04-19.
10. **Klein R**, *Myocardial Blood Flow Quantification with PET: Making it more available*, Multi-modality Education Day: Emerging Technologies, CAMRT & OAMRS, 2017-04-28
11. **Klein R**, *Squeezing Insight out of Photons: Emerging technologies and PET/CT and*

- SPECT/CT*, Multi-modality Education Day: Emerging Technologies, TOH & OAMRS O&D Section, 2016-10-05
12. **Klein R**, *Myocardial Blood Flow Imaging and Quantification*. Molecular Function and Imaging Rounds, UOHI, 2012-02-06
 13. **Klein R**, *PET Basics*. Nuclear Cardiac Imaging Rounds, UOHI, 2011-11-24
 14. **Klein R**, *Basic CT Physics – Part 1*. Cardiac CT Imaging Rounds, UOHI, 2011-11-21
 15. **Klein R**, *SPECT and PET Cardiac Tracers*. Nuclear Cardiac Imaging Rounds, UOHI, 2011-01-26
 16. **Klein R**, Mackasey K, *Myocardial Blood Flow Imaging and Quantification*. Molecular Function and Imaging Rounds, UOHI, 2011-02-15
 17. **Klein R**, *PET Basics*. Nuclear Cardiac Imaging Rounds, UOHI, 2010-11-18
 18. **Klein R**, *SPECT and PET Cardiac Tracers*. Nuclear Cardiac Imaging Rounds, UOHI, 2010-01-26
 19. **Klein R**, *Validation of Myocardial PET Images*. Research Methods Rounds, UOHI, 2010-03-01
 20. **Klein R**, *Concepts in Digital Images*. Molecular Function and Imaging Rounds, UOHI, 2009-11-23
 21. **Klein R**, Pursuit of physiologically accurate factor analysis to improve quantification of perfusion. Research in Progress Rounds, UOHI, 2008-04-07
 22. **Klein R**, *Volumetric cardiac PET images and pretty pictures*. Molecular Function and Imaging Rounds, UOHI, 2006-11-12
 23. **Klein R**, Renaud J, Lortie M, deKemp R *FlowTrace–RBTM Rubidium-82 Generator Manufacturing, Tracer Delivery, and Kinetic Modeling*. Ottawa Nuclear Imaging City Wide Rounds, 2006-09-26

GRADUATE SUPERVISIONS: career numbers; masters, doctoral, postdoctoral - completed/in progress; please distinguish between supervisor, co-supervisor and supervisory committee member

Completed: 3 M.A.Sc., 1 PhD

In Progress: 0 M.A.Sc., 1 Ph.D.

Graduate Supervision

1. Elaheh Amini (PhD Biomedical Engineering), *Lung Lobe Segmentation in SPECT/CT*, Co-supervised with Leila Mostaço-Guidolin, Sept 2021 (Carleton University)
2. Quinn de Bourbon (MSc Medical Physics), *Lesion Synthesis in PET and CT*, Sept 2021 (Carleton University)
3. Martin Klamrowski (MAsc Systems and Computer Engineering), *Predicting Acute need for Renal Replacement Intervention in Chronic Kidney Disease*, Co-supervised with J. Green, May 2021 (Carleton University)
4. Odai Salman (PhD Systems and Computer Engineering), *Development of an Integrated System for Automatic Tumor Detection for PET-CT Images*, Co-supervised with A. Adler, Sept 2017-2021 (Carleton University)
5. Hanif Gabrani-Juma (M.A.Sc Biomedical Engineering), *Lesion synthesis in PET-CT*, Co-supervised with A. Adler, Jan 2017- April 2019 (Carleton University)

