UHN Princess Margaret Cancer Centre

International Cancer Expert Corps
Partnering to transform global cancer care

Cancer AI & Big Data:

Success Through Global Collaboration

February 20-21, 2020 | Courtyard Marriott Toronto Downtown Hotel

Conference Handbook

Platinum Sponsor

NOVARTIS

Bronze Sponsors

Bristol-Myers Squibb Canada

Roche

Exhibitor

Elekta

TABLE OF CONTENTS

WELCOME FROM THE CO-CHAIRS

Dear Participants:

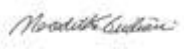
Welcome to the Joint Princess Margaret / International Cancer Expert Corps Conference – Cancer AI and Big Data: Success through collaboration in Toronto. We are pleased to offer a very exciting program including our Keynote speakers, breakout sessions and debates on Health Economics of AI, AI Explained, Global Inequities and Health Systems, Social and Ethical Impacts, Cross Collaboration, and Digital Compassion. Our debate "Human vs. Machines" proves to be exciting and thought-provoking.

At a time when global cancer incidence is growing and there is increasing political and social polarization, the incorporation of responsible and innovative use of AI and Big Data in medicine generally, and in oncology specifically, has the opportunity to transform the delivery of cancer care in resource-limited settings globally. We look forward to sharing ideas towards developing sustainable global solutions to address the growing cancer crisis.

Our networking opportunities include a special ICEC Meet and Greet Lunch and Young Leaders breakfast, among the few. Come by the poster viewing and welcome reception on Thursday at 4:00 pm to say hello and catch up with your friends and colleagues.

While here, Toronto offers music, film, sports, cultural, entertainment, performing arts, festivals and events, international cuisine, parks and recreation, first-rate accommodations, and shopping. We hope you will have the opportunity to enjoy some of these activities.

Sincerely,



Co-chairs:
Meredith Giuliani, MD — Alejandro Berlin, MD — Chika Nwachukwu, MD


Mira Shah, MD — Benjamin Haibe-Kains, PhD

Conference Learning Objectives:

- To envision clinical practice in the era of AI & Big Data
- To conceptualize the role of AI in global health: closing or widening the gap
- To explore the translation of AI & Big Data into clinical practice
- To examine the role of AI & Big Data in shaping the healthcare teams of the future

GENERAL INFORMATION

Accreditation
This continuing education event is held under the auspices of Continuing Professional Development, Faculty of Medicine, University of Toronto and Princess Margaret Cancer Centre.

Royal College of Physicians and Surgeons of Canada – Section 1:
This event is an Accredited Group Learning Activity (Section 1) as defined by the Maintenance of Certification Program of The Royal College of Physicians and Surgeons of Canada, approved by Continuing Professional Development, Faculty of Medicine, University of Toronto. You may claim a maximum of 12 hours (credits are automatically calculated).

The American Medical Association - AMA PRA Category 1
Through an agreement between the Royal College of Physicians and Surgeons of Canada and the American Medical Association, physicians may convert Royal College MOC credits to AMA PRA Category 1 Credits™. Information on the process to convert Royal College MOC credit to AMA credit can be found at https://edhub.ama-assn.org/pages/agreement-royal-college-physicians-surgeons-canada

European Union for Medical Specialists (EUMS) ECMEC
Live educational activities, occurring in Canada, recognized by the Royal College of Physicians and Surgeons of Canada as Accredited Group Learning Activities (Section 1) are deemed by the European Union of Medical Specialists (UEMS) eligible for ECMEC®."

Each participant should claim only those hours of credit that he/she actually spent participating in the educational program

Certificate of Attendance
To receive your certificate of attendance, you must complete the online evaluations (see Evaluation section below). Upon completion, you will be directed to your certificate where you will be able to type in your name, the number of credits you are eligible for, and print the certificate. Please find a breakdown of the hours below:

Thursday, February 20: 5.5 hours
Friday, February 21: 6.5 hours

Evaluation
The evaluation will be done through an online survey that will be sent to you by the end of the day. The email will include a link to the survey. The survey will be easily accessible on your smart phone or you can choose to complete the survey online at your desktop computer/laptop. Please note that if you open the survey, you must complete the survey in its entirety. If you close out of the survey, it will not save. Once you complete the survey and click "Done", you will be directed to your certificate of attendance. Please make sure you are able to download and save or print the certificate from your device prior to starting the evaluation.

WiFi Access
The Courtyard Marriott Hotel has a password protected WiFi network throughout the meeting area. To access your complimentary WiFi, open your device's network settings, select Courtyard_Conference, and enter the password **PMICEC** when prompted.

Information
Should you require assistance at any time during this conference, please visit the registration desk, located in the foyer.

Poster Presentations
We invite you to view the posters during the breaks and lunches. The official poster viewing is during the reception at 4:00 pm at which time all authors are asked to be present at their poster. Please take the time to visit the authors and learn about their research. All posters are eligible for a prize. Please use the stickers provided in your name badge to vote for your favourite poster during the breaks through the day. Voting will close at 4:00 pm and one winner will be announced during the reception. Posters may be taken down after the reception at 5:30 pm. Any posters left behind will be discarded.

FACULTY

Keynote Speakers

Rich Caruana, PhD
Senior Principal Researcher
Microsoft Research

Avi Goldfarb, PhD
Rotman Chair in Artificial Intelligence and Healthcare, University of Toronto

Mary Gospodarowicz, MD FRCPC FRCR(Hon)
Professor, University of Toronto
Medical Director
Princess Margaret Cancer Centre

David Jaffray, PhD
Senior Vice President, Chief Technology and Digital Officer, University of Texas MD Anderson Cancer Center

Sabelo Mhlambi
Computer Scientist, Researcher, Fellow, Berkman Klein Centre for Internet & Society, Harvard

Faculty

Ajay Aggarwal, MBBS FRCR MSc PhD
Consultant Clinical Oncologist
Guy's & St. Thomas' NHS Trust

Alejandro (Ale) Berlin, MD MSc
Assistant Professor, University of Toronto
Princess Margaret Cancer Centre

Michael Brudno, PhD
Professor and Associate Chair – Research
Department of Computer Science
University of Toronto

Ben Brzezynski, MA
Director of Business Development Operations, Enlitic

Luke Brzozowski, PhD
Senior Director, TECHNA and Diagnostic Innovation, University Health Network

Amanda Caissie, MD FRCPC
Assistant Professor, Dalhousie University

Allison Crawford, MD PhD
Associate Professor, University of Toronto
Centre for Addiction and Mental Health

Irene Dankwa-Mullan, MD MPH
Deputy Chief Health Officer, IBM Watson Health, IBM Corporation

Michael Duong, PhD
Head of Personalized Healthcare
Hoffmann-La Roche Canada

Thomas Eichler, MD FASTRO
Physician, VCU Health, Massey Cancer Center

Meredith Giuliani, MBBS MEd FRCPC
Associate Professor, University of Toronto
Princess Margaret Cancer Centre

Ezra Hahn, MD FRCPC
Assistant Professor, University of Toronto

Benjamin Haibe-Kains, PhD
Associate Professor, University of Toronto
Princess Margaret Cancer Centre

Nazik Hammad, MD MSc MEHP FACP
Associate Professor, Department of Oncology, Queen's University

Ann Heesters, PhD
Director of Bioethics, University Health Network

Fabrice Jotterand, PhD MA
Associate Professor, Director, Center for Bioethics and Medical Humanities
Medical College of Wisconsin

Jamal Khader, MD
Consultant, Radiation Oncologist
King Hussein Cancer Center

Kelly Lane
Project Director, TECHNA Institute
University Health Network

Yolande Lievens, MD PhD
Chair and Professor, Radiation Oncology
Ghent University

Maria Athina (Tina) Martimianakis, MA Med PhD
Associate Professor, University of Toronto

Melissa McCradden, PhD
Junior Bioethicist, SickKids Hospital

Chris McIntosh, PhD
Scientist, TECHNA Institute
University Health Network

Fabio Ynoe De Moraes, MD
Assistant Professor, Queen's University

Alison Paprica, PhD
Vice President, Health Strategy and Partnerships, Vector Institute

FACULTY

Thomas Purdie, BSc PhD
Staff Physicist, Radiation Medicine Program
Princess Margaret Cancer Centre

Danielle Rodin, MD FRCPC
Assistant Professor, University of Toronto
Princess Margaret Cancer Centre

Gary Rodin, MD FRCPC
Shirley Lederman Chair in Psychosocial Oncology and Palliative Care
Princess Margaret Cancer Centre

Duoaud Shah, MSc
Manager, Consulting Services and Co-Development, TECHNA Institute
University Health Network

Stephanie Sliekers, MEd
Manager, Simulation and Digital Innovation
Centre for Addiction and Mental Health

Gillian Strudwick, RN PhD
Registered Nurse and Scientist
Centre for Addiction and Mental Health

Erin Watson, DMD
Deputy Chief of Dentistry
Princess Margaret Cancer Centre

David Wiljer, PhD
Executive Director of Education, Technology and Innovation, University Health Network

Co-Chairs

Alejandro Berlin, MD MSc
Princess Margaret Cancer Centre

Meredith Giuliani, MBBS MEd FRCPC
Princess Margaret Cancer Centre

Chika Nwachukwu, MD
University of Texas Southwestern Medical School

Mira Shah, MD
Henry Ford Health System

Benjamin Haibe-Kains, PhD
Princess Margaret Cancer Centre

Committee Members

Lyllian Acevedo
Medical College of Wisconsin

Onyinye Balogun, MD
Weill Cornell Medicine

C. Norman Coleman, MD
National Cancer Institute (NCI)
International Cancer Expert Corps (ICEC)

Mary Hooey, CMP
Princess Margaret Cancer Centre

Sophie Huang, MSc
Princess Margaret Cancer Centre

Mac Longo, MD
Medical College of Wisconsin

Tina Papadakos, MA(Ed)
Princess Margaret Cancer Centre

Danielle Rodin, MD FRCPC
Princess Margaret Cancer Centre

Eugenia (Nina) Wendling, COO
International Cancer Expert Corps (ICEC)

Advisory Board

Nazek Abdelmutti, MSc
Senior Manager, Cancer Strategy Stewardship
Princess Margaret Cancer Centre

Alexandra Boasie MSc MBA
Director, Toronto Central South Regional Cancer Program South and Medical Affairs
Princess Margaret Cancer Centre

Nazik Hammad, MD MSc MEHP FACP
Associate Professor, Department of Oncology
Queen's University

Ceferino Obcemea, PhD
Program Director, Medical Physics
Radiation Research Program
National Cancer Institute

David Wiljer, PhD
Executive Director of Education, Technology and Innovation, University Health Network

Rebecca Wong, MDChB FRCPC MSc
Professor, University of Toronto
Princess Margaret Cancer Centre

PROGRAM AGENDA

Thursday February 20, 2020

Time	Program Title
0700-0800	**Breakfast and Registration -** *Foyer*
0800-0815 *Ballroom*	**Welcome and Introductions** *Alejandro Berlin, Meredith Giuliani*
0815-0900 *Ballroom*	**Moderator:** *Timothy Hanna* **General and Potential Roles for AI** *Rich Caruana* **Learning Objectives** At the end of this session, learners will be able to: • Demonstrate the good and bad things machine learning models learn from medical data. • Describe the risk of deploying black-box models such as deep neural nets that are not well understood. • Show how the care patients currently receive can confuse machine learning models because they do not understand how to take treatment effects into account. • Discuss how machine learning can be used to learn important new findings in medical data that can improve patient care and save lives.
0900-0945 *Ballroom*	**Moderators:** *Alejandro Berlin, Fabio Moraes* **Health Economics of AI** *Avi Goldfarb* **Learning Objectives** At the end of this session, learners will be able to: • Provide an economic understanding of the potential impact of AI in healthcare. • Recognize the unique challenges to technology adoption generally, and AI adoption in particular, in healthcare.
0945-1015	**Refreshment Break**
1015-1145	**Concurrent Sessions** **AI Explained/Applied** *Ballroom* **Moderators:** *Benjamin Haibe-Kaines, Nazik Hammad* **Panelists:** *Michael Brudno, Thomas Eichler, Ezra Hahn* **Learning Objectives** At the end of this session, learners will be able to: • Identify the major obstacles for deployment of AI-based tools in the clinic. • Describe ongoing initiatives regarding the requirements for the use AI technologies in clinical settings. • Discuss the open challenges for AI-base clinical tools. **Classifications vs Expert Systems in AI** *Alexander AB* **Moderator:** *Tom Purdie* **Panelists:** *Rich Caruana, Chris McIntosh* **Learning Objectives** At the end of this session, learners will be able to: • Describe safety in implementing AI in healthcare. • Explain AI to provide more relevant results to end users. • Discuss bias in training AI algorithms and in end user evaluation of AI. • Discuss lessons learned from clinical deployment of an AI system.
1145-1300	**Lunch / Exhibitor Showcase -** *Foyer*
1200-1300	**ICEC Meet and Greet** - *Bay*

