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

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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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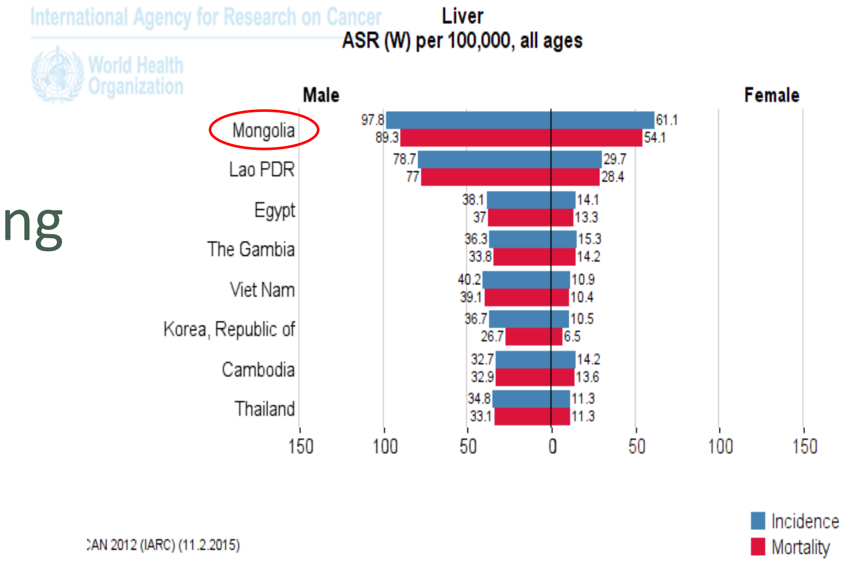
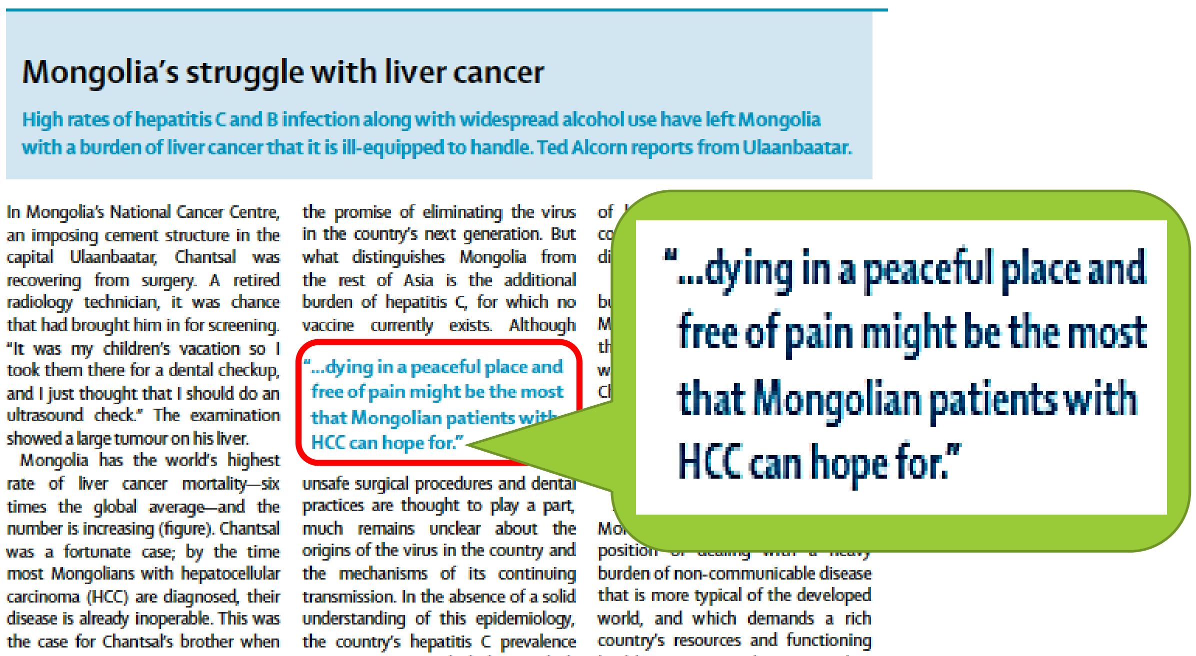
# Background

- ✧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.