6. Colin Jones (M.A.Sc Biomedical Engineering), *Correction for patient motion in PET reconstruction*, Co-supervisor with A. Adler and R. deKemp, Jan 2015-Aug 2017
7. Spencer Manwell, (Ph.D. Physics), *Data driven motion correction in dynamic cardiac PET*, Co-supervised with T. Xu and R. deKemp, Sept 2015 – Aug 2020 (Carleton University)
8. Adrian Ocneanu (Ph.D. Electrical Engineering), *Right Ventricle Myocardial Blood Flow and Metabolic Quantification Using Dynamic PET*, Co-supervisor with A. Adler, Jan 2014-Sept 2017 (Carleton University)
9. Anbhu Sritharan (M.A.Sc. Biomedical Engineering), *Gross Patient Motion Correction in Dynamic Cardiac Positron Emission Tomography*, Co-supervisor with A. Adler, Sept 2013- Dec 2015 (Carleton University)
10. Simisani Takobana (M.A.Sc. Biomedical Engineering), *Quantification of Right Ventricular Function in Pulmonary Hypertension using Cardiac PET Images*, Co-supervisor with A. Adler Sept 2010-Dec 2012 (Carleton University)

Honour's Project Supervision

- 2015-Sep – 2016 Apr - Hanif Gabrani-Juma, Tyler Holmwood, Erik Zakher, BSc Biomed Eng candidates, “*Dynamic contrast-enhanced phantom flow quantification software – Quantify*”.

Internship Supervision

- 2021 – Shahin (Sean) Abtahi, 1st year Medical Student, University of Ottawa, “*Perception of synthetic lesions in PET images for evaluation of trainee performance*”
- 2021- 2022 – Dhruvil Naik, University of Ottawa, “*Quality Improvement in Nuclear Medicine*”
- 2020-2021 – Soroush Fard, University of Ottawa, “*Deep Vein Thrombosis Direct Referral Tool*”
- 2020-2021 – Vidit Vyas, Ontario Institute of Technology, “*COVID-19 ICU Triage calculator*”
- 2020-2021 – Punit Daga, University of Ottawa, “*COVID-19 ICU Triage calculator*”
- 2020 – Karl Zhu, University of Waterloo, “*Deep Vein Thrombosis Direct Referral Tool*”
- 2020 – Sanat Nayar, University of Ottawa, “*Electronic calculators for Nuclear Medicine Clinic*”
- 2017 – Doaa Nadouri, BSc Candidate, Biopharmaceutical Science (Genetics), University of Ottawa, “*Diastolic dysfunction can precede systolic dysfunction on MUGA in cancer patients receiving trastuzumab based therapy.*”
- 2017 – Erin Osler, BSc Candidate, “*Fiducial marker motion tracking in dynamic PET*”.
- 2016 – Erin Osler, BSc Candidate, “*Quality assurance tracking in nuclear medicine*”.
- 2015 – Simin Razavi, MSc, “*Synthesis of artificial lesions in nuclear images*”.
- 2015 – Rayhan Memon, “*Quality assurance management software in nuclear medicine*”.
- 2015 – Andrew Coathup, BSc, “*Synthesis of artificial lesions in nuclear images*”.
- 2014 – Brittany Reiche, BAsC, “*Coronary Contrast Opacification as an Indicator of Myocardial Perfusion*”.

- 2013-2016 – Hanif Gabrani-Juma, BEng Candidate, “*Dynamic splash viewer for FlowQuant*”, “*CT Angiography Dose Reduction Impact on Image Quality*”, “*Dynamic imaging phantom*”

Undergraduate Co-op Students

- 2010 - Trevor Burn, Physics Department, University of Ottawa, “*Optimizing execution speed of factor analysis of dynamic PET*”.
- 2009 - Charles Malo, School of Information Technology and Engineering, University of Ottawa, “*Heart left ventricle function analysis using gated PET*”.