PROGRAM AGENDA

Time	Program Title
1300-1430 *Ballroom*	**Moderator:** *Danielle Rodin* **AI Will Close Global Inequities in Cancer** **Panelists:** *Ajay Aggarwal, Thomas Eichler, Avi Goldfarb, Yolande Lievens* **Learning Objectives** At the end of this session, learners will be able to: • Identify the economic, social, and technical aspects of AI that impact health disparities. • Describe how artificial intelligence can worsen health disparities and inequalities in health. • Demonstrate examples of how artificial intelligence can, conversely, provide opportunities to improve health outcomes for populations and decrease inequalities in health.
1430-1500	**Refreshment Break**
1500-1600 *Ballroom*	**Moderator:** *C. Norman Coleman* **Global Cancer Control – Challenges and Opportunities** *Mary Gospodarowicz* **Learning Objectives** At the end of this session, learners will be able to: • Understand the global burden of cancer. • Identify reasons for cancer equity divide. • Evaluate current challenges in global cancer control. • Consider current and future opportunities to close cancer divide.
1600-1730	**Poster Viewing and Welcome Reception -** *Alexander C / Foyer*

Friday February 21, 2020

Time	Program Title
0700-0800 *Bay*	**Networking Breakfast – Young Leaders** **Moderators:** *Nazek Abdelmutti, Erin Watson* Topics include: Cancer Care and Technology, Patient and Public Education, Growing Capacity through Cancer Networks, Education, Training and the Cancer Workforce
0700-0800	**Breakfast and Registration**
0800-0815 *Ballroom*	**Welcome and Introductions** *Danielle Rodin*
0815-0900 *Ballroom*	**Moderator:** *Nazik Hammad* **Social and Ethical Impacts of AI and Big Data** *Sabelo Mhlambi* **Learning Objectives** At the end of this session, learners will be able to: • Link the history and early philosophical, mathematical foundations of AI and how these assumptions can lead to exclusion of marginalized groups. • Use Ubuntu Ethics as a framework for the ethical creation and use of AI.

PROGRAM AGENDA

Time	Program Title
0900-0945 *Ballroom*	**Cross Collaboration** **Moderator:** *Luke Brzozowski* Making it happen with a hospital, big pharma perspective *Michael Duong, Head of Personalized Healthcare, Roche Canada* Making it happen with an industrial partner, hospital insider perspective *Duoaud Shah, Techna, Manager, Consulting Services and Co-development* Making it happen with a hospital, start-up perspective *Ben Brzezynski, Director BD Operations, Enlitic* Making it happen with other hospitals, hospital insider perspective *Kelly Lane, Techna, Project Director* Making it happen with other companies, industry perspective *Irene Dankwa-Mullan, Deputy Chief Health Officer, IBM Watson Health* **Learning Objectives** At the end of this session, learners will be able to: • Provide different perspectives on cross collaboration between industrial partners and hospitals, in-between hospitals, and in-between industrial partners in the field of Health AI and Digital Innovation. • Describe mechanics of 'how to get things done' to ensure efficient collaboration: what works, what does not, where we go from here. • Provide examples of successful collaborations as well as talk about the arrangements that did not work out and why.
0945-1015	**Refreshment Break**
1015-1145	**Concurrent Sessions** **Learning Digital Compassion: A Global Challenge for AI and Big Data** *Alexander AB* **Moderator:** *Jamal Khader* **Panelists:** *Allison Crawford, Tina Martimianakis, Stephanie Sliekers, Gillian Strudwick, David Wiljer* **Learning Objectives** At the end of this session, learners will be able to: • Understand how compassionate care can be delivered in the context of AI and digital care. • Articulate a framework to identify essential components of digital compassion. • Identify evidence-based approaches to providing compassionate care in a digital environment. • Identify competencies and capabilities of digital compassion from multiple perspectives. **Health Equity and Ethical Considerations in the Era of AI and Big Data** *Ballroom* **Moderator:** *Ann Heesters* **Panelists:** *Irene Dankwa-Mullan, Fabrice Jotterand, Melissa McCradden, Sabelo Mhlambi* **Learning Objectives** At the end of this session, learners will be able to: • Provide a definition of health equity and framework for addressing issues around disparities, fairness, and bias that may stem from the implementation of AI and Big Data. • Establish the boundaries for the responsible use of AI and machine learning with big data. • Outline recommendations for the ethical use of AI and Big Data in clinical practice.
1145-1300	**Lunch / Exhibitor Showcase**

PROGRAM AGENDA

Time	Program Title
1300-1430 *Ballroom*	**Debate** **Humans vs Machines: Be it resolved that AI is THE solution to the human resources crisis in cancer** **Moderators:** *Thomas Eichler, Meredith Giuliani* **Panelists:** *Alison Paprica, Gary Rodin* **Learning Objectives** At the end of this session, learners will be able to: • Review the future projections for human resources for cancer. • Debate potential solutions to the human resource crisis in cancer control globally.
1430-1500	**Refreshment Break**
1500-1600 *Ballroom*	**Plenary Abstracts** **Moderators:** *Amanda Caissie, David Jaffray* **Learning Objectives** At the end of this session, learners will be able to: • Review and discuss top plenary abstracts research projects. 2 - Managing Cancer and Living Meaningfully (CALM): A Global Initiative *Alanna Chu* 17 - Clinical Evaluation of the Watson for Genomics Platform for Cancer Variant Interpretation *Ian King* 33 - Applications of Deep Learning for Automatic Contouring of Tumours in the Brain *Robert Henderson* 37 - An Implementation Framework for AI in Healthcare *Tran Truong*
1600-1645 *Ballroom*	**Moderator:** *Danielle Rodin* **Collaboration in a Digital World: Mindsets, Skillsets, and Toolsets** *David Jaffray* **Learning Objectives** At the end of this session, learners will be able to: • Understand the growing pressure to digitally-enable cancer care and research. • Understand the opportunities and challenges raised by automation and prediction. • Learn about the need for data governance technologies to facilitate collaboration.
1645-1700	**Closing Remarks / Awards Presentation**

ABSTRACTS

#	Name	Abstract Title
1	Adam Shulman	Rayos Contra Cancer: A Model for Longitudinal Training in Radiotherapy Delivery in Lower-Middle Income Countries
2	Alanna Chu	Managing Cancer and Living Meaningfully (CALM): A Global Initiative
3	Amanda Aleong	Segmentation of Multiple Needles for MR-guided Prostate Brachytherapy using Machine Learning
4	Amanda Caissie	A Multi-Level Approach to Building a Pan-Canadian System for Radiotherapy Big Data
5	Andrew Hope	Risk Stratification of Pulmonary Computed Tomography to Assist in Diagnosis of Inflammatory Lung Disease
6	Anjali Silva	Delineation of the Molecular Heterogeneity Underlying Patient Outcomes in Follicular Lymphoma
7	Brandon Driscoll	Creation and Validation of the QIPCM Imaging AI Development and Collaboration Environment
8	C Norman Coleman	Radiation Oncology is an ideal situation to utilize, develop, test, and implement AI/ML
9	Jennifer Law	Using AI to Improve Precision Medicine: Real-World Impact of Biomarker Testing in Advanced Lung Cancer
10	Denis Keimakh	An Analysis of Structural Variant Callers
12	Farnoosh Khodakarami	DeepCINET: A deep Learning Approach to Predict Noisy Phenotypes
13	Farnoosh Khodakarami	Deep Learning Radiomics Model for Head and Neck Survival Prediction
14	Hassan Mahmoud	Omics Complementary Role for Biomarker Discovery in Cancer
15	Hina Saeed	Global Implications and Challenges Associated with Big Data Explosion in Healthcare: Is Blockchain the Answer?
16	Hina Saeed	Exploring the Significance and Challenges of Implementing AI and Big Data in Clinical Practice: How Ready Are We?
17	Ian King	Clinical Evaluation of the Watson for Genomics Platform for Cancer Variant Interpretation
18	Jamal Khader	King Hussein Cancer Center in Jordan as an Example of a Successful Story of Regional and International Collaboration
19	Jamal Khader	Variables Altering the Impact of Respiratory Gated CT simulation on Planning Target Volume in Radiotherapy for Lung Cancer
20	Jamal Khader	Enhancing Value of Quality Assurance Rounds in Improving Radiotherapy Management: A Retrospective Analysis from King Hussein Cancer Center in Jordan
21	Frederick Ng	Predicting treatment planning evaluation parameter in radiotherapy QA using machine learning

ABSTRACTS

#	Name	Abstract Title
22	James Chow	A Chatbot with Characterization on Radiotherapy Using Artificial Intelligence and Machine Learning
23	Janet Papadakos	Plain Language and Patient Education in Systemic Therapy: A Formative Evaluation
24	Naa Kwarley Quartey	Health literacy Assessment of Cancer-related Whiteboard Animation Videos for Patients
25	Karen Lawrie	From Research to Resource: Creating Patient Education Materials Toward Clinical Trials Recruitment and Retention
26	Janet Papadakos	Exploring the Role of Family Caregivers as Informal Health Human Resources in Cancer Care: A Scoping Review
27	Jim Leng	Comparative Cost-Benefit Analysis of 2D vs. 3D Radiotherapy Using Quality Adjusted Life Years
28	Justin Burgener	Comprehensive Detection of ctDNA in Localized Head and Neck Cancer by Genome- and Methylome-based Analysis
29	Kesavi Kanagasabai	Developing a Machine-learning Based Automated Planning Method for Partial Breast Radiotherapy
31	Mei Ling Yap	Factors Associated with Treatment Type for Prostate Cancer Patients in the 45 and Up Study, New South Wales, Australia
32	Nicole Liscio	Digital Screens: Guidelines for Managing Content with a Patient-Focused Lens
33	Robert Henderson	Applications of Deep Learning for Automatic Contouring of Tumours in the Brain
34	Abbasali Hossein Pourfeizi	Delays in Initial Referral, Diagnosis and Treatment in Children with Cancer
35	Tina Papadakos	Fostering the Next Generation of Diverse Oncology Leaders Through the Summer Student Clinician Scientist Program
36	Steven De Michino	Exploration of Epigenetic Profiles in Circulating Tumor DNA to Identify Predictive Cancer Biomarkers
37	Tran Truong	An Implementation Framework for AI in Healthcare
38	Fred Fu	Comparison of Computational Pathology Approaches for the Quantitation of Bone Marrow Plasma Cell Percentages
39	Tina Papadakos	Difficult Conversations in Cancer
40	Yasin Mamatjan	The Promise and Potential of AI and Big Data to Revolutionize Cancer Diagnosis
41	Yasin Mamatjan	Novel Clinical Application of Machine Learning Approaches to Predict Meningioma Recurrence Risk

ABSTRACTS

Abstract #1

RAYOS CONTRA CANCER: A MODEL FOR LONGITUDINAL TRAINING IN RADIOTHERAPY DELIVERY IN LOWER-MIDDLE INCOME COUNTRIES

Adam Shulman[1], Jim Leng[2], Damilola Oladeru[3], Claire Dempsey[4,5], Peter Sandwall[6], Benjamin Li[7]

[1]Radiating Hope, USA
[2]University of Chicago Pritzker School of Medicine, USA
[3]Harvard Medical School, USA
[4]Calvary Mater Newcastle Hospital, University of Newcastle, Australia
[5]University of Washington, USA
[6]Ohio Health, USA
[7]University of California San Francisco, USA

Background: Safe, timely, and effective delivery of radiotherapy in lower-middle income countries (LMICs) require more than the purchase of treatment machines, but also significant investment in staff, education, and training. While many centers around the world have now gained the technology to treat patients with radiation, they lag decades behind counterparts in high-income countries due to lack of technical expertise. By addressing these educational needs in LMICs, existing equipment can be used to deliver modern treatments that drastically improve patient outcomes.

Methods: Using a network of volunteers, Rayos Contra Cancer, Inc. (RCC) leverages expertise from cancer centers in high-income countries to deliver free telehealth training in partnership with centers in LMICs. These trainings are delivered via conference calls over a longitudinal period of 4-5 months, followed by a 2-week post-training onsite education and assessment visit. These trainings are conducted in parallel with medical physicists and radiation oncologists, preparing each RCC partner clinic to train other centers in their respective global region.