## 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.

In Mongolia's National Cancer Centre, an imposing cement structure in the capital Ulaanbaatar, Chantsal was recovering from surgery. A retired radiology technician, it was chance that had brought him in for screening. "It was my children's vacation so I took them there for a dental checkup, and I just thought that I should do an ultrasound check." The examination showed a large tumour on his liver.

Mongolia has the world's highest rate of liver cancer mortality—six times the global average—and the number is increasing (figure). Chantsal was a fortunate case; by the time most Mongolians with hepatocellular carcinoma (HCC) are diagnosed, their disease is already inoperable. This was the case for Chantsal's brother when

the promise of eliminating the virus in the country's next generation. But what distinguishes Mongolia from the rest of Asia is the additional burden of hepatitis C, for which no vaccine currently exists. Although

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

unsafe surgical procedures and dental practices are thought to play a part, much remains unclear about the origins of the virus in the country and the mechanisms of its continuing transmission. In the absence of a solid understanding of this epidemiology, the country's hepatitis C prevalence

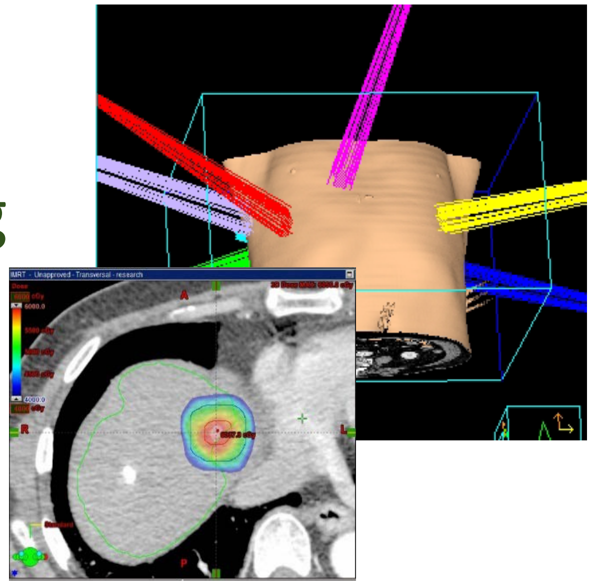
position of dealing with a heavy burden of non-communicable disease that is more typical of the developed world, and which demands a rich country's resources and functioning

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

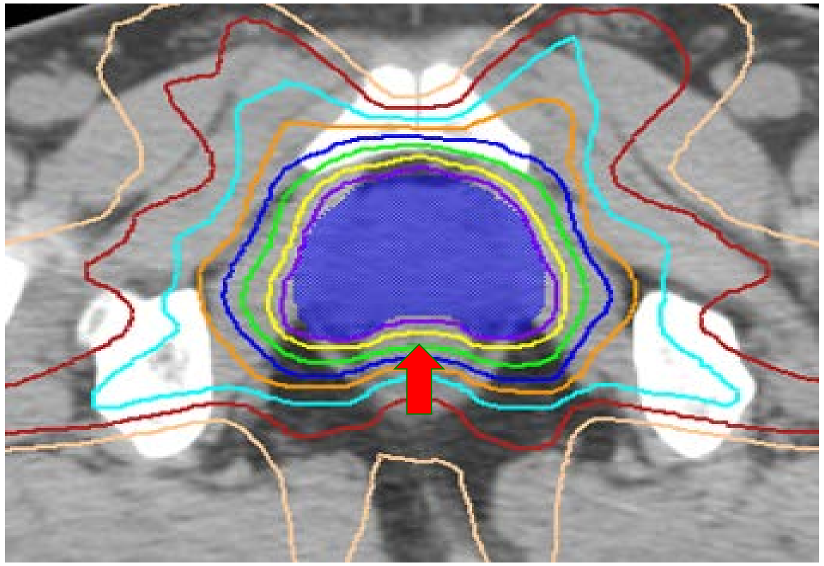
- ✧In 2013, approximately 5200 new cancer cases were diagnosed in Mongolia and 40 % (~2000) of them were liver cancer.
- ✧We haven't yet started any radiotherapy for liver cancer in Mongolia.

