ARADOS:
Asian Network for Radiation Dosimetry

The 5th ARADOS meeting
Organized by NIRP, China CDC and NIM, China
Garden Hotel, Beijing, China
6-8th November 2019

The presentation was originally prepared for the SSD19 conference in Sep. 2019.

Osamu Kurihara¹*, Wi-Ho Ha², Cao Qijian³

¹National Institutes for Quantum and Radiological Science and Technology, Chiba, Japan
²Korea Institute of Radiological and Medical Sciences, Seoul, Korea
³China Institute of Radiation Protection, Shanxi, China
What is ARADOS?

ARADOS is a similar acronym to EURADOS, Asian Radiation Dosimetry Group to establish a platform for Asian Dosimetry Network.

Main missions of ARADOS
(through discussion at KIRAMS in 2015)

- To enhance and harmonize radiation dosimetry capabilities in Asian countries
- To exchange research activities on radiation dosimetry of each institute
- To prepare the joint response for radiation dosimetry services in radiological / nuclear accidents
Chain of NPPs in East Asia

- East Asia is the most dense NPP area in the world.
- Emergency response preparedness for a large-scale nuclear disaster is one of the concerned issues between ARADOS members.
- Lessons learned from the Fukushima NPP accident should be shared.

From presentation by Park Chang-youn (KIRAMS)

Mobile WBC units operating in Fukushima


Prompt population monitoring for the public is important.
Members of ARADOS

Institutes hosting or participating in annual meetings

<table>
<thead>
<tr>
<th>Country</th>
<th>Institute</th>
</tr>
</thead>
<tbody>
<tr>
<td>REPUBLIC OF KOREA</td>
<td>• KIRAMS/NREMC</td>
</tr>
<tr>
<td></td>
<td>• KHNP/RHI</td>
</tr>
<tr>
<td></td>
<td>• KAERI</td>
</tr>
<tr>
<td></td>
<td>• KARA</td>
</tr>
<tr>
<td></td>
<td>• KINS</td>
</tr>
<tr>
<td>CHINA</td>
<td>• NIRP (hosting the next AM)</td>
</tr>
<tr>
<td></td>
<td>• CIRP (co-hosting the next AM)</td>
</tr>
<tr>
<td></td>
<td>• NIM</td>
</tr>
<tr>
<td></td>
<td>• Tsinghua Univ.</td>
</tr>
<tr>
<td>JAPAN</td>
<td>• QST</td>
</tr>
<tr>
<td></td>
<td>• JAEA</td>
</tr>
<tr>
<td></td>
<td>• AIST</td>
</tr>
<tr>
<td></td>
<td>• Hirosaki Univ.</td>
</tr>
<tr>
<td></td>
<td>• Fukushima Medical Univ.</td>
</tr>
<tr>
<td></td>
<td>• Hiroshima Univ.</td>
</tr>
<tr>
<td></td>
<td>• Nagasaