How I can apply cross-disciplinary learning in PLEP to my professional field

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Phoenix Leader Education Program for Renaissance
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I. Main thesis (Radiation Oncology)

✓ Why did we do this study?
✓ Methodology & Results & Conclusions
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✓ My achievements
✓ How I can apply cross-disciplinary learning in PLEP to my professional field
Functional image-guided stereotactic body radiation therapy planning for patients with hepatocellular carcinoma

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Background

- Hepatocellular carcinoma (liver cancer) is the 2nd leading cause of cancer-related death worldwide by 2016.

- Mongolia has the highest rate of liver cancer worldwide.

- More than 80% of the patients are diagnosed at an advanced stage and only 10% of patients are eligible for surgery in Mongolia.

- In 2013, approximately 5200 new cancer cases were diagnosed in Mongolia and 40% (~2000) of them were liver cancer.

- We haven’t yet started any radiotherapy for liver cancer in Mongolia.

Mongolia’s struggle with liver cancer

High rates of hepatitis C and B infection along with widespread alcohol use have left Mongolia with a burden of liver cancer that it is ill-equipped to handle. Ted Alcorn reports from Ulaanbaatar.

"...dying in a peaceful place and free of pain might be the most that Mongolian patients with HCC can hope for."
Introduction

- Stereotactic Body Radiotherapy [SBRT]: delivers very high dose per fraction within few fractions while limiting the high dose area to adjacent normal tissues.

- Intensity Modulated Radiation Therapy [IMRT]: Non-uniform radiation beam intensities: based on various computer-based optimization techniques.

**IMRT**

**3D Conventional RT**

DOSE SPARING for Rectum

Rectum is not spared from high dose
Challenges: HCC treatment include limited liver function

- **Risk of** Radiation Induced Liver Disease:
  1. Mean liver dose,
  2. Irradiated liver volume
  3. Chronic hepatic diseases
- SBRT to liver should be planned carefully, especially for patients with poor liver functions to avoid radiation-induced liver disease.
- An assessment of the current level of liver function using imaging modalities are important for RT planning.
- **Gadoxetate disodium enhanced hepatic MRI** (EOB-MRI) during the hepatobiliary phase can detect regional and global liver function.

Purpose

“To evaluate the ability of EOB-MRI guided SBRT planning using IMRT technique for liver cancer to spare functional liver tissues”
# Materials and Method

## 20 datasets of patients with HCC:

- RT planning CT & EOB-MR images
- Radiotherapy Planning System: Pinnacle$^3$ ver. 9.6
- Deformable imaging software: Insight segmentation and registration toolkit (ITK)
- Statistical software: R Version 3.1.2

### Dosimetric analysis

**I. Target**

- Dose to 95% of planning target volume
- PTV mean dose

**II. Organs at risk (OARs)**

- **a) Hepatic OARs:**
  - Total and functional liver mean dose
  - Percentages of total and functional liver volume, doses from 5 Gy to 30 Gy

- **b) Non-hepatic OARs:**
  - Stomach, Duodenum, Intestine:
    - Mean dose; dose to 0.5cc; dose to 5cc
SBRT planning using IMRT techniques

1. **Anatomical plan: without EOB-MRI**
   
   (A) Contouring targets and organs at risk
   
   Based on planning CT

   (B) IMRT planning
   
   ✔ 8 beams IMRT technique.
   ✔ Prescription dose: 48 Gy /4 fr

2. **Functional plan: with EOB-MRI**
   
   Additionally generate functional liver map

   (C) Complete IMRT plans
   
   Anatomical plan (Plan A)
   
   Functional plan (Plan F)
Results

Compared to anatomical RT planning, functional RT planning was able to achieve reductions in functional liver mean dose, total liver mean dose, as well as total and functional liver volumes, which receive from 5 to 30 Gy, while maintaining the target dose coverage. EOB-MRI can be good functional imaging modality for SBRT planning of liver tumor.

Conclusion

This simulation study demonstrates the potential of functional imaging with EOB-MRI for SBRT planning in patients with HCC. EOB–MRI-guided SBRT planning using the IMRT technique may improve functional liver preservation in patients with HCC.
How I can apply my PhD project to my professional field

- My highest ambition is to start liver SBRT in Mongolia.

- New LINAC machines being installed at the National Cancer Center of Mongolia (NCCM).

- In the last one year, the Department of Radiation Oncology (DRO), Hiroshima University (HU) has started a new project with the aim to disseminate their excellent experience to Asian countries.

- A collaboration between DROs of HU and NCCM started in Sep, 2016.
Radiation Disaster Recovery Studies

Contents

II. Radiation Disaster Recovery Studies

- PLEP activities
- My achievements
- How I can apply cross-disciplinary learning in PLEP to my professional field
Phoenix Leader Education Program (PLEP)
Radiation Disaster Medicine Course

D1
Interdisciplinary Common Subjects

D2
Radiation Emergency Training

D3
Qualifying Exam

D4
Research
International Conferences

I will get a PhD degree on May 25, 2017.

Decontamination procedure in affected area
Temporary Housing at Minami Soma City, 2013

Short-term Field work at Fukushima and Minami Soma City

Long-term Internship Incident Emergency Center, IAEA:

Phoenix conference
ASTRO conference
Phoenix symposium

STS-Journal Clubs
IPPNW

I will get a PhD degree on May 25, 2017.