Volunteers

- 2020 - Sanat Nayar, BAsC, Candidate, Computer Engineering, University of Ottawa, “*Machine Learning based differentiation of synthetic and real liver lesions in FDG PET*”
- 2018 – Ahmed Rezk, BSc Candidate, Physics, University of Ottawa, “*Improved differential kidney function measurements using attenuation correction of planar scintigraphy*”
- 2016-2018 – Doaa Nadouri, BSc Candidate, Biopharmaceutical Science (Genetics), University of Ottawa, “*Diagnostic value of diastolic dysfunction and right ventricular function parameters for cardiotoxicity during chemotherapy*”
- 2016-2017 – Pia Kristensen, MSc, Health Sciences, University of Copenhagen, Denmark, “*Quality control of region of interest area in bone mineral densitometry with DEXA*”
- 2015 – Doaa Nadouri, BSc Candidate, Biopharmaceutical Science (Genetics), University of Ottawa, “*Evaluation of brown fat exclusion tool in FDG PET*”.
- 2013-2014 – Bachar Almazloum, B.A.Sc Candidate, “*Changes in CTA image quality with CT dose reduction strategies*”.
- 2013 – Hisham Turkistani, M.A.Sc. candidate, Biomedical Engineering, Carleton University, “*Generating myocardial images from dynamic water PET*”.
- 2013 – Ryan Gotfrit, B.Sc. candidate, Biomedical Science, University of Ottawa, “*Scoring myocardial perfusion ⁸²Rb-PET images for ARMI trial*”.
- 2013 - Hanif Juma, B.A.Sc. candidate, Biomedical Engineering, Carleton University, “*Left ventricle short axis display of dynamic PET*”.
- 2013 – Inas Morsy, M.Sc., “*Automated localization of coronary vascular obstructions using myocardial blood flow gradients*”

GRADUATE COURSES: past 7 years, by year

Not applicable

EXTERNAL RESEARCH FUNDING: past 7 years only, by year, indicating source (granting councils, industry, government, foundations, other); amount; principal investigator; purpose (operating, equipment, travel, publications, etc...) (Include information on principal- or co-investigator)

Principle Investigator

YEAR	SOURCE	AMOUNT
2020-2025	Natural Sciences and Engineering Research Council (NSERC) Discovery Program Grant <i>"Pushing the limits of detection with PET"</i> P.I.: R. Klein	\$165,000
2020-2023	Natural Sciences and Engineering Research Council (NSERC) Discovery Accelerator Supplement <i>"Pushing the limits of detection with PET"</i> P.I.: R. Klein	\$120,000
2017-2018	Natural Sciences and Engineering Research Council (NSERC) Engage <i>"Integration of Human and Machine Observers for the Interpretation of Medical Images"</i> P.I.: R. Klein	\$25,000
2016-2017	Ontario Centres of Excellence (OCE) Voucher for Innovation and Productivity 1 (VIP1) <i>"Quantitative Medical Imaging Validation Flow Phantom"</i> P.I.: R. Klein	\$20,000
2014-2015	Canadian Institutes of Health Research (CIHR) Bridge Funding <i>"The Effects of Psoriatic Arthritis on coronary Flow Reserve and Markers of Inflammation and Evaluation of the Response to Biological Therapy"</i> P.I.: G. Dwivedi Role: collaborator)	\$100,000
2014-2018	Canadian Institutes of Health Research (CIHR) Operating Grant <i>"Translational Imaging of Coronary Endothelial Function with Positron Tomography"</i> P.I.: R. deKemp Role: collaborator	\$534,782
2014-2014	Medical Imaging Trail Network of Canada (MITNEC) Mentorship Exchange Program <i>"Myocardial Blood Flow Quantification with Computed Tomography"</i> P.I. R. Klein	\$5,000
2014-2014	Natural Sciences and Engineering Research Council (NSERC) Engage <i>"Perfusion Flow Phantom using a Peristaltic Pump Flow Source of Multi-Modality Medical Imaging"</i> P.I.: R. Klein	\$22,500
2014-2014	Natural Sciences and Engineering Research Council (NSERC) Engage <i>"Image Data De-identification for Biomedical Research"</i> P.I.: R. Klein	\$24,500