Results: A curriculum in 3-dimensional high-dose rate brachytherapy was the first developed. The initial cohort of 10 centers in Egypt, Ghana, Iraq, Jordan, Mozambique, Nepal, Nigeria, Qatar, and Zambia received the training from July – September 2019. Combined, these centers are expected to treat over 4,500 brachytherapy patients per year and train 2 additional clinics in the region over next year. Using this model, RCC is partnering with 75 centers over time, with additional curriculums being developed in intensity-modulated radiation therapy, equipment commissioning, imaging, and stereotactic body radiotherapy and radiosurgery.

Conclusion: Through a robust framework of longitudinal telehealth and onsite trainings, RCC provides a cost-effective, sustainable model for delivering radiotherapy training that remain lacking in many LMIC centers. These specialized treatment modalities will help transition LMICs to modern radiation cancer care, providing better outcomes for patients who most need them.

Abstract #2

MANAGING CANCER AND LIVING MEANINGFULLY (CALM): A GLOBAL INITIATIVE

Alanna K Chu, Sarah Hales, Ekaterina An, Carmine Malfitano, Lesley Chalkin, Joanna Shnall, Kenneth Mah, Anne Rydall, Gary Rodin

Princess Margaret Cancer Centre, Toronto, ON

Purpose: Individuals with advanced cancer are at significant risk for depression, due to the distress related to disease progression, side effects of treatment, practical and profound demands of advanced disease, and impending threat of mortality. Despite this, few tailored interventions are available for this population. Managing Cancer and Living Meaningfully (CALM) is a brief, semi-structured, manualized psychotherapeutic intervention designed for individuals living with advanced cancer, which has been proven efficacious in alleviating psychological distress, and improving and preventing depressive symptomology in the Canadian population.

Methods: To address the dearth of tailored psychosocial interventions, the Global CALM Program seeks to implement CALM as a standard of clinical care for patients with advanced cancer across the globe. The program supports the development of CALM sites internationally, through training and certification of international CALM therapist via workshops and the provision of case supervision, assistance in program development and implementation through clinical consultation with the CALM developers, and providing support to develop site research capacity.

Results: The Global CALM Study has the primary objective of evaluating the implementation of the CALM Program in diverse cultural settings, including its feasibility, fidelity and acceptability. Participants include clinicians from Global CALM Sites from North America, South America, Europe, Middle East, Asia, and Australia. Participants complete baseline, 1 and 2 year quantitative measures of confidence with therapy and supervision evaluation, qualitative interviews, and are assessed for treatment integrity by the developers of CALM through online clinical supervision. Site leads additionally provide organization-level feasibility data. The study secondarily assesses the cross-cultural generalizability of the CALM intervention by supporting the development of CALM research at participating Global CALM Sites, and the collection and analysis of aggregated, site specific, patient-reported data of psychological well-being and quality of life.

Conclusion: This study will assess the implementation and generalizability of CALM in a diverse, global context.

Abstract #3

SEGMENTATION OF MULTIPLE NEEDLES FOR MR-GUIDED PROSTATE BRACHYTHERAPY USING MACHINE LEARNING

Amanda Aleong[1], Robert Weersink[2]

[1]University of Toronto, Toronto, ON
[2]University Health Network, Toronto, ON

Purpose: Rapid automatic needle segmentation is a vital step towards improving the safety and efficiency of MR-guided percutaneous procedures. Current techniques in the clinic employ intermittent imaging and visual inspection to assess the placement of the needle relative to a planned trajectory. Machine learning strategies such as neural networks offer the potential for fast, robust, automated localization of a needle in the image frame. This work reports on retrospective segmentation of T2-weighted clinical prostate images of patients undergoing brachytherapy, with multiple needles in view, using a convolutional neural network.

Methods: Images and corresponding binary needle segmentation maps from 12 patients who underwent HDR prostate brachytherapy (1340 images i.e. 67 image volumes; slice thickness=3mm; matrix=256x256, no. of slices=20) were used to train and test a 3D convolutional neural network with a U-Net architecture (depth=4; activation function = SeLU; optimizer = Adam; loss function = -Dice coefficient). The model was built using a sequential model from the Keras API with a TensorFlow backend in Python3. The network was trained on data from 10 patients (55 volumes) for 100 epochs with a batch size of 4 image volumes and a validation split of 0.2. The remaining 2 patients (12 volumes) were used to test the performance of the model.

Results: The model achieved a training and validation Dice coefficient of 0.75 and 0.68 respectively after 10. epochs. At test time, the model was able to detect 82% of needles with a prediction time of 1.47s/image volume.

Conclusion: Rapid localization of needles within an MR volume will facilitate the integration of robotic systems with imaging feedback and ensure the safety of the patient during operation. The developed algorithm may be applied to MR images acquired in near real-time to assess needle deflection during insertion through inhomogeneous soft tissue for robotic control.

ABSTRACTS

Abstract #4

A MULTI-LEVEL APPROACH TO BUILDING A PAN-CANADIAN SYSTEM FOR RADIOTHERAPY BIG DATA

Amanda Caissie, John Kildea, Chuck Mayo, Lisa Barbera, Erika Brown, Michael Milosevic

On behalf of CPQR's Patient Reported Outcomes (PRO) and Canadian Big Radiotherapy Data Initiative (CBRTDI) Working Groups

Purpose: Radiation treatment (RT) is fundamental to a national cancer control strategy. The importance of linking the technical aspects of RT to clinical and patient reported outcomes (PROs) across RT programs is increasingly recognized as essential to ensuring harmonized, best-practice clinical care. To this end, the Canadian Partnership for Quality in Radiotherapy (CPQR) established a multi-level approach to building a national system for Big Data in RT, including the collection and utilization of PROs, to inform front-line clinical care and population-based learning and promote system performance improvement.

Materials & Methods: CPQR, working with a national, interdisciplinary team of experts, developed and evaluated key quality indicators (KQI) of RT program readiness to collect and utilize Big Data and PROs. Based on these findings, priority CPQR programs were established to enable harmonized collection of these data across the country and promote future collaboration and data sharing.

Results: CPQRs Big Data working group partnered with stakeholders across Canada and internationally to develop Guidance on the Use of Common Nomenclature in Canadian Radiation Treatment Programs to promote uptake of a standardized technical language for RT planning. This was adapted from the American Association of Physicists in Medicine (AAPM) TG-263 standard and the American Society for Radiation Oncology (ASTRO) list of minimum data elements. The PRO working group developed Guidance on the Use of Patient Reported Outcomes for Canadian Radiation Treatment Programs, including recommendations for standardized, tumour-site specific PRO tools.

Conclusions: The CPQR model for promoting system-level change was used to build a national platform for RT Big Data and PROs collection and utilization, through both top-down initiatives to guide practice harmonization and the promotion of local grass roots efforts. International collaborations will be critical for expansion and harmonization of RT Big Data and PROs activities globally.

Abstract #5

RISK STRATIFICATION OF PULMONARY COMPUTED TOMOGRAPHY TO ASSIST IN DIAGNOSIS OF INFLAMMATORY LUNG DISEASE

Andrew Hope, Sonja Kandel, Chris McIntosh

University Health Network, Toronto, ON

Purpose: Patients with inflammatory lung disease have increased risk of toxicity related to cancer treatment including radiation therapy. Methods to automatically screen computed tomography (CT) studies used for radiation treatment planning for ILD risk could potentially improve the therapeutic ratio by excluding patients at high risk of treatment toxicity.

Methods: Lung cancer patients with/without ILD were included. Diagnostic radiology identified known ILD patients as having imaging features consistent with ILD including ground glass opacity/reticulation, non-dependent GGO, non-dependent reticular abnormality, honeycombing, traction bronchiectasis, non-emphysematous cysts, architectural distortion and/or subpleural fibrosis. A convolutional neural network was trained using available datasets identified by classified by ILD (yes/no) using a 3D denseNet architecture.

Results: With a preliminary dataset of 50 patients with ILD and 50 without ILD (normal), a model was trained in 5 hours on a single-GPU nVidia v100. Using 10 fold cross-validation, the model had an area under the curve of 0.72 on the receiver operating characteristic (ROC) curve. Setting the threshold to identify patients with more than a 80% risk of ILD the system had a false positive rate of 40%. With a false positive rate of 10%, 45% of ILD cases would be detected.

Conclusion: A preliminary neural network has been trained and can discriminate between patients with/without ILD. Extended validation is underway to test this model in both larger cohorts of retrospective patients and prospectively in routine clinical imaging.

Abstract #6

DELINEATION OF THE MOLECULAR HETEROGENEITY UNDERLYING PATIENT OUTCOMES IN FOLLICULAR LYMPHOMA

Anjali Silva, Mehran Bakhtiari, Lourdes Calvente, Rosemarie Tremblay-LeMay, Robert Kridel

Princess Margaret Cancer Centre, Toronto, ON

Purpose: Follicular lymphoma (FL) is a common cancer that exhibits molecular heterogeneity along with highly variable disease outcomes. To date, the biological underpinnings of the heterogeneity remains poorly understood. We hypothesize that FL is not just one disease, but that it can be classified into biologically distinct subgroups.

Methods: The aim of our project is to dissect the molecular heterogeneity in FL with the goal of identifying robust molecular subtypes. To understand the basis of the heterogeneity, the multi-omics landscapes of primary FL patient samples were explored. To this effect, we created a global network of collaboration, accruing samples from North America, Europe and Australia. Herein, the first results from a pilot study including biospecimens from Princess Margaret Cancer Centre are presented. Unsupervised clustering approaches, e.g., RPMM and HTSCluster, were used to identify patient clusters. In addition to singular clustering, integrative clustering was applied to combined multi-omics data. The stability of clusters was evaluated using resampling-based consensus clustering. Significance was evaluated by associating clusters with pathological annotation and survival outcomes.

Results: Based on a first set of 171 FL patients, clustering of transcriptome data identified a model with distinct clusters that permitted to segregate clinical class, i.e., limited-stage FL patients from advanced-stage patients in an unsupervised fashion. For 30 of these patients, who had DNA methylation data available, integrative clustering of methylome and transcriptome data identified two distinct clusters. Using Fisher's exact test, it was found that clinical class of patients, CREBBP mutation status, and progression free survival were each significantly associated with the clusters.

Conclusion: This ongoing project continues to accrue patient samples from international collaborators, including clinical trial and population-based cohorts. Our ambition is to re-define the taxonomy of FL by granular analysis of the underlying molecular heterogeneity.

Abstract #7

CREATION AND VALIDATION OF THE QIPCM IMAGING AI DEVELOPMENT AND COLLABORATION ENVIRONMENT

Brandon Driscoll, Tirth Patel, Tony Tadic, Shailaja Sajja, Duoaud Shah, Tina Shek, Luke Brzozowski, Ivan Yeung, Julia Publicover

University Health Network, Toronto, ON

Purpose: The evolution of deep learning (DL) algorithms combined with increasing computing power have driven the development of artificial intelligence (AI) in radiology. By applying DL to large-volume clinical imaging datasets there is an opportunity for identification of imaging biomarkers that can identify disease sooner or predict response more accurately leading to improved decision support. Quantitative Imaging for Personalized Cancer Medicine (QIPCM) has recently developed an AI development and collaboration environment in which academic researchers or industry partners interested in pursuing AI-related research can develop and validate their tools and algorithms while adhering to privacy and security regulations within QIPCMs robust regulatory framework.

Methods: QIPCM provides a central repository for imaging data and analysis tools to support multi-centre clinical trials. This platform has been adapted to provide a supportive framework for the development, testing and validation of deep learning algorithms. Large-volume datasets can be ingested into the QIPCM platform along with accompanying information such as labels and contours using the recently adopted MIRA radiation oncology processing pipeline tool developed at Princess Margaret Hospital.

Results: The QIPCM platform currently serves 34 active clinical trials spanning 32 sites globally with over 17,000 studies in the archive. The addition of MIRA to the QIPCM infrastructure has provided the ability to rapidly collate data from multiple clinical systems and process them with radiomic feature extraction tools and send the resulting feature sets to the connected HPC4Health cluster for DL analysis. This collaboration environment has been used to successfully collate data and extract radiomic features for three trials to date spanning over 200 patients.

Conclusion: The QICPM AI Development and Collaboration Environment has shown early success and should continue to grow. Future steps are to add the elements of the system to QIPCMs regulatory structure and validate it with larger volume data sets to make it more efficient for our collaborators.

ABSTRACTS

Abstract #8

RADIATION ONCOLOGY IS AN IDEAL SITUATION TO UTILIZE, DEVELOP, TEST, AND IMPLEMENT AI/ML

C Norman Coleman[1], Jeffrey Buchsbaum[2]

[1]International Cancer Expert Corps, Washington, DC
[2]National Cancer Institute, Bethesda, MD

Purpose: The rapidly emerging application of Artificial Intelligence/Machine Learning is touching all aspects of medicine. What is particularly critical is high-quality data upon which to train the AI. For cancer care and for healthcare decision-making in general, cancer is both highly complex and data-rich, often with timelines for decision-making requiring AI. Radiation oncology is well suited as a field and laboratory to developed, test and utilize AI and ML.

Methods: We have assembled examples of the unique benefits of radiation oncology to the development of AI for practice and research.

Results: Radiation therapy is already involved: • Treat complete spectrum of cancers; anatomically oriented (surgery), systemic disease (medical oncology and immuno-oncology). Treat defined volumes of tumor and normal tissues. • Able to physically target and accurately measure radiation dose with a variety of types of radiation sources (X-rays (Linacs), particle beams (protons), systemically administered radionuclides). Dose serves as a ground truth. • Routine clinical care involves imaging- anatomic (where it is), biological (what is it), physical adaptation (with motion- gating; and with change during treatment (shrinkage) and biological adaptation (treatment-induced changes). A broad spectrum of imaging can be integrated as can biological interrogation of tumors and normal tissues • Healthcare & global health- technology-capable so can use in low-resource settings

Conclusion: "Big Picture" data for each patient includes the physical property of the radiation; initial and radiation-induced biology; anatomic and functional imaging; external influences including drugs, microbiome, diet and immune-therapy. The composite "Big Picture" for each patient can be serially analyzed to inform treatment for the Next Patient. Furthermore, considering radiation as both a physical entity (dose in gray, Gy) and biological perturbation requires complex analysis and offers highly innovative approaches to using radiation therapy "as a drug" as part of "focused biology".

Abstract #9

USING AI TO IMPROVE PRECISION MEDICINE: REAL-WORLD IMPACT OF BIOMARKER TESTING IN ADVANCED LUNG CANCER

Jennifer Law[1], Christopher Pettengell[2], Lisa Le[1], Ling Chen[2], Steven Aviv[2], Patricia DeMarco[3], Dave Merrit[3], Mike Sung[1], Natasha Leighl[1]

[1]Princess Margaret Cancer Centre, Toronto, ON
[2]Pentavere, Toronto, ON
[3]Hoffmann La-Roche Ltd. Canada, Mississauga, ON

Purpose: Advances in targeted therapy and immunotherapy for lung cancer improves patient outcomes but requires molecular testing of cancer samples. Successful biomarker testing depends on many factors; quality improvement initiatives require access to real-world data. Natural Language Processing (NLP) and Artificial Intelligence (AI) technology automate data abstraction from unstructured electronic health records (EHR), eliminating the need for resource-intensive manual chart review.

Methods: The DARWEN™ automated data abstraction platform (Pentavere, Toronto, Canada) was used to extract data from EHR of advanced lung cancer patients diagnosed and treated at Princess Margaret Cancer Centre (Toronto, Canada) between 01/2015 and 05/2018. Demographics, tumour characteristics including EGFR, ALK and PD-L1 status, treatment and survival data were extracted.

Results: Of 1210 advanced lung cancer patients, 615 had accessible electronic pathology records and were reviewed by DARWEN™. Of these, 246 had non-squamous NSCLC and received systemic therapy (analysis set). Complete biomarker testing was performed in 79% (by minimum standard at time of diagnosis). Never smokers (p=0.001) and patients with better performance status (p=0.014) were more likely to have biomarker testing. After initiation of routine PDL1 testing (09/2016), the rate of PD-L1 testing increased 28% to only 55% and remained high for EGFR and ALK (93% each). Successful testing resulted in more patients accessing targeted therapy (p<0.001) or immunotherapy (p=0.002) as initial treatment, and fewer patients receiving chemotherapy first-line (p<0.001). One-year survival rates were similar pre/post introduction of routine PDL1 testing, 70% (95% CI: 62-77%) and 76% (95% CI: 67-83%), respectively.

Conclusion: NLP and AI technologies like DARWEN™ give clinicians access to previously unavailable real-world data. Herein, we identified opportunities to improve molecular testing and patient outcomes in advanced lung cancer and personalized therapy. Novel technologies that facilitate collection of real-world data will improve patient access to precision medicine and better outcomes.

ABSTRACTS

Abstract #10

AN ANALYSIS OF STRUCTURAL VARIANT CALLERS

Denis Keimakh[1], Matthew Kowal[2], Benjamin Haibe-Kains[1]

[1]University of Toronto, Toronto, ON
[2]Ryerson University, Toronto, ON

Purpose: The use of next-generation sequencing techniques has enabled de-novo detection of predictive and prognostic cancer biomarkers. A key area of interest in biomarker discovery concerns fusion genes and their tumor driver or predictive effects on cancer. Currently, many tools exist that are able to detect structural variants indicative of gene fusions, yet many are plagued by a myriad of confounding factors, such as a high rate of false positives and inefficient CPU usage. Furthermore, many tools are benchmarked using simulated datasets, which have been shown to be poor indicators of real-world performance Herein, we conduct the first ever study comparing multiple fusion callers with real genomic data, to obtain reliable benchmarking data on each tool. Having a reliable benchmark of the most popular gene fusion tools will enable researchers to make more informed decisions when designing future studies, and will help reduce the overall rate of falsely reported fusions

Methods: For this study, cancer cell line data was used, spanning over 15 different tissue types. RNA-sequencing data was obtained from four different studies, for a total of 126 samples. Each cell line sequenced had some degree of overlap between the studies, for a total of 40 biological triplicates and 6 biological quadruplicates. Ten gene fusion tools were tested, and benchmarks for precision, accuracy, CPU usage and memory were determined.

Results: We rank our top tools and describe ideal use cases for each tool.

Conclusion: While certain tools were more accurate than others, the ideal algorithm used will depend on the research conducted. We found discrepancies with stated precision figures that authors of these structural variant callers stated, as real datasets behave very differently from simulated data. Overall, we recommend that the community shift to testing their algorithms with real data, as performance is more reliably measured in this way.

Abstract #12

DEEPCINET: A DEEP LEARNING APPROACH TO PREDICT NOISY PHENOTYPES

Farnoosh Khodakarami, Seyed Ali, Madani Tonekaboni, Pete Smirnov, Ian Smith, Wail Ba-Alawi, Benjamin Haibe-Kains

Princess Margaret Cancer Centre, University Health Network, University of Toronto, Vector Institute for Artificial Intelligence, Toronto, ON

Purpose: One of the key challenges in cancer precision medicine consists of of developing predictive models of drug response. Noisy phenotypes and genotypes negatively affect the predictive value of the current machine learning methods. Most supervised learning approaches have been designed to account for the noise present in the genotype data and little attention has been paid to the development of methods able to deal with the potentially high level of noise in the phenotypic data. Our purpose is to design a new objective function and a deep neural network architecture accounting for the noisy nature of the phenotype data during the supervised learning process.

Methods: We designed deepCINET, a deep neural network architecture inspired from siamese neural networks. DeepCINET learns from each pair of samples based on their genomic profiles and drug response orders. DeepCINET only learns from pairs of cell lines yielding differential drug response that is beyond the noise of the pharmacological (referred to as "valid" cell line pairs) as a way to account for the high level of noise in the phenotype.

Results: We trained and validate DeepCINET using two large independent pharmacogenomic datasets, namely CTRPv2 (Broad) and gCSI (Genentech), respectively, for 4 drugs (erlotinib, lapatinib, vorinostat, and doxorubicin). We found that DeepCINET benefited greatly by restricting learning to only the valid pairs of cell lines and outperformed traditional machine learning techniques and known biomarkers for all drugs (concordance index>0.8).

Conclusion: We showed that our new deep learning framework yield better predictors of drug response than current machine learning approaches in large preclinical pharmacogenomic datasets. Our novel approach to deal with noisy phenotypes can be generalized to other research fields in natural sciences and engineering.

Abstract #13

DEEP LEARNING RADIOMICS MODEL FOR HEAD AND NECK SURVIVAL PREDICTION

Farnoosh Khodakarami[1], Scott Bratman[1], Aleix Lascorz[1], Joan Marcè Igual[2], John Waldron[1], Shao Hui (Sophie) Huang[1], Tirth Patel[1], Nathan Becker[1], Tony Tadic[1], Benjamin Haibe-Kains[1]

1Princess Margaret Cancer Centre, Toronto, ON
2Universitat Politècnica de Catalunya Catalonia, ES

Purpose: High-dose radiotherapy with or without chemotherapy is standard of care for many locally advanced cancers, including cancers of head & neck. Most cancers are treated with a one-size-fits-all approach, which leads to over/under-treatment for some patients. Refined prognostic models are required to assist clinicians with delivering the appropriate level of care. Radiomics recently emerged as a promising approach to extract informative features from radiological images routinely acquired as standard- of-care. Advances in deep neural networks (DNNs) are further pushing the limits for prediction with unprecedented performance for cancer prognostication from radiological images. The purpose is to develop a Radiomic clinical model for survival prediction in Head and Neck Squamous Cell Carcinoma (HNSC) patients using a new DNN optimizing the concordance index (C-index).

Methods: This study was performed on a set of 533 HNSC patients (2005 to 2015 at Princess Margaret Cancer Centre) for whom clinical data and CT scans were available. We applied a neural network model (DeepCINET) based on Siamese neural networks and deep transfer learning pipelines to build a multivariate prognostic model predictive of overall survival.

Results: DeepCINET achieved a median C-index of 0.696 with statistically significant increase of 1.5% compared to the Cox model including clinical parameters and tumor volume yielding a C-index of 0.63 (superiority test, Wilcoxon signed rank test p=0.025.

Conclusion: DNNs trained from radiological images will enable the development of prognostic models outperforming current clinical tools.

Abstract #14

OMICS COMPLEMENTARY ROLE FOR BIOMARKER DISCOVERY IN CANCER

Hassan Mahmoud, Benjamin Haibe-Kains

Princess Margaret Cancer Centre, Toronto, ON

Purpose: Biomarker discovery is challenging due to the massive amount of data generated, their heterogeneity, limitations, complementary biological and functional role. Most of the clinically approved biomarkers rely on genomics, however proteomics enables analyzing changes in the modifications of many proteins expressed by a cell like protein localization and compartmentalization and the regulatory mechanisms. Proteomics is not properly leveraged in pharmacogenomics because their coverage and quality remain limited. Our purpose is to conduct a comparative analysis to evaluate the efficacy of combining different drug sensitivity analysis models for targeted and chemotherapies in multiple cancer types by integrating omics features from large-scale preclinical pharmacogenomic data.

Methods: We built ensemble models for sensitivity analysis using PharmacoGx package and elastic nets with 10 fold cross validation for drug sensitivity prediction. The proposed models integrate several proteomics (RPPA) signatures available from CCLE together with the master regulators (namely, transcription factors) inferred using Virtual Inference of Protein activity by Enriched Regulon analysis (VIPER) and used robust concordance index (rCI) we developed for drug sensitivity analysis.

Results: We tested our models using known biomarkers in the pharmacogenomics literature. Combining omics boosted the robustness of sensitivity prediction for several drugs. For example, ERBB2 biomarker for lapatinib showed the best rCI= 0.95 by combining CNV, and VIPER models while rCI equals 0.77, and 0.9 for each of them respectively. Moreover, MET biomarker for Crizotinib showed best rCI=0.89 by integrating RNASeq, Mutation, RPPA, and VIPER together while each model obtained rCI= (0.45, 0.5, 0.85, 0.5) respectively.

Conclusion: Multi-Omics pharmacogenomic analysis holds the potential to improve precision medicine by extending our portfolio of drug response biomarkers.

Abstract #15

GLOBAL IMPLICATIONS AND CHALLENGES ASSOCIATED WITH BIG DATA EXPLOSION IN HEALTHCARE: IS BLOCKCHAIN THE ANSWER?

Hina Saeed

Medical College of Wisconsin, Milwaukee, WI

Purpose: Global healthcare big data is projected to grow at an unprecedented rate to $68 billion by 2025.This sensitive data needs to be collected securely, shared, analyzed and adequately managed.

Healthcare received a low DATCON (DATa readiness CONdition) score of 2.4 (below average in data competency metrics). Going forward, the healthcare industry needs to take a global approach to improve its data management, provenance and security.