Temporary Housing at Minami Soma City, 2013
Dr. Rethy Chhem advised LP students to conduct a regular Journal Club on Radiation Disaster through STS.

Phoenix advisor’s seminar:
Dr. Chhem Rethy, Cambodia Development Resource Institute, Feb 17, 2014

Journal club with Dr. Kim Fortun, Professor of STS at Rensselaer Polytechnic Institute, Nov 26, 2014

Journal club with Dr. Scott Knowles, Assoc. Professor of History at Drexel University, Aug 5, 2015
Motivation to joining MPPNW was initiated through PLEP

Learned about “International Physicians for the Prevention of Nuclear War” through “Natural Disaster and International Cooperation” subject of PLEP in 2013.

MPPNW was re-activated in September 2015. I am a board member of the MPPNW.
A professor and a student, Nagasaki University, talked about rescue activities after the bombing of Nagasaki, and nuclear issues in Japan today.

I conducted a seminar on “Prevention of accidental exposures in medical use of radiation” for medical professionals at NCCM.
A long-term Internship at Incident Emergency Centre, IAEA from March 1 to June 30, 2015

Incident Emergency Centre serves as the global focal point for international preparedness and response for nuclear and radiological incidents, emergencies, threats or events of media interest.

My tasks at IEC

1. Medical tool for assessment and follow-up of patients from radiological or nuclear accidents.

2. Review 18 published accident reports, IAEA

3. Create a bank with medical photos of local radiation injuries of patients.

Dept. of Radiation Oncology, Hiroshima University Hospital
“Accidental overexposure related to new radiation therapy technologies”

Journal of Radiation Oncology, 2017, in press

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Dept. of Radiation Oncology, Hiroshima University Hospital

International Atomic Energy Agency
**Background**

Number of reported cases of overexposure worldwide, 1980-2013

Enhancing safety of currently available techniques in Radiation Oncology is essential.

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Purpose

To analyze the main causes of RT accidental overexposure related to expansion of new technologies in order to enhance safety in the field of modern radiation oncology.

Materials

• Publications & reports:

• Official websites:
  – Radiation Protection of Patients, IAEA – [link]
  – United State Nuclear Regulatory Commission: [link]; Radiation Oncology Safety Information System
  – ROSIS [ESTRO]: [link]
## Results

<table>
<thead>
<tr>
<th>Pattern of errors</th>
<th>Affected patients</th>
<th>Death</th>
<th>Root cause of errors</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>Human error</td>
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<tr>
<td>Calibration</td>
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<td>0</td>
<td>4</td>
<td>2</td>
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<tr>
<td>Treatment planning</td>
<td>55</td>
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<td>Treatment setup</td>
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<td>Treatment delivery</td>
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<td><strong>Total</strong></td>
<td><strong>941</strong></td>
<td><strong>8</strong></td>
<td><strong>15</strong></td>
<td><strong>24</strong></td>
</tr>
</tbody>
</table>

Of the 24 RT accidents, a total of 941 patients were overexposed and 8 patients died as a result of their overexposure.
Conclusion

The proper preparation and availability of resources, including adequate staff training, risk estimation before the installation of new technology, enhanced safety culture and quality-assurance, can reduce the number of accidental events related to the use of new radiation therapy technologies.
My achievements from PLEP

i. I obtained comprehensive interdisciplinary knowledge and practice in Radiation Disaster Recovery Studies, as well as Radiation Oncology.

ii. Research protects: 2 publications


iii. I improved my presentation and communication skills: 8 oral and 7 poster presentations at international conferences

iv. I gained working experience at international organization

v. Building international network
How I can apply cross-disciplinary learning in PLEP to my professional field
Applications of nuclear technology and preparedness and response for radiation emergencies in Mongolia

- Nowadays, applications of nuclear technology in different areas have been largely expanded in Mongolia.
- Radiation accidents are always a possibility.

- An adequate medical system for radiation emergencies is not established!
Main reasons to establish Radiation Emergency Medicine program in Mongolia

- In the health sector, modern RT and nuclear technologies are newly introduced. Thus, significant challenges are posed in quality assurance of the advanced nuclear technologies, as well as in radiation safety and protection issues.

- Recently, the uranium mining sector has rapidly expanded in Mongolia. However, the field of radiation protection and safety has not been developed well.

- In addition, public perception of radiation and radiation protection are very weak.

- Mongolia is sandwiched between Russia and China, and both these countries have nuclear power plants and nuclear weapons.

- There is a lack of specialists in radiation disaster medicine in Mongolia.

I am keen to play a leadership role in developing a radiation emergency medicine program and enhancing the field of radiation protection in my country.
Steps towards the establishment of a Radiation Emergency Medicine program in Mongolia

- Establishment of the system for radiation emergency medicine
  - To prepare specialists and other human resources in the field of radiation emergency medicine
  - To establish a 24/7 national and local radiation emergency response capability at NCCM.

- Education and training of Radiation Disaster Medicine:
  - Medical professionals
  - Medical students

- Radiation education for the public
- Building international cooperation

STS will be included as a tool for establishing the radiation emergency medicine program.
I wish to thank to:

- PLEP for giving me great opportunities to obtain broad, interdisciplinary knowledge and skills for a specialist in radiation disaster recovery.
- My PhD supervisor Prof. Nagata and team members from DRO.
- The IAEA for providing me with the opportunity to gain international experience through a long-term internship.
- Phoenix advisors for their support and mentoring.
Thank you very much for your kind attention!