2013-2018	Natural Sciences and Engineering Research Council (NSERC) Discovery Program Grant <i>“Improving the accuracy of cardiac PET with motion-free imaging”</i> P.I.: R. Klein	\$160,000
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Under Review

2021	Canadian Institutes of Health Research (CIHR) Project Grant <i>“Artificial Intelligence for the Prevention of Unplanned Dialysis”</i> P.I.: A. Akbari Role: Principle Applicant	\$350,000
2021	Kidney Foundation of Canada Kidney Health Research Grant <i>“Artificial Intelligence for the Prevention of Unplanned Dialysis”</i> P.I.: A. Akbari Role: Co-Principle Investigator	\$99,000

Collaborator

YEAR	SOURCE	AMOUNT
2014/9 - 2018/8	GE Healthcare (formerly General Electric Medical Systems) Collaborative Research Grant <i>“Comparison of Myocardial Blood Flow Measurements with Dedicated Solid State SPECT Camera Imaging and 99mTc-Tetrofosmin versus PET Imaging and Rubidium-82”</i> Portion of Funding Received - 0 Funding Competitive?: No Co-investigator : G Wells; B Chow; R deKemp P.I.: T. Ruddy Role: Co-investigator	\$100,174

INTERNAL RESEARCH FUNDING:

Not applicable

PUBLICATIONS: Trainees are indicated with an asterisk *

Life-time summary (count) according to the following categories:

Book Chapters	4
Papers in refereed journals	67 (+0 submitted)
Editorials	5
Papers in refereed conference proceedings	10
Abstracts	108 (+0 submitted)

Major invited contributions and/or technical reports 15

Presentations

International	12 (+12 invited)
National	1 (+6 invited)
Local	2 (+5 invited)
Open source software	3

Rankings

Google scholar:

H-index: 28

7 papers cited over 100 times

Published Book Chapters

1. Croteau E, **Klein R**, Renaud JM, Premaratne M, deKemp RA, *Cardiovascular PET-CT, Hybrid Imaging in Cardiovascular Medicine*, Liu YH, Sinusas AJ, 2017:27-56.
2. **Klein R**, deKemp R, *Cardiac PET Imaging: principles and new developments*, Basic Science of PET Imaging, Khalil MM. 2017:451-83.
3. **Klein R**, Pourmoghaddas A, Mc Ardle B, Chow BJW, *Use of radio-labelled compounds and imaging as cardiac biomarkers*, Biomarkers in Disease: Methods, Discoveries and Applications, V. Preedy. 2015:811-40.
4. **Klein R**, deKemp RA, Rotstein B, Yoshinaga K, *Kinetics of Conventional and New Cardiac Radiotracers*, Nuclear Cardiac Imaging 6th Edition, Ami Iskandrian and Fadi Hage. 2021:[In Press]