Methods: Blockchain, could offer a unique opportunity for healthcare to transform digitally. In blockchain, blocks of data are linked together by a cryptographic hash to form a 'chain' that contains the complete history of the transaction and any tampering requires all nodes to be changed. This immutable, shared digitally-distributed ledger system will allow stakeholders anywhere to access a single source of timestamped records.

Results: With its holacratic approach, Blockchain empowers patients to fully manage their data including who has access to it. It can underpin a patient's medical record, which will accelerate predictive care and prescription management while maintaining the privacy and integrity of personal patient data. Through behavioral economics using cryptocurrency and non-monetary (reputation) incentives, Blockchain can help to incentivize people to participate in biomedical research and clinical trials by contributing their anonymized data.

Conclusion: The combination of Blockchain with technologies such as cloud computing, artificial intelligence, eHealth/mHealth applications, and the Internet of Medical Things (IoMT) enables real-time data collection, transparent supply chain management, quality improvement by increasing efficiency in high volume centers, continuous evaluation of massive training datasets, advancing genomics and precision medicine, increased integrity of clinical research including automated consents, smart contracts for optimized payments, claims management, fighting counterfeit drugs, improving the pharma supply chain and regulatory compliance. Global Interoperability, governance and access in Blockchain can be further modified to fit a specific healthcare goal. Whether Blockchain reaches its revolutionary status remains to be tested?

Abstract #16

EXPLORING THE SIGNIFICANCE AND CHALLENGES OF IMPLEMENTING AI AND BIG DATA IN CLINICAL PRACTICE: HOW READY ARE WE?

Hina Saeed

Medical College of Wisconsin, Milwaukee, WI

Purpose: With Big Data being generated at a phenomenal rate, it is difficult for oncologists to process all the available information that could influence treatment decisions with traditional analytics. Clinical and financial success is going to become increasingly reliant on Big Data dependent predictive analytics, real-time clinical decision support, precision medicine, and proactive population health management and these are driven largely by groundbreaking research in AI especially deep learning (DL) that analyzes unstructured data and uses layered "artificial neural networks" to develop sophisticated models.

Methods: Currently, AI has shown potential in improving cancer imaging diagnostics and treatment response evaluation, facilitating radiogenomics, assisting in digital pathology, predicting clinical outcomes, and accelerating drug development and translational oncology. Natural language processing (NLP), a branch of AI, assists in analyzing, extracting and augmenting unstructured data sets such as health records and medical literature and transforming them to fill semantic data lakes with meaningful information accessible for computation and assistance in clinical decision making.

Results: Challenges such as lack of standardized used cases for validation, generalization and avoiding "overfitting", streamlined secure data sharing, interpretability or "black box" problem, and the need for increased collaboration between clinicians, researchers, data scientists, bioinformatics and industry, needs to be addressed as they limit translation of evolving AI tools into meaningful clinical applications. The future of NLP relies on algorithms that are accurate, intelligent, and healthcare-specific in order to eradicate the growing mindless hours spent navigating the medical data.

Conclusion: There has also been some resistance to adoption of AI due to perceived notion of AI replacing physicians. This has been disputed by data suggesting that AI rather augments human intelligence and serve to increase physician efficiency, engagement, and superior decision making. AI, with the power of big data, has the potential to allow oncologists to provide the highest level of cutting-edge, patient-centered care.

Abstract #17

CLINICAL EVALUATION OF THE WATSON FOR GENOMICS PLATFORM FOR CANCER VARIANT INTERPRETATION

Ian King, Afia Hasnain, Rong Zeng, Gregory Downs, Natalie Stickle, Tracy Stockley

University Health Network, Toronto, ON

Purpose: Genomic testing has rapidly become a routine part of clinical practice in oncology. Increasingly, the limitation on scaling the scope and availability of genetic testing is not the cost of the generation of sequence data but its interpretation. IBM Watson for Genomics is a commercially available platform that uses a machine learning-based system to generate an interpretation of variants detected in clinical tumor sequencing used to both guide therapy selection and to enable enrollment in clinical trials. The Watson platform takes filtered variant data (.vcf format) from clinical sequencing and generates variant description and interpretation, and also matches available therapies and clinical trials to inputted variants. Watson is the only predominantly AI-driven platform for variant interpretation on the market currently, and is unique in providing fully automated interpretation.

Methods: To evaluate the accuracy of variant interpretations generated by the Watson platform we developed a method for systematic comparison of data elements between automated interpretations and clinically reported interpretations. We evaluated the performance of the Watson platform on 1000 lung tumor cases and 1000 hematological cancer cases previously reported by UHN's clinical labs.

Results: While automated interpretations were highly concordant with reported clinical interpretations, discordant interpretations resulted largely from differing allele descriptions - assignment of RefSeq transcript and adherence to HGVS naming conventions impacted interpretation of 12% of all unique variants in the dataset. Additionally, AI-generated interpretations considered variants only in isolation, and did not incorporate known interactions between variants in a case.

Conclusion: Limitations of automated interpretation must be balanced against the considerable savings in time and effort that these platforms provide. The methods developed here establish a means of comparing automated interpretation tools directly to each other and to manually generated clinical data, and provide a foundation for benchmarking of these systems as they develop and improve.

Abstract #18

KING HUSSEIN CANCER CENTER IN JORDAN AS AN EXAMPLE OF A SUCCESSFUL STORY OF REGIONAL AND INTERNATIONAL COLLABORATION

Jamal Khader

King Hussein Cancer Center, Amman, JO

Purpose: The King Hussein Cancer Center (KHCC) in Amman, Jordan is a non-governmental not-for-profit comprehensive cancer center. It is a leading cancer center in the Middle East region providing adult and pediatric patients with state of the art comprehensive cancer care for all types of cancer.

Methods: KHCC, through regional and international collaboration reaches highest level of cancer care provider that matches best cancer centers in the West. The impact of such collaboration was obvious & resulted in achieving many international accreditations like the Joint Commission International (JCI) as a disease specific cancer center, making it the first and only center in the developing world to earn such a distinction. KHCC added another accomplishment to their journey of remarkable achievements by attaining the (MAGNET) Recognition Certificate (certificate of excellence) from the American Nurses Credentialing Center (ANCC). This accreditation provides an opportunity for the KHCC Nursing staff to advance their nursing career as well as prove their ability to provide high- quality patient care. Also, achieved Hazard analysis and critical control points (HACCP) Systems and Guidelines for its Application, College of American Pathologists Accreditation (CAP) and Health Care Accreditation Council of Jordan. Areas of collaboration included, collaborative agreements with highly reputed cancer centers like Princess Margret Hospital-Canada , Leeds Cancer Center- UK , Moffit Cancer Center-USA, St Jude Cancer Center-USA, The Hospital for Sick Children-Canada, Lombardi Cancer Center, USA, NCI-USA, NCI-Egypt, Augusta Victoria Hospital-Palestine & Sister-hip status with MD Anderson Cancer Center, USA. Collaborative activities included implementing of new high tech procedures & techniques, faculty exchange visits, clinical staff capacity building, consultations & cases presentation via teleconferences, hands-on training workshops &joint conferences

Results: Through such collaboration, KHCC becomes a leading cancer center in the Middle EAST & a regional hub, not only for cancer treatment, but also for cancer training & education.

Conclusion: Regional and international collaboration is very beneficial for better cancer care specially for developing countries.

Abstract #19

VARIABLES ALTERING THE IMPACT OF RESPIRATORY GATED CT SIMULATION ON PLANNING TARGET VOLUME IN RADIOTHERAPY FOR LUNG CANCER

Jamal Khader, Fawzi Abuhijla

King Hussein Cancer Center, Amman, JO

Purpose: Respiratory gated CT simulation (4D-simulation) has been evolved to estimate the internal body motion. This study aimed to evaluate the impact of tumor volume and location on the planning target volume (PTV) for primary lung tumor when 4D simulation is used.

Methods: Patients who underwent CT simulation for primary lung cancer radiotherapy between 2012 and 2016 using a 3D- (free breathing) and 4D- (respiratory gated) technique were reviewed. For each patient, gross tumor volume (GTV) contoured in a free breathing scan (3D-GTV), and 4D-simulation scans (4D-GTV). Margins added to account for the clinical target volume (CTV) and internal target motion (ITV) in 3D and 4D simulation scans. Additional margins added to account for planned target volume (PTV). Univariate and multivariate analyses performed to test the impact of the volume of the GTV and location of the tumor (relative to the bronchial tree and lung lobes) on PTV changes by more than 10% between the 3D and 4D scans.

Results: 10 patients were identified. 3D-PTV significantly larger than the 4D-PTV; median volumes were 182.79 Vs.158.21cc, p = 0.0068). On multivariate analysis, neither the volume of the GTV (p = 0.5027) nor the location of the tumor (peripheral, p = 0.5027 or lower location, p = 0.5802) had an impact on PTV differences between 3D-simulation and4D-simluation.

Conclusion: The use of 4D-simulation reduces the PTV for the primary tumor in lung cancer cases. Further studies with larger samples are required to confirm the benefit of 4D- simulation in decreasing PTV in lung cancer.

Abstract #20

ENHANCING VALUE OF QUALITY ASSURANCE ROUNDS IN IMPROVING RADIOTHERAPY MANAGEMENT: A RETROSPECTIVE ANALYSIS FROM KING HUSSEIN CANCER CENTER IN JORDAN

Jamal Khader, Fawzi Abuhijla

King Hussein Cancer Center, Amman, JO

Purpose: The quality assurance (QA) chart rounds are multidisciplinary meetings to review radiation therapy (RT) treatment plans. This study focus on describing the changes in RT management based on QA round reviews in a single institution.

Methods: After 9 full years of implementation, a retrospective review of all patients whose charts passed through departmental QA chart rounds from 2007 to 2015. The reviewed cases were presented for RT plan review; subcategorized based on decision in QA rounds into: approved, minor modifications or major modifications. Major modification defined as any substantial change which required patient re-simulation or re-planning prior to commencement of RT. Minor modification included treatment plan changes which didn't necessarily require RT re-planning.

Results: Overall 7,149 RT treatment plans for different anatomical sites were reviewed at QA rounds. From these treatment plans, 6,654 (93%) were approved, 144 (2%) required minor modifications, while 351 (5%) required major modifications. Major modification included changes in: selected RT dose (96/351, 27%), target volume definition (127/351, 36%), organs-at-risk contouring (10/351, 3%), dose volume objectives/constraints criteria (90/351, 26%), and intent of treatment (28/351, 8%). The RT plans which required major modification according to the tumor subtype were as follows: head and neck (104/904, 12%), thoracic (12/199, 6%), gastrointestinal (33/687,5%), skin (5/106, 5%), genitourinary (16/359, 4%), breast (104/2387, 4%), central nervous system (36/846, 4%), sarcoma (11/277, 4%), pediatric (7/251, 3%), lymphoma (10/423, 2%), gynecological tumors (2/359, 1%), and others (11/351, 3%).

Conclusion: Multi-disciplinary standardized QA chart rounds provide a comprehensive and an influential method on RT plans and/or treatment decisions.

Abstract #21

PREDICTING TREATMENT PLANNING EVALUATION PARAMETER IN RADIOTHERAPY QA USING MACHINE LEARNING

Frederick Ng[1], James Chow[2], Runging Jiang[3]

[1]Ryerson University, Toronto, ON
[2]Princess Margaret Cancer Centre, Toronto, ON
[3]Grand River Regional Cancer Centre, Kitchener, ON

Purpose: In this study, we predicted the dose distribution index (DDI) using artificial intelligence/machine learning and found out the optimal corresponding learning algorithm. Evaluation parameters in treatment planning are used to justify the plan merit in radiotherapy QA. These parameters are based on medical physics and radiobiological formulas using dose-volume histograms (DVH) reflecting the dose distributions of the target and organs-at-risk.

Methods: DDIs of fifty prostate volumetric modulated arc therapy plans were calculated and compared to results predicted by machine learning. Different machine learning algorithms, namely, linear regression, tree regression (Fine, Medium and Coarse), support vector machine (SVM) (Linear, Quadratic and Cubic) and Gaussian process regression (GPR) (Square Experimental, Matern 5/2, Rational Quadratic and Exponential) were used to predict the DDI based on the DVH in the plans. The learning, training and validation curve, root mean square error (RMSE), prediction speed and training time were determined for all algorithms in the performance evaluation.

Results: From the machine learning results and parameters, it is found that the Square Exponential GPR algorithm had the smallest RMSE (0.0038), relatively high prediction speed (4100 observation/s) and short training time (0.18s). Moreover, all the linear regression, SVM and GPR algorithms performed well with RMSE in the range of 0.0038 - 0.0193. For the GPR algorithms, the training and validation learning curves were initially very close together. At around 20 examples, the validation learning curve stopped following the training curve, causing a gap between the training and learning curve. This indicated that additional examples stop helping the model generalize to unseen data that additional data for GPR is likely not going to improve the model accuracy.