# 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.

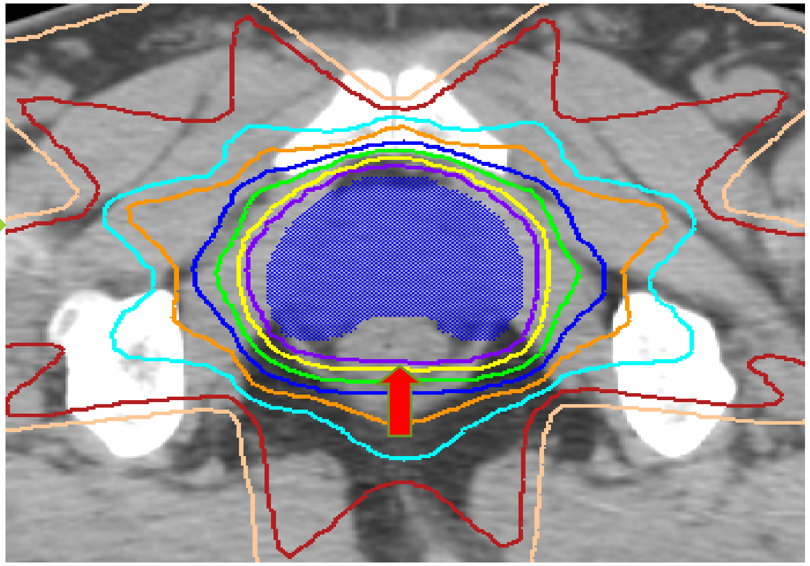


**IMRT**



**DOSE SPARING for Rectum**

**3D Conventional RT**



**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

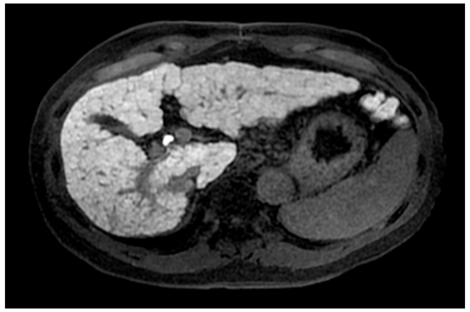
*"To evaluate the* ***ability of EOB-MRI*** *guided* ***SBRT planning*** *using IMRT technique for liver cancer* ***to spare functional liver tissues****"*

# 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

**1) Planning CT**



**2) EOB-MRI**

# 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:

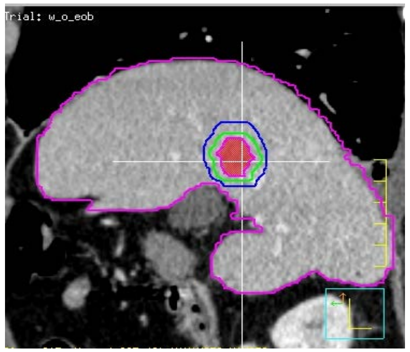
- Stomach, Duodenum, Intestine :
  Mean dose ; dose to 0.5cc; dose to 5cc