Published Papers in Refereed Journals

- | Reference | PMID |
|---|----------|
| 1. Su N, Wiefels C, Klein R , Zeng W, Abbaspour F, <i>Intensity of hypermetabolic axillary lymph nodes in oncologic patients in relation to timeline following COVID-19 vaccination</i> , <u>J Med Img and Rad Sci</u> . Jan 2022 [In Press] | |
| 2. Naik D*, Ternan S, Degagne R; Zeng W, Klein R , <i>Thyroid Uptake Exceeding 100%: Causes and Prevention</i> , <u>J Nuc Med Tech</u> , June 2021 [In Press] | |
| 3. Wallis J, Klein R , Bradshaw T, Catana C, Hatt M, Laforest R, Liu C, Mawlawi O, McCall K, Osborne D, Tang J, Wells RG, Ghesani M, <i>PIDSC Remote Viewing Guidelines Document</i> , <u>J Nuc Med Technol</u> , 2021;49(1):2-6. | 33380520 |
| 4. Klein R , deKemp RA, <i>Selection of PET Camera and Implication on the Reliability and Accuracy of Absolute Myocardial Blood Flow Quantification</i> , <u>Curr Cardiol Reports</u> , 2020;22(10):109. | 32770426 |
| 5. Manabe O; Yoshinaga K, Katoh C, Magota K, Klein R , deKemp RA, Naya M, Oyama-Manabe N, Tamaki N, <i>Validation of regional myocardial blood flow quantification using 3D PET with rubidium-82 –repeatability and comparison with 2D PET data acquisition</i> . <u>Nuc Med Comm</u> , 2020;41(8):768-75. | 32459715 |
| 6. Salman O*, Klein R , <i>Anatomical Region Identification in Medical x-ray Computed Tomography (CT) Scans: Development and Comparison of Alternative Data-Analysis and Vision-Based Methods</i> , <u>Neural Computing and</u> | |

- Applications, 2020;32:17519-31.
7. **Klein R**, Celiker-Guler E, Rotstein BH, deKemp RA, *PET and SPECT Tracers for Myocardial Perfusion Imaging*, Sem in Nucl Med, 2020;50(3):208-18.
 8. Gabrani-Juma H*, Zuckier LS, **Klein R**, *Development and validation of the Lesion Synthesis Toolbox and the Perception Study Tool for quantifying observer limits-of-detection of lesions in positron emission tomography*, J Med Imaging, 2020;7(2):022412 32341935
 9. Ahmadi A, **Klein R**, Lewin HS, Beanlands RSB, deKemp RA, *Rubidium-82 Generator Yield and Efficiency for PET Perfusion Imaging: Comparison of Two Clinical Systems*, J Nucl Card, 2020;27(5):1728-38. 32436115
 10. Ahmadi A, Renaud JM, Promislow S, Burwash IG, Dwivedi G, **Klein R**, Zelt JGE, deKemp RA, Beanlands RS, Mielniczuk LM, *Increased myocardial oxygen consumption rates are associated with maladaptive right ventricular remodelling and decreased event-free survival in heart failure patients*, J Nucl Card, 2020;[Online ahead of print]. 32383088
 11. Manwell S*, **Klein R**, Xu To, deKemp RA, *Clinical comparison of the Positron Emission Tracking (PeTrack) algorithm with the Real-Time Position Management System for respiratory gating in cardiac positron emission tomography*, Med Phys, 2020;47(4):1713-26. 31990986
 12. Currie G, Hawk KE, Rohrer E, Vial A, **Klein R**, *Machine Learning and Deep Learning in Medical Imaging: Intelligent Imaging*, J Med Image and Rad Sci, 2019;450(4):477-87. 31601480
 13. Thorn S, Barlow S, Feher A, Stacy M, Doviak H, Jacobs J, Zellars K, Renaud J, **Klein R**, deKemp R, Khakoo A, Lee TW, Spinale F, Sinusas A, *Application of Hybrid MMP-Targeted and Dynamic 201Tl SPECT/CT Imaging for Evaluation of Early Post Myocardial Infarction Remodeling*, Circ Cardiovascular Imaging, 2019;12(11):e009055. 31707811
 14. **Klein R**, deKemp RA, *⁸²Rb is the best flow tracer for high-volume sites*, Annals of Nuc Cardiol 2019;5(1):53-62.
 15. Sriperumbuduri S, Dent R, Malcolm J, Hiremath S, **Klein R**, White CA; Akbari A, *Accurate GFR in obesity – Protocol for a systematic review*, Sys Review, 2019;8:147. 31228953
 16. Pfau D, Thorn SL, Zhang J, Mikush N, Renaud JM, **Klein R**, deKemp RA, Wu X, Hu X, Sinusas AJ, Young LH, Tirziu D, *Angiotensin receptor neprilysin inhibitor attenuates myocardial remodeling and improves infarct perfusion in experimental heart failure*. Scientific Reports, 2019;9(1):5791. 30962467
 17. Robin P, **Klein R**, Gardner J, Ziebarth B, Bazarjani S, Razavi S*, Zuckier LS, Zeng W, *Quantitative analysis of technetium-99m-sestamibi uptake and washout in parathyroid scintigraphy supports dual mechanisms of lesion conspicuity*. Nuc Med Comm., 2019;40(5):469-76. 30762617
 18. Hunter CRRN, **Klein R**, Alessio A, deKemp RA, *Correction for Rigid Patient body motion correction for dynamic cardiac PET-CT by attenuation-emission alignment according to projection consistency conditions*. Med. Phys. 2019;46(4):1697-1706. 30710381
 19. **Klein R**, Nadouri D*, Osler E*, Johnson C, Dent S, Dwivedi G, *Diastolic* 30418380