Conclusion: It is concluded that machine learning can be used to predict the DDI accurately, and the selection of a suitable machine learning algorithm is important for an effective prediction.

Abstract #22

A CHATBOT WITH CHARACTERIZATION ON RADIOTHERAPY USING ARTIFICIAL INTELLIGENCE AND MACHINE LEARNING

James Chow[1], Kay Li[2]

[1]Princess Margaret Cancer Centre, Toronto, ON
[2]York University, Toronto, ON

Purpose: To disseminate general radiotherapy information to the patient, radiation staff and general public, we suggested developing a chatbot with characterization for the cancer centre/hospital, community centres and schools. The Bot will be a bot character that can be personalized as per the user's temperament using artificial intelligence and machine learning on the IBM Cloud. Through multiple sets of dialogues with the Bot, the users will be provided with knowledge specially personalized for them.

Methods: The Bot will be created using the IBM Watson Assistant functionalities on the IBM Cloud to personalize its character using natural language understanding, entities, slots so that the bot can find out what the end user wants to know through questions and answers with the users, and provide information that will reflect the users' concerns. Machine learning will be enable the Bot to be trained through the users' questions to improve accuracy, so that it can predict the background and general information of the user, and find out the best way to communicate with him/her.

Results: Knowledge exchange and dissemination of information on radiotherapy are expected using the Bot. Cancer patient can acquire information about the processes of radiotherapy and possible side effects and patient care. Radiation staff in the cancer centre or hospital can have information regarding dose delivery policies, radiation treatment protocol and radiation safety. General public can learn from information on basic cancer statistics, cancer preventive measures and various screening programs offered by Canada.

Conclusion: It is concluded that a chatbot with characterization can help to transfer knowledge on radiotherapy to the patient, radiation staff and general public effectively using the machine learning technology. The Bot can provide general educational information regarding radiotherapy to the user. It can also answer questions on radiotherapy and interact with patient using artificial intelligence.

Abstract #23

PLAIN LANGUAGE AND PATIENT EDUCATION IN SYSTEMIC THERAPY: A FORMATIVE EVALUATION

Janet Papadakos[1], Eleni Giannopoulos[1], Pryanka Jain[2], Sarah McBain[2], Maisha Fahmida Na[1], Colleen Fox[2]

[1]Princess Margaret Cancer Centre, Toronto, ON
[2]Cancer Care Ontario, Toronto, ON

Purpose: Cancer patients are best able to cope with their cancer when supported with patient education (PE). However, PE resources are only helpful if they adhere to plain language best practices. The purpose of the study was to evaluate systemic-therapy patient education resources utilized across Ontario and determine whether they adhere to plain language best practices.

Methods: Patient education leaders at cancer centres across Ontario were asked to share the full collection of systemic therapy PE resources used at their cancer centres. Collected resources were included in the assessment if they were: written in English, pamphlets, and relevant to systemic therapy. A random sample of included resources was assessed for readability using validated readability calculators with grade 6 being the recommended grade level. The resources were evaluated for Actionability and Understandability using the Patient Education Materials Assessment Tool (PEMAT), which computes scores in each category out of a possible 100%, with 80% being an acceptable score.

Results: A total of 683 resources were collected and after duplicates were removed and inclusion criteria applied, 366 resources remained. A random sample was derived from the 366 and 38 resources were evaluated. Ninety-five percent (n=36) of systemic therapy-specific patient education resources had readability scores above the recommended plain language grade 6 level with the average grade level at grade 8.2 (SD=1.3). The mean PEMAT scores were below 80% with the mean Actionability score at 67% (SD=19.86) and the mean Understandability score at 76% (SD=17.51%).

Conclusion: The prevalence of PE resources that did not meet plain language best practices may have significant meaning and impact to cancer care. PE resources that do not adhere to plain language best practices may leave patients more vulnerable to their disease and may contribute to the high rates of distress.

Abstract #24

HEALTH LITERACY ASSESSMENT OF CANCER-RELATED WHITEBOARD ANIMATION VIDEOS FOR PATIENTS

Naa Kwarley Quartey, William Boateng, Kalsoom Shahzad, Meredith Giuliani, Janet Papadakos

Princess Margaret Cancer Centre, Toronto, ON

Purpose: The purpose of this assessment is to determine if publicly available cancer-related patient whiteboard animation videos published on popular search engine websites adhere to health literacy best practices.

Methods: Whiteboard animation videos, images drawn on screen by hand with accompanying voiceover, were retrieved from the two most popular search engines, Google and YouTube, by two independent reviewers. A search was carried out using Medical Subject Heading (MeSH) keywords for neoplasm/carcinoma. Twelve searches were conducted in accordance with the search strategy to retrieve videos which met the inclusion assessment criteria. The first 30 cancer-related, English, whiteboard animation videos for patients were retrieved from each search engine. Whiteboard animation videos were evaluated using the Patient Education Materials Assessment Tools for Audiovisual materials (PEMAT-A/V) to assess understandability and actionability of videos. Videos with a score of 80% or greater for Understandability and Actionability is acceptable in PEMAT-A/V.

Results: 720 videos were retrieved and filtered based on the determined inclusion criteria. Upon application of the inclusion criteria, 16 videos were included for analysis and were assessed using the PEMAT-A/V. PEMAT-A/V scores for understandability ranged from 42%-83% while actionability ranged from 0-100%. Only one video met the acceptable score for understandability; 3 videos met the acceptable score for actionability. The majority of cancer-related whiteboard animation videos were below the acceptable level for understandability and actionability.

Conclusion: While whiteboard animations may be a creative method for disseminating knowledge to patients, the majority of whiteboard animations assessed do not meet the minimum acceptable score of 80% for understandability and actionability. This demonstrates that majority of the publicly available whiteboard animations do not adhere to best practices in cancer health literacy.

Abstract #25

FROM RESEARCH TO RESOURCE: CREATING PATIENT EDUCATION MATERIALS TOWARD CLINICAL TRIALS RECRUITMENT AND RETENTION

Karen Lawrie, Stephanie L'heureux, Meredith Giuliani, Natasha Icliates, Adam Latuns, Amit Oza, Janet Papadakos

Princess Margaret Cancer Centre, Toronto, ON

Purpose: Standard research consent forms are reported to be too complex for patients to fully understand, resulting in poor recruitment and retention. The aim of this project was to develop supplementary educational resources to promote patient engagement and participation in the clinical trials. It was imperative that the supplementary resources did not compromise important details while allowing patients to be better informed.

Methods: Using the clinical trials consent forms and protocols, a suite of patient education resources was created following best practices. Best practices included defining the purpose and audience, using plain language and applying clear design. The clinical trial material was analyzed by two plain language specialists to determine the most salient information patients would need. Throughout the process, subject matter experts were frequently consulted to ensure accuracy and relevancy.

Results: A consent form for a study on biomarkers in ovarian cancer, and its companion patient pamphlet were evaluated for understandability, actionability, and reading level using the PEMAT, and two readability calculators. The patient pamphlet was eight grade levels lower than the consent form which scored in the college/university level. The pamphlet also had an 87% score of understandability, and an actionability score of 100%. The pamphlet was stringently reviewed by the REB to ensure the material was both non-coercive and factual. The patient pamphlet captured the complexity of the trial, while providing easy-to-understand information to aid patients in making informed decisions.

Conclusion: This project demonstrates the there is a significant difference between study documents that have not been written in plain language and those that have been. This project also demonstrates that it is possible to create supplementary information for patients without compromising the complexity of trial information while greatly increasing patient understanding.

Abstract #26

EXPLORING THE ROLE OF FAMILY CAREGIVERS AS INFORMAL HEALTH HUMAN RESOURCES IN CANCER CARE: A SCOPING REVIEW

Janet Papadakos, Diana Samoil, Ben Umakanthan, Rebecca Charow, Meredith Giuliani

Princess Margaret Cancer Centre, Toronto, ON

Purpose: Research suggests that the cancer system is experiencing an increasing prevalence of persons living with cancer, an oncology workforce shortage, and a resource-stretched health system. Due to advancements in prevention, diagnosis and treatment, cancer incidence and mortality rates are declining; shifting cancer from a death sentence to a disease of chronicity requiring ongoing maintenance. Patients' unpaid, informal family caregivers are thus required to take on expanded care roles, subjecting them to burnout and distress. Despite the high prevalence of cancer caregiving in Canada, no comprehensive skills training programs are currently available to meet the needs of this population. The objective of this review is to explore and summarize what is known about training programs for unpaid, family caregivers of cancer patients in the literature.

Methods: A systematic search was conducted in ten databases. The following terms were used: "caregiver", "carer", "support", "training", and "online". Duplicate screening was conducted. Full text files were obtained for articles deemed eligible using predetermined criteria.

Results: The literature review revealed that interventions are primarily focused on in-person psychoeducational training sessions for caregivers of patients undergoing treatment. Only a proportion of studies explored remote training interventions through telephone or website modalities. Few studies explored caregiver training when addressing the practical, social and spiritual needs of cancer patients.

Conclusion: Current training programs do not adequately account for the myriad skills required of caregivers. The results indicate an urgent need to create remotely accessible training programs and to tailor educational material beyond the psychological aspects of cancer care.

Abstract #27

COMPARATIVE COST-BENEFIT ANALYSIS OF 2D VS. 3D RADIOTHERAPY USING QUALITY ADJUSTED LIFE YEARS

Jim Leng[1], Joshua Vertolli[2], Santiago Peralta[3], Damilola Oladeru[4], Adam Shulman[5], Benjamin Li[6]

[1]University of Chicago Pritzker School of Medicine, USA
[2]Vanderbilt University's Owen Graduate School of Management, USA
[3]Vanderbilt Peabody Graduate School of Education, USA
[4]Harvard Medical School, USA
[5]Radiating Hope, USA
[6]University of California San Francisco, USA

Background: 3D conformal radiotherapy (3D-CRT) and intensity modulated radiotherapy (IMRT) are standard treatments in developed countries for improvements to survival and toxicity profiles compared to 2D planning. The economics of transition to 3D radiotherapy in in lower-middle income countries (LMICs) remain unclear, and no tools exist for center-specific implementation, forecast, and operational optimization.

Methods: We determined the relative toxicity and survival outcomes for radiotherapy with IMRT and 3D-CRT vs. 2D treatment. A literature review of each modality was performed for individual disease sites to compile probability estimations of long-term toxicities graded 1-5. Overall survival at 5 and 10 years were estimated using historical outcomes for each modality. Primary cost estimates were based on locally reported costs by hospital administrators at representative public and private cancer centers in Latin American, African, Middle Eastern, and Southeast Asian regions. A secondary cost estimation was derived using time-based activity costing based on existing models, normalized for each country using purchasing power parity.

Results: A model was developed to forecast the relative benefit of IMRT and 3D-CRT vs. 2D treatments in quality-adjusted life years. Based on a cancer center's patient demographics, operational capacity, and center-specific treatment costs, the model calculates the optimal distribution of 2D, 3D-CRT, and IMRT treatment. It was tested at one cancer center in each representative global region to illustrate its application and quantify estimations of real-world economic benefits. Sensitivity analyses to quantify the economic value of operation-enhancing interventions were conducted. Investigations are ongoing to further quantify downstream healthcare costs of radiation-induced treatment toxicities and optimize resource utilization for country-specific economic development at the level of individual centers.

Conclusion: Implementation of 3D-CRT and IMRT in LMICs offers significant downstream economic benefits by increasing survival and reducing disabling toxicities. Training in these modalities and streamlined workflows can help centers achieve individually optimized operations.

Abstract #28

COMPREHENSIVE DETECTION OF CTDNA IN LOCALIZED HEAD AND NECK CANCER BY GENOME- AND METHYLOME-BASED ANALYSIS

Justin Burgener, Jinfeng Zou, Roxana Shen, Daniel DeCarvalho, Scott Bratman

Princess Margaret Cancer Centre, Toronto, ON

Purpose: Head and neck squamous cell carcinoma (HNSCC) comprise 3% of all cancer cases worldwide. Despite intensive multi-modal therapies, HNSCC patient outcomes remain heterogeneous with minimal improvements in survival. Utilization of fluid-based biomarkers for prognostication, risk stratification, and disease surveillance may improve patient outcomes by enabling more effective treatment decisions. However, to date no such biomarkers have demonstrated significant clinical utility for HNSCC due to limited sensitivity of detection. Here, we describe the performance of hybrid-capture sequencing and genome-wide methylome analysis for highly sensitive detection of ctDNA in HNSCC plasma.