# SBRT planning using IMRT techniques

## 1. Anatomical plan: without EOB-MRI

**(A) Contouring targets and organs at risk**

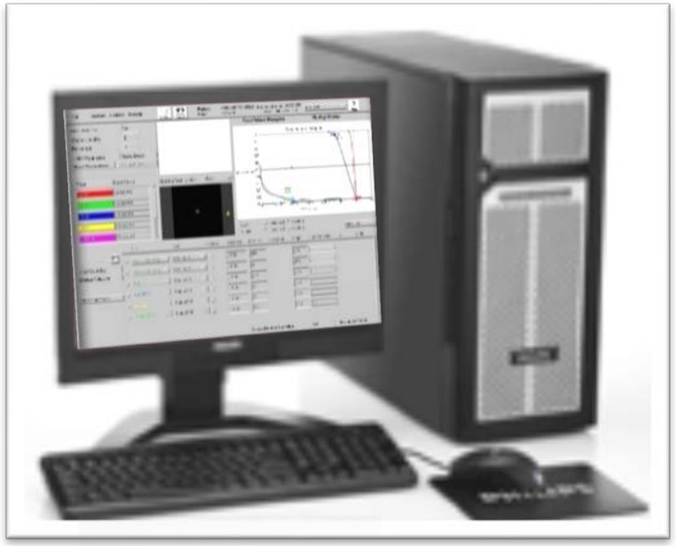
Based on planning CT



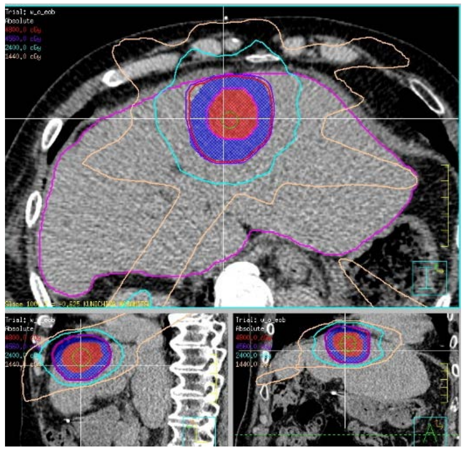
**(B) IMRT planning**

✓*8 beams IMRT technique.*

✓*Prescription dose: 48 Gy /4 fr*

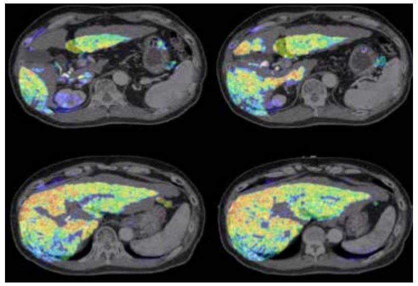


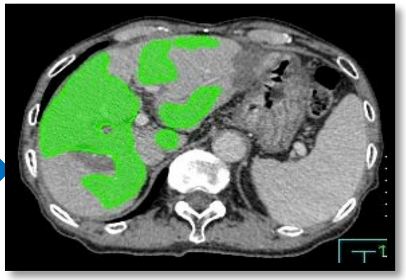
**(C) Complete IMRT plans**



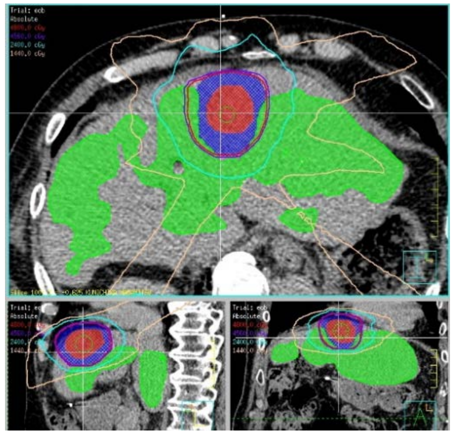
Anatomical plan (Plan A)

## 2. Functional plan: with EOB-MRI





IMRT planning with **additional functional liver Information**



Functional plan (Plan F)

Additionally generate functional liver map

# 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.**

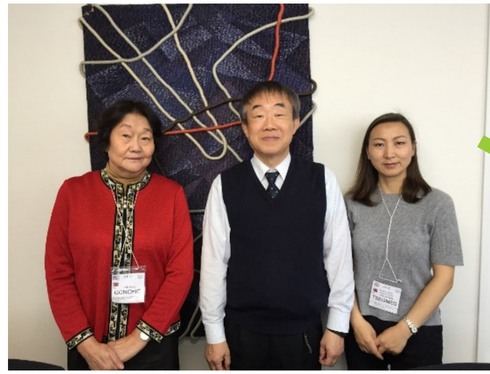
# Conclusion

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.