- dysfunction can precede systolic dysfunction on MUGA in cancer patients receiving trastuzumab based therapy.* Nuc Med Comm. 2019;40(1):22-29.
20. **Klein R**, Razavi S*, Memon R*, Zuckier L, *An electronic 99mTc-DTPA Glomerular Filtration Rate spreadsheet with novel embedded quality assurance features,* Nuc Med Comm. 2019;40(1):30-40. 30362986
21. Abele JT, Raubenheimer M, Bain VG, Wandzilak G, AlHulaimi N, Coulden R, deKemp RA, **Klein R**, Williams RG, Warshawski RS, Lalonde LD, *Quantitative blood flow evaluation of vasodilation-stress compared with dobutamine-stress in patients with end-stage liver disease using ⁸²Rb PET/CT.* J Nuc Cardiol. 2018;19(11) [Epub ahead of print]. 30456495
22. **Klein R**, *Initial steps to tracer kinetic modeling and MBF quantification,* Annals of Nuc Cardiol. 2018;4(1):68-73.
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Abstracts Submitted

Invited Contributions and Technical Reports

1. **Klein R**, Oliver M, La Russa D, Agapito J, Gaede S, Bisonnette JP, Rahmim A, Uribe C, *Technical Quality Control Guidelines for use of Positron Emission Tomography – Computed Tomography (PET/CT) in Radiation Treatment Planning*, Canadian Partnership for Quality Radiotherapy, 2019, <http://www.cpqr.ca/wp-content/uploads/2019/09/PET-2019-09-01-DRAFT.docx>
2. Salman O*, **Klein R**, *Organ segmentation in whole-body PET-CT*, Project final report to Hermes Medical Solutions, 2018.
3. **Klein R**, Zuckier LS, *Hermes in an evolving multi-site organization –The Ottawa Hospital experience*. White paper, Hermes Medical Solutions, 2018
4. Gabrani-Juma H*, **Klein R**, *QuantifyDCE – Tutorial*, Shelley Medical Solutions, 2018
5. Gabrani-Juma H*, **Klein R**, *QuantifyDCE – Flow Quantification validation procedure and manual (including software and tutorials)*, *Software and Operator’s Manual*, Shelley Medical Solutions, 2018
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8. **Klein R**, *VolumeViewer User Manual*, 2007.
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13. **Klein R**, *⁸²Rb Elution System Quality Assurance and Testing Manual*, Internal documentation 2005.
14. **Klein R**, *Wall-Thickening Extraction from Smoothed PET Scans*, Internal report to the National Cardiac PET Centre, 2003.
15. **Klein R**, *Control System Implementation for the Tower Semiconductor Fabrication Facility Environment and Production Support Systems*, LEAD Controls Co-op report, 2002.
16. **Klein R**, *Development and Comparison of Various Paired Comparisons Techniques*, Internal report to the National Cardiac PET Centre, 2001.
17. **Klein R**, *Detection of Serial Changes in Absolute Myocardial Perfusion with ⁸²Rb PET*, University of Ottawa Heart Institute Co-op report, 2001.