Methods: To detect HNSCC-specific mutations and aberrant methylation in plasma cell-free DNA (cfDNA), we conducted CAPP-Seq (CAncer Personalized Profiling by deep Sequencing) and cfMeDIP-seq (cell-free Methylated DNA ImmunoPrecipitation sequencing), respectively. For CAPP-Seq, we developed a HNSCC-specific hybrid capture panel and applied it to cfDNA and peripheral blood leukocyte (PBL) genomic DNA from a cohort of HNSCC patients (n=27) and healthy controls (n=19).

Results: SNVs were detected by CAPP-Seq in plasma of 19/29 HNSCC patients. Mean mutant allele frequency ranged from 0.05 - 5%. Using cfMeDIP-seq, 389 hypermethylated differentially methylated regions (hyper-DMRs) in HNSCC plasma were identified from patients with ctDNA detected by CAPP-Seq. These hyper-DMRs classified HNSCC cases in an additional four patients with undetectable ctDNA and showed significant overlap with HNSCC-specific methylated regions in TCGA. When applied to all 35 HNSCC patients, hyper-DMR abundance was positively correlated with mutation-based ctDNA abundance. The median DNA fragment size within these hyperDMRs was lower in HNSCC patients compared to healthy controls, a characteristic of ctDNA described in previous studies, and correlated with both hyperDMR-based and mutation-based ctDNA abundance.

Conclusion: We have conducted the first comparative analysis of genetic and epigenetic profiling approaches for ctDNA detection in HNSCC. Both CAPP-Seq and cfMeDIP-seq have the potential to detect ctDNA in patient plasma without prior knowledge of patient-specific tumor aberrations.

Abstract #29

DEVELOPING A MACHINE-LEARNING BASED AUTOMATED PLANNING METHOD FOR PARTIAL BREAST RADIOTHERAPY

Kesavi Kanagasabai

Princess Margaret Cancer Centre, Toronto, ON

Purpose: For women with low-risk breast cancer, partial breast irradiation (PBI), localized radiation post-lumpectomy, provides equivalent tumour control as whole breast radiotherapy (WBRT) with lower radiation dose to organs-at-risk. At Princess Margaret Cancer Centre, PBI cases are treated with intensity modulated radiotherapy (IMRT), four static beams converging at the planning target volume (PTV). However, planning PBI using IMRT is a lengthy process. Planners go through a repetitive cycle between choosing beam angles, specifying dose-volume objectives and executing IMRT optimization. Volumetric modulated arc therapy (VMAT) is another technique with dynamic beams and multi-leaf collimators conforming to the precise three-dimensional shape of the PTV. The purpose is to optimize PBI treatment plans using VMAT for low-risk breast cancer patients and develop an automated planning method using advanced machine-learning systems that could be implemented for PBI as standard of care.

Methods: Thirty left and right-sided (n=60) clinical PBI plans were re-planned and optimized using VMAT. Clinical goals for the PBI cases were adopted from dose constraints from PBI clinical trials: Randomized Trial of Accelerated Partial Breast Irradiation (RAPID), Radiation Therapy Oncology Group (RTOG 0413), and Italian Trial. VMAT plan dose distributions were reviewed by radiation oncologist and medical physicists. Approved plans will be used as a training cohort for a machine learning system for the automated PBI planning.

Results: The analysis compared the dosimetric data of sixty approved IMRT plans to the VMAT plans. The dose distributions of VMAT plans displayed greater PTV coverage, organ-at-risk sparing, increased conformity and hence, were superior to IMRT plans.

Conclusion: VMAT plans were superior to IMRT plans. Using this study, an automated routine practice for planning PBI at Princess Margaret can produce an efficient framework that utilizes machine learning to automatically select treatment plans may be helpful for reducing the overall planning workload.

Abstract #31

FACTORS ASSOCIATED WITH TREATMENT TYPE FOR PROSTATE CANCER PATIENTS IN THE 45 AND UP STUDY, NEW SOUTH WALES, AUSTRALIA

Mei Ling Yap[1], Dianne L O'Connell[2], David Goldsbury[2], Marianne Weber[2], David P Smith[2], Michael Barton[1]

[1]Collaboration for Cancer Outcomes, Research and Evaluation (CCORE), Ingham Institute for Applied Medical Research, UNSW, Liverpool, NSW, Australia
[2]Cancer Research Division, Cancer Council NSW, Kings Cross, NSW, Australia

Purpose: We aimed to ascertain factors associated with type of active treatment received by prostate cancer patients, using a large-scale record linkage study.

Methods: There were 267,153 individuals aged ≥45 years in the Sax Institute's 45 and Up Study, a population-based cohort study in New South Wales (NSW), Australia. Participants completed a baseline questionnaire during 2006-2009, which included items on socio-demographic and health factors that was linked to administrative health datasets by the Centre for Health Record Linkage. Incident prostate cancer cases were identified from the NSW Cancer Registry to December 2013. Receipt of radical prostatectomy (RP) and external beam radiotherapy (EBRT) were identified in the NSW Admitted Patient Data Collection (to June 2016) and/or the Medicare Benefits Schedule (to June 2016, provided by the Department of Human Services). Competing risks regression was used to examine variation in treatment received by sociodemographic and health characteristics.

Results: 4022 men had a new diagnosis of prostate cancer (median age 68, median follow-up 5.4 years). The first treatments received were RP (40%, n=1619) and EBRT (22%, n=896). Of RP patients, 205(13%) had a radiation oncology consultation recorded prior to surgery. From multivariable analysis, RP was associated with younger age ($p<0.001$), regional stage ($p<0.001$), being partnered ($p<0.001$), living >=100km from a radiotherapy centre ($p<0.001$), having a lower BMI ($p=0.019$), better performance status ($p=0.007$), living in a less disadvantaged area ($p=0.033$) and having private health insurance ($p<0.001$). EBRT receipt was associated with older age ($p<0.001$), higher stage ($p<0.001$), living <100km from a radiotherapy centre ($p<0.001$), fewer co-morbidities ($p=0.002$), not working full time ($p=0.019$) and not having private health insurance ($p<0.001$).

Conclusion: Prostate cancer patients were twice more likely to receive RP than EBRT. Despite the evidence, few RP patients saw a radiation oncologist prior to surgery. Type of treatment varied by health and sociodemographic factors.

Abstract #32

DIGITAL SCREENS: GUIDELINES FOR MANAGING CONTENT WITH A PATIENT-FOCUSED LENS

Nicole Liscio, Tina Papadakos

Princess Margaret Cancer Centre, Toronto, ON

Purpose: The main floor is one of the first spaces where patients and families interact with a hospital and its services. Princess Margaret Cancer Centre's main floor is being redesigned to create an inviting space with improved flow. Plans include digital screens in lobbies, hallways, closed spaces, and waiting areas. The screens could help improve patient experience - or detract from it. A needs assessment was completed to develop screen guidelines to support patient care.

Methods: The Digital Screens Steering Committee was established to investigate the needs of visitors on the main floor and to establish governance for the screens to promote a positive experience for patients and families. A multi-pronged needs assessment was conducted to: 1. Understand needs and knowledge gaps of patients and families 2. Develop guidelines for screen content curation and governance 3. Establish a long-term screen content management strategy, including plans for content curation and maintenance The Needs Assessment included: • Environmental scan, to understand the current landscape of screen content. Locations were from different industries including healthcare, government, and public learning spaces. • Key informant interviews, to gain insight into what staff feel are gaps in patient and family knowledge. Thematic analysis was done based on 6 Domains of Need (adapted from Supportive Care Framework in Cancer Care (Fitch, 2008)). • Patient and family survey, distributed in person and online.

Results: Key takeaways: importance of accessibility functions on screens, tailoring content to specific audiences, and role of screen placement in content display. Screen content governance guidelines have been developed. Guidelines encompass standards in visual design, accessibility, usability, and health literacy.

Conclusion: As Cancer Centres refresh their appearance, it is critically important that the needs of patients and families supersede design decisions. Involving multi-generational people (staff and patients/family) in the planning processes for new and renovated spaces can contribute to a positive experience.

Abstract #33

APPLICATIONS OF DEEP LEARNING FOR AUTOMATIC CONTOURING OF TUMOURS IN THE BRAIN

Robert Henderson[1], Vijayananda Kundapur[1], Joshua Giambattista[1], Niranjan Venugopal[2], Jonathan Giambattista[3]

[1]University of Saskatchewan, Saskatoon, SK
[2]CancerCare Manitoba, Winnipeg, MB
[3]Limbus AI, Regina, SK

Purpose: To evaluate the role of Deep Learning in applications of automatic contouring of tumours in the brain both from a treatment planning and trainee perspective.

Methods: We applied a new Deep Learning algorithm to an MRI dataset of 28 glioblastoma multiforme cases to generate automatic contours of the tumours. Manual contours were then generated by a new trainee (a medical student) both without assistance from the automatic contours and then with guidance from the algorithm. We then compared, with Hausdorff distance and Dice scores, these sets of contours to those created by a practicing radiation oncologist, which were considered to be the gold standard.

Results: Comparing the trainee contours, without and with assistance, to the gold standard, both mean Hausdorff distance and Dice scores improved slightly (from 8.59mm and 0.90, respectively, to 8.31mm and 0.91) from use of the algorithm. The automatic contours themselves compared to the gold standard achieved a mean Hausdorff distance of 8.45mm and Dice score of 0.89.

Conclusion: The use of automatic contours yielded modest improvement in contouring performance by a trainee versus no assistance, and may thus serve as one method to assist new trainees in improving their contour performance.

Abstract #34

DELAYS IN INITIAL REFERRAL, DIAGNOSIS AND TREATMENT IN CHILDREN WITH CANCER

Abbasali Hosein Pourfeizi

Tabriz University of Medical Science, Tabriz, Iran

Purpose: Cancer has been one of the most critical health problems during the past decades which require serious consideration, especially in developing countries. Therefore, it is important to identify delayed and referral and diagnosis and treatment factors due to the high success of treatment in the early stages of onset of cancer.

Methods: 80 parents of the children with different types of cancers were studied via both questionnaire and person-to-person interview after announcing their informed consent.

Results: The highest delay in patients' initial referral was due to the following factors: lack of attention or ignoring the first symptoms, delay in referring to the physician, low economic status and even lack of family support for the patient. In addition, visiting several doctors after the initial diagnosis, uncertainty about the first proposed method, and high cost of treatment can be mentioned as the main causes of delays in the start of treatment.

Conclusion: Education plays an important role in identifying the signs of cancer. In addition, proper relationship and cooperation between the health system and physicians as well as provision of adequate information to patients could lead to the long-term cooperation of these patients in continuing their treatment.

Abstract #35

FOSTERING THE NEXT GENERATION OF DIVERSE ONCOLOGY LEADERS THROUGH THE SUMMER STUDENT CLINICIAN SCIENTIST PROGRAM

Sandra Clark, Tina Papadakos, Sarah Storer, Nazek Abdelmutti, Marnie Escaf, Meredith Giuliani

Princess Margaret Cancer Centre, Toronto, ON

Purpose: Research has shown that when students from diverse backgrounds become medical professionals, health equity and access to health care services increases. The Summer Student Clinician Scientist Program was created to help increase pursuit of oncology careers in underrepresented populations by providing barrier-free work placements. Short and long-term program evaluations were performed to determine program success.

Methods: Students from the Toronto District School Board were paired with clinician or scientist investigators from the Princess Margaret Cancer program at the University Health Network for an 8-week mentored placement. Students also participated in a weekly lecture series and presented a Ted-style talk and research poster. Program success was measured by student satisfaction through pre and post-program surveys, group interviews, and intent to pursue health or science-based post-secondary education. Long-term success was and continues to be measured through 1-year and ultimately 5-year follow-ups with past cohorts.

Results: Three cohorts of students (n=8, n=9, and n=10) have completed the program. As of summer 2019, students also earn co-operative education credits with the Toronto District School Board. 100% of students from all cohorts agreed the program was a valuable part of their education and career development, they felt better prepared to pursue post-secondary education in a health or science field, and would recommend the program to a colleague. 1-year follow up surveys from the first two cohorts (n=4 and n=6 respondents) showed 100% of students applied to post-secondary education in a health or science field.

Conclusion: The Summer Student Clinician Scientist Program has provided three cohorts of students with immersive oncology workplace experiences with 100% student satisfaction and achievement of program goals to date. Longitudinal evaluations will continue to track student and program success. Similar barrier-free programs to increase the pursuit of oncology careers in underrepresented populations can be successfully adapted to run in most healthcare institutions.