Dr. Odontuya, a head of DRO, NCCM was invited by Prof. Nagata, a chairmen of DRO, HU in Jan, 2017.

Start a collaboration

Dr. Kimura, an associate professor of HU and SBRT specialist conducted a seminar at NCCM in Sep, 2016.

Training Program

Clinic practical training for Mongolian staff (medical physicist and two radiotherapy technicians ) at HU in 10-20 Jan, 2017

# 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

HIROSHIMA UNIVERSITY

# Phoenix Leader Education Program (PLEP)
# Radiation Disaster Medicine Course

HIROSHIMA UNIVERSITY

**Doctoral Dissertation**

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

D4

Research

International Conferences

Phoenix conference


ASTRO conference

Phoenix symposium

D3

Long-term Internship **Incident Emergency Center, IAEA:**

STS-Journal Clubs

IPPNW

D2

Qualifying Exam

Radiation Emergency Training


D1

Short-term Field work at **Fukushima and Minami Soma City**

Interdisciplinary Common Subjects

Decontamination procedure in affected area

Temporary Housing at Minami Soma City, 2013

# Coordinating STS-Journal Clubs

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 Politechinic 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

## IPPNW North Asia Regional Meeting

1st 1997 Nagasaki
2nd 1999 Beijing
3rd 2001 North Korea (postponed)
4th 2003 Kyoto
5th 2005 Hiroshima
6th 2007 Mongolia
7th 2009 Hiroshi… Joint Conference with South Asia Region)
8th 2011 Nepal… Conference with South Asia Region)



The 6th IPPNW North Asia Regional Meeting (Mongolia, 2007)

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.

# MPPNW/JPPNW joint Symposium on Nuclear awareness on June 7-8, 2016 in Mongolia

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- A professor and a student, Nagasaki University, talked about rescue activities after the bombing of Nagasaki, and nuclear issues in Japan today.

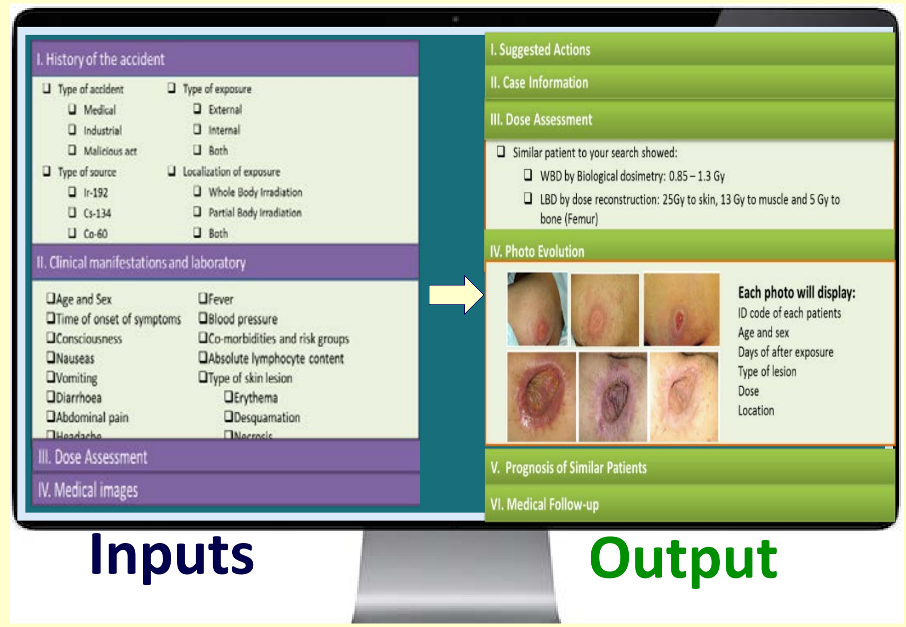

- I conducted a seminar on “Prevention of accidental exposures in medical use of radiation” for medical professionals at NCCM.