Technology Transfer, Copyrights and Patents

Patents

Inventors	Name	Assigned to	Country	Filing Date	Patent Number	Grant Date	Status
Lefort E, Teoli V, deKemp RA, Klein R	<i>Rubidium Elution System</i>	Jubilant Draximage, Montreal, QC	Canada	2017-04-13			Pending
			US	2017-04-14			Pending
			EU	2018-04-16			Pending
			Australia	2018-04-13			Pending
			Argentina	2017-04-14			Pending
			Pakistan	2017-04-14			Pending
			Lebanon	2018-04-13	11403	2018-04-16	Granted
			PCT	2017-04-14			Pending
Lefort E, Teoli V, deKemp RA, Klein R	<i>Rubidium Elution System Control</i>	Jubilant Draximage, Montreal, QC	EU	2012-10-26	2893540	2018-01-10	Granted
			EU	2012-10-26	3309796		Pending
			Australia	2012-09-05	2012389470B2	2017-08-31	Granted
			Australia (divisional)	2012-09-05	2017213596B2	2019-02-28	Granted
			Colombia	2012-09-05	31789	2017-06-05	Granted
			Japan	2012-09-05	6148341	2017-05-26	Granted
			Mexico	2012-09-05	351398	2017-10-13	Granted
			China	2012-09-05	201280075656.9	2017-10-24	Granted
			Singapore	2012-09-05	10201701766P	2017-04-27	Granted
			Australia (divisional)	2012-09-05			Pending
			Brazil	2012-09-05			Pending
			Canada	2012-09-05			Pending

			China (divisional)	2012-09-05			Pending
			Japan (divisional)	2012-09-05			Pending
			US	2012-09-05	10943707B2	2021-03-21	Granted
			Singapore (divisional)	2012-09-05			Pending
			India	2012-09-05			Pending
			Mexico (divisional)	2012-09-05			Pending
			South Korea	2012-09-05			Pending
			UAE	2012-09-05			Pending
			Chile	2012-09-05			Pending
			Costa Rica	2012-09-05			Pending
			Dominican Republic	2012-09-05			Pending
			Peru	2012-09-05			Pending
			Israel	2012-09-05			Pending
			Malaysia	2012-09-05			Pending
			Hong Kong	2012-09-05			Pending
			Hong Kong	2017-04-14			Pending
			Hong Kong (divisional)	2012-09-05			Pending
deKemp RA, Klein R	<i>Rubidium Elution System Control</i>	Jubilant Draximage, Montreal, QC	US	2006-03-10	7813841	2010-10-12	Granted
			Canada	2006-03-10	2562453	2014-11-18	Granted
			EU	2007-02-26	1996276	2018-08-15	Granted
			India	2007-02-26			Pending

Copyrights

1. deKemp RA, **Klein R**, Epstein N, *RbES*© – *Rb-82 Elution System*. Canadian Intellectual Property Office, Copyright 2003.
2. deKemp RA, **Klein R**, Renaud J, Lortie M, *FlowQuant*© – *Image Analysis Software for Cardiac Positron Emission Tomography (PET)*. Canadian Intellectual Property Office, Copyright 2008.

Technology Transfer

1. deKemp RA, **Klein R**, Renaud J, Myocardial blood flow quantification – technology transfer to Invia Medical Imaging Solutions, Ann Arbor, MI, 2014.
2. FlowQuant© distribution agreement with Siemens Preclinical Solutions, Knoxville, TN, June 2008
3. FlowQuant© distribution agreement with BIOSCAN Inc., Washington DC, October 2010

Media

1. **Klein R**, Enabling Quality Management in Diagnostic Imaging with QATrack+, CAMRT Webinar Series, https://camrt.force.com/CPBase_item?id=a102L000004BL1xQAG, Dec 2018.