Abstract #36

EXPLORATION OF EPIGENETIC PROFILES IN CIRCULATING TUMOR DNA TO IDENTIFY PREDICTIVE CANCER BIOMARKERS

Steven DeMichino, Justin Burgener, Scott Bratman

University of Toronto, Toronto, ON

Purpose: Liquid biopsy has recently garnered interest due to technological advances that enable noninvasive molecular diagnosis and cancer monitoring. There is precedent for using predictive information from liquid biopsies to guide treatment decisions. For instance, EGFR mutations in non-small cell lung cancer (NSCLC) can be detected within ctDNA to guide use of tyrosine kinase inhibitors. Unlike mutations, epigenetic alterations in ctDNA have not yet been utilized as predictive biomarkers. Current technologies lack the sensitivity required to detect covalent histone modifications in circulating nucleosomes, so novel approaches are needed. We hypothesize that specific profiles of histone modifications in ctDNA may be unique to cancer patients and can be used to guide treatment decisions.

Methods: Two methods adapted in the Bratman Lab will be leveraged to simulate ctDNA/nucleosome release into media, and build cell-line specific cell-free epigenetic profiles for specific histone modifications using low input cell-free ChIP-Seq (cfChIP-Seq). Cell-free epigenetic profiles will be compared with publicly available epigenetic profiles in the ENCODE database for validation. cfChIP-Seq will be applied to cell lines treated with epigenetic modifying drugs (such as EZH2 inhibitors) with the goal of uncovering non-invasive pharmacodynamic biomarkers for drug activity. Lastly, we will use cfChIP-Seq to build epigenetic profiles from ctDNA obtained from cancer patient blood.

Results: Our methods have been piloted and optimized for our panel of cancer cell lines, and cell-free nucleosomes can be reliably produced in cancer cell line media.

Conclusion: Our cell culture-based assay opens avenues for obtaining epigenetic signatures of drug resistance or to validate the epigenetic mechanisms of various drugs. The future impact of detection of epigenetic profiles in ctDNA from cancer patient plasma could include the detection of early disease and monitoring of recurrence, as well as prediction of patient tumor drug response to aid in treatment decisions, contributing to the field of personalized cancer medicine.

Abstract #37

AN IMPLEMENTATION FRAMEWORK FOR AI IN HEALTHCARE

Tran Truong[1], Paige Gilbank[2], Kaleigh Johnson-Cover[2], Andrew Hope[1], Jennifer Jones[1],

[1]University Health Network, Toronto, ON
[2]University of Toronto, Toronto, ON

Purpose: Significant efforts are being made to develop artificial intelligence (AI) technologies for health settings. In a health system notoriously slow to adopt innovative technologies, it is important to consider implementation risks early. Due to the "black box" nature of AI and the high dependency on accurate patient data for training, there are unique challenges to successful implementation of AI in health care.

Methods: A qualitative research study was conducted to understand the critical factors to clinician buy-in. Specific aims of the study were 1) to understand the clinician's perception of AI in health care, 2) to explore the clinician's threshold of acceptance of AI in clinical decision-making, and 3) to explore the professional standards around usage of AI in clinical decision-making. Semi-structured interviews were conducted with 10 radiation oncologists at the Princess Margaret Cancer Centre and a conventional content analysis approach was used to analyze the data.

Results: Themes identified included Trust, Ethics, Buy-in and Personal conduct vs. Professional Standards. The theme of Trust included considerations around the robustness of data and technology, and the idea of transparency through explainability. The theme of Ethics included considerations around privacy, consent and secondary use of data. The theme of Buy-In focused on acceptance, readiness and sustainability. And the theme Personal Conduct vs. Professional Standards centered around the need for critical reasoning based on the whole picture, acceptability of risks and the legal responsibilities to act on predictions. A preliminary implementation framework for AI in health care was developed based on the study findings.

Conclusion: With the rapid emergence of AI technologies for health, organizations need to better understand the key considerations for their successful implementation. The implementation framework is preliminary work that can help healthcare organizations to integrate new AI technologies, facilitating timely adoption to improve patient care and outcomes.

Abstract #38

COMPARISON OF COMPUTATIONAL PATHOLOGY APPROACHES FOR THE QUANTITATION OF BONE MARROW PLASMA CELL PERCENTAGES

Fred Fu, Angela Guenther, Daniel Xia, Trevor McKee

University Health Network, Toronto, ON

Purpose: Accurate quantification of plasma cell percentages from bone marrow biopsies is critical for disease diagnosis, stratification, and assessment of treatment response. The combination of immunohistochemical staining, whole slide scanning, and computational image analysis represents an alternative to human-based estimation of plasma cell percentages, with the potential for greater precision. Here we evaluate deep learning approaches for cell detection against previously applied out-of-the-box solutions for scoring CD138-stained slides used in the diagnosis of multiple myeloma.

Methods: We used QuPath, an open-source software, to acquire pathologist annotations of CD138+ plasma cells and other CD138- hematopoietic cells from scanned images of bone marrow biopsies, to serve as the gold standard for supervised training. Labeled images were assessed by three general classes of image analysis methods: 1) A standard positive pixel analysis, 2) a cell segmentation methodology that first identifies cells with classical computer vison-based segmentation, followed by classification based on DAB intensity, and 3) a deep-learning based analysis, utilizing a convolutional neural network to directly detect CD138+ and CD138- cells within the images.

Results: Manual ("gold standard") annotations from pathologists on selected images allows for development of a deep learning approach to classify and accurately count these cells, improving over classical computer vision based algorithms. Classical algorithms' accuracy plateaus due to tradeoffs in over- and under-segmentation, while addition of training data serves to improve the accuracy of the deep learning algorithm. Initial development of the algorithm indicated that introduction of a balanced training set was useful in optimizing the accurate identification of cells in the resulting biopsy. Analysis of whole slide images is also compared against pathologist scoring.

Conclusion: Although our study is preliminary, the algorithm developed may eventually contribute to precision and standardization in hematopathology, potentially by acting as a digital "second opinion" tool for difficult cases that require precise rather than human-estimated percentages.

Abstract #39

DIFFICULT CONVERSATIONS IN CANCER

Tina Papadakos, Tylar Stringer, Janet Papadakos, Jennifer Croke, Anne Embleton, Caitlin Gillan, Kim Miller, Andrea Weiss, Kirsten Wendtlandt, Meredith Giuliani

Princess Margaret Cancer Centre, Toronto, ON

Purpose: Oncology healthcare providers (HCPs) face difficult conversations regularly throughout their careers. These conversations can have profound effects on both the HCP and the patient or caregiver receiving the bad news (Buckman & Kason, 1992; Hider & Hoepfer, 2018). Despite how common breaking bad news is and the amount of didactic training available (Alelwani & Ahmed, 2014), HCPs often report feeling unprepared (Gysels, Richardson, & Higginson, 2005) and feeling fear in anticipation of these conversations (Sykes, 1989).

Methods: The Cancer Education team conducted a needs assessment (n=64) for oncology HCP trainees at Princess Margaret Cancer Centre in Toronto, Canada. Based on the results, a course called Difficult Conversations in Cancer was developed using a flipped classroom format with eLearning and in-person simulations with standardized patient actors. The course includes training content on communication skills, adult learning principles, plain language, breaking bad news, disclosing incidents, and building provider resilience.

Results: Nine sessions of Difficult Conversations in Cancer have run since its inception in September 2017 with nearly 200 participants. Feedback was collected using detailed participant surveys for each of seven cohorts to iteratively improve the course content and layout. Learners were asked questions to evaluate their perceived competence and confidence in handling difficult conversations. After completing the course, participants' self-perceived competence significantly increased by an average of 25 points on a scale of 1-100 (95% CI: 18.5, 32.4, $P<0.0001$, n=40).

Conclusion: A blended training program for trainees on having difficult conversations increased their self-competence.

Acknowledgements: The authors would like to acknowledge Ahmad Al-Awamer, Michal Basch, Tracie Burke, Abel Cheng, Jaimie Coleman, Celina Dara, Daniela Fierini, Jordan Holmes, Elizabeth Hanna, Kerry Knickle, Sharon Konyen, Wilson Lam, Nicole Liscio, Luanne MacKenzie, Phyllis Mancini, Barbara-Ann Millar, Mohammad Salhia, Sarah Storer, Kieng Tan, and Kerri Weir for their contributions to the program.

Abstract #40

THE PROMISE AND POTENTIAL OF AI AND BIG DATA TO REVOLUTIONIZE CANCER DIAGNOSIS

Yasin Mamatjan, Kenneth Aldape, Gelareh Zadeh

Princess Margaret Cancer Centre, Toronto, ON

Purpose: With the advent of new digital technologies came big data acquisition, which revolutionized the field of healthcare. The application of machine learning in particular brought great promise in cancer diagnosis due to advanced analytics of large scale genomics data. The classification and accurate characterization of human diseases are essential for appropriate diagnosis, patient management and treatment. However, diagnostic discrepancies among pathologists may range from 25-45 percent according to a recent JAMA article on breast cancer. We aim to (1) investigate molecular platforms and signatures from TCGA data to examine the properties of DNA methylation and gene expression data, and (2) build practical classifiers to classify tumors in the clinic.

Methods: We built a Random Forest based robust classifier on training data set and calculated the classification error rate on test data set to demonstrate that the strength of single platform (methylation and gene expression) based classification. We used 6216 TCGA tumor samples representing 19 cancer types.

Results: The results showed high degree of classification accuracy of 98 % and 97 % using the Random Forest classifier. Further analysis identified outliers (misclassified samples) that are concordant in both mRNA and DNA methylation based classifiers. Unsupervised approaches also identified those outliers, while this further illuminated biologically distinct entities that are not resolvable by morphology a lone.

Conclusion: Our results showed that mRNA and DNA methylation classifiers both have good accuracy for tumor classification as single platforms and can complement current standard histologic tumor diagnosis. Our findings provide a framework for the development of genomic tools to aid in tumor classification that this classification system also could be easily integrated into CLIA approved labs assisting in the diagnosis, prognosis and classification of patient cancers.

Abstract #41

NOVEL CLINICAL APPLICATION OF MACHINE LEARNING APPROACHES TO PREDICT MENINGIOMA RECURRENCE RISK

Yasin Mamatjan, Farshad Nassiri, Shirin Karimi, Sheila Mansouri, Severa Bunda, Suganth Suppiah, Abulizi Maimaitiming, Kenneth Aldape, Gelareh Zadeh

Princess Margaret Cancer Centre, Toronto, ON

Purpose: Meningiomas are benign tumors, but significant number of meningiomas display risk of early tumor recurrence. The inter-observer variability among pathologists for grading and some indistinguishable features of meningioma under the microscope prevent accurate prediction of recurrence risk that critically limits appropriate treatment and management of patients who may benefit from adjuvant radiation therapy. Our goal is to develop clinical machine-learning tool to predict early recurrence risk in each meningioma patient using DNA methylation signatures and prognostic clinical factors.

Methods: The predictor is based on (1) GBM classification model (generalized boosting machine) to calculate the probability of recurrence over a time cut-off, and (2) continuous survival random-forest modelling to calculate the probabilities of a recurrence over various time frames. We processed over 500 meningioma samples using our machine-learning model that predicts probability of tumor recurrence based on methylation data. To develop a predictor for recurrence, we use recurrence as a binary outcome (yes/no) within a certain time period. Then we developed a meningioma predictor that would predict the probability of recurrence at 5 years.

Results: We validated the predictor using independent external datasets using the selected probes and model developed based on the original discovery dataset. Methylation-based predictor distinguishes clear risk groups in each independent validation cohort. We found that a methylation-based predictor of recurrence in meningioma has the potential to identify even grade I patients with higher recurrence risk and helps determine the choice of adjuvant treatment (radiation versus observation) in patients with grade II meningiomas. Genomic predictor also more reliably predicts 5-year recurrence free survival compared to a Grade-based model.

Conclusion: This novel predictor outperformed established standard diagnostic tests. This predictor could be used to individualize decisions in the clinic regarding whether to treat patients with adjuvant radiation therapy versus observation alone.

NOTES

NOTES

NOTES

NOTES

NOTES

NOTES

THANK YOU TO OUR SPONSORS

The Conference Planning Committee would like to acknowledge the following individuals/groups for their contributions to this year's event:

Platinum Sponsor

Novartis

Bronze Sponsors

Bristol-Myers Squibb

Hoffman-La Roche Limited

Exhibitor

Elekta