# **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.**

# “Accidental overexposure related to new radiation therapy technologies”

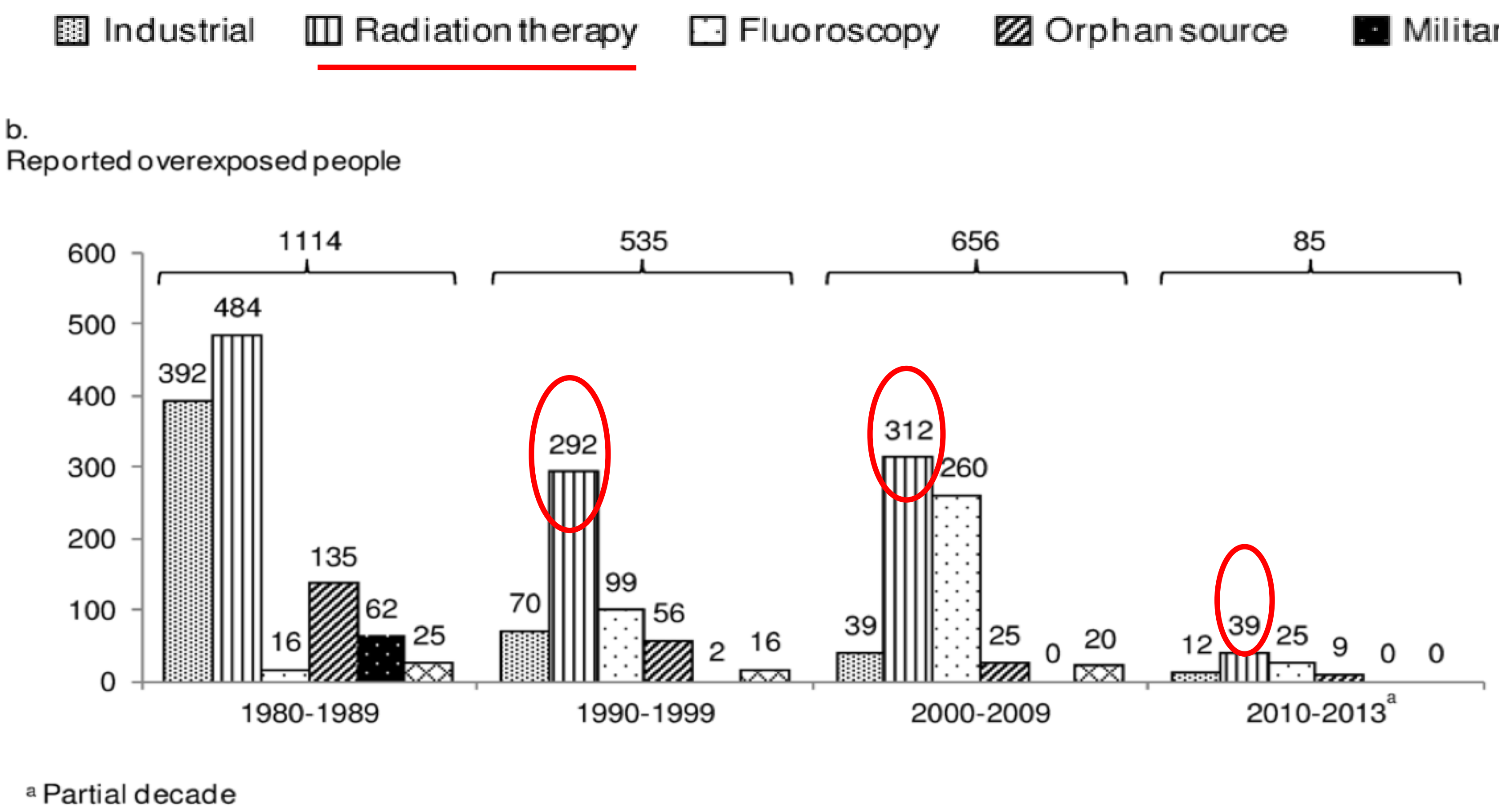
Journal of Radiation Oncology, 2017, in press