Invited Presentations

International

1. **Klein R**, Interview with Famous Physicists series, Editor Geoff Currie, https://www.youtube.com/watch?v=pFMUxCqy_kU
2. **Klein R**, *Advances in SPECT and SPECT/CT Technologies*, Continued Education Session, Society of Nuclear Medicine and Molecular Imaging, New Orleans, LA, June 15, 2020 – deferred due to COVID-19.
3. **Klein R**, *Deep learning in diagnosis, therapy and clinical applications*, Pre-conference symposium, Australian New-Zealand Society of Nuclear Medicine Annual Meeting, Sydney, Australia, April 24, 2020 – deferred due to COVID-19.
4. **Klein R**, *Virtual reality applications in nuclear medicine*, Australian New-Zealand Society of Nuclear Medicine, Sydney, Australia – virtual due to COVID-19.
5. **Klein R**, *Quantification of Lung Lobar Function*, Australian New-Zealand Society of Nuclear Medicine, Sydney, Australia, April 26, 2020 – deferred due to COVID-19.
6. **Klein R**, *⁸²Rb PET myocardial blood flow quantification*, Australian New-Zealand Society of Nuclear Medicine, Sydney, Australia, April 26, 2020 – deferred due to COVID-19.
7. **Klein R**, *Quantification of V/Q Scans*, Continued Education Session, Society of Nuclear Medicine and Molecular Imaging, Anaheim, CA, June 22, 2019.
8. **Klein R**, *Introduction to Virtual Tele Nuclear Medicine*, Continued Education Session, Society of Nuclear Medicine and Molecular Imaging, Anaheim, CA, June 23, 2019.
9. **Klein R**, *Rubidium-82 PET: Bang-for-Buck Technology for Steering Cardiac Care*. University of Sao Paulo, Sao Paulo, Brazil, May 23, 2013.
10. **Klein R**, *Nuclear cardiology image analysis and software development*. Japanese Society of Nuclear Medicine Annual Meeting, Sapporo, Japan, Oct 12, 2012.
11. **Klein R**, *Myocardial Blood Flow Quantification with FlowQuant*, General-Electric Medical Imaging, Haifa, Israel, Jan 18, 2012.
12. **Klein R**, *Clinical Application of ⁸²Rb Positron Emission Tomography*. Meir Hospital Scientific Rounds, Kfar-Saba, Israel, Feb 7, 2010.

National

1. **Klein R**, *Artificial intelligence in Nuclear Medicine*, Canadian Association of Medical Radiation Technologists and Ontario Association of Medical Radiation Sciences - Annual General Conference, Ottawa, Ontario, May 28, 2020.
2. **Klein R**, *Myocardial Blood Flow Quantification with Positron Emission Tomography (PET): Making More Available*, Canadian Association of Medical Radiation Technologists and Ontario Association of Medical Radiation Sciences - Annual General Conference, Ottawa, Ontario, Apr 28, 2017.
3. **Klein R**, *Negotiating a first contract – Basic Research*. CCS annual meeting, Vancouver, BC, Oct 22, 2011.
4. **Klein R**, *Myocardial Perfusion Imaging*, Canadian Association of Nuclear Medicine: Image Acquisition and Processing, Montreal, Quebec, Jan 30, 2015.
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6. **Klein R**, *Rb-82 generator production, tracer delivery and modeling*, Canadian Society of Nuclear Medicine annual meeting, Quebec, PQ. Apr 27, 2006.

Local

1. **Klein R**, *Quantification in Lung V/Q Scans*, Ontario Association of Medical Radiation Sciences, Ottawa District, Ottawa, Ontario, November 16, 2019.

2. **Klein R**, *The rise of artificial intelligence in medical imaging. And we thought as isotope shortage was disruptive?* Ontario Association of Medical Radiation Sciences, Ottawa District, Ottawa, Ontario, April 19, 2018.
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