U. Tsegmed[1,2], N. Fahim[1], A. K. Batcha[1], T. Nakashima[3], Y. Nagata[2], M. Abdel-Wahab[4]

[1]Intern at the International Atomic Energy Agency, Vienna, Austria
[2]Department of Radiation Oncology, Graduate School of Biomedical and Health Sciences, Hiroshima University, Hiroshima, Japan
[4]Division of Human Health, International Atomic Energy Agency, Vienna, Austria

# Background

## Number of reported cases of overexposure worldwide, 1980-2013




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

Karen Coeytaux et al, “Reported Radiation overexposure accidents worldwide, 1980-2013: A systematic Review”, J. Plos One, 2015

# 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:**
  - ICRP, IAEA, UNSCEAR, Japanese Intersociety Council of Medical Physics (JRS, JASTRO, JSMP, JSRT).
- **Official websites:**
  - Radiation Protection of Patients, IAEA – www.rpop.iaea.org/SAFRON/
  - United State Nuclear Regulatory Commission: www.nrc.gov; Radiation Oncology Safety Information System
  - ROSIS [ESTRO]: www.rosis-info.org;

# Results

| Pattern of errors | Affected patients | Death | Root cause of errors | | | |
|---|---|---|---|---|---|---|
| | | | Human error | System related | Equipment related | **Total** |
| Calibration | 379 | 0 | 4 | 1 | 2 | **7** |
| Treatment planning | 55 | 7 | 6 | 0 | 2 | **8** |
| Treatment setup | 400 | 1 | 3 | 1 | 0 | **4** |
| Treatment delivery | 107 | 0 | 2 | 0 | 3 | **5** |
| **Total** | **941** | **8** | **15** | **2** | **7** | **24** |

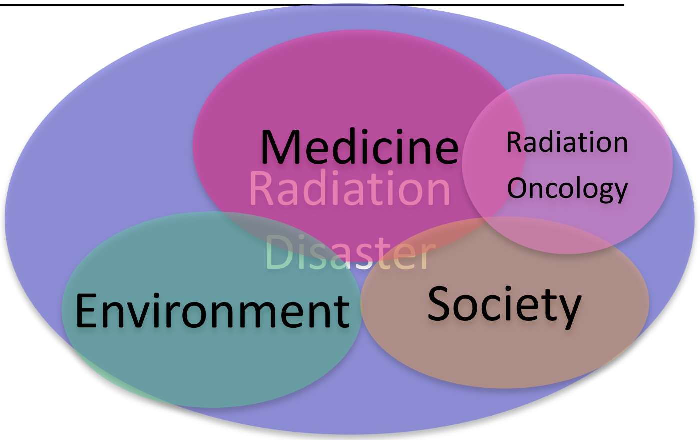
❖ Of the 24 RT accidents, a total of 941 patients were overexposed and 8 patients died as a result of their overexposure.

# 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

1) U. Tsegmed, T. Kimura, et al., Functional image-guided stereotactic body radiation therapy planning for patients with hepatocellular carcinoma. Medical Dosimetry, 2017,42(2):p. 97-103.
2) U. Tsegmed, N. Fahim, et al., Accidental overexposure related to new radiation therapy technologies. Journal of Radiation Oncology, 2017

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

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# 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

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- 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

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- 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.***

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# Acknowledgements

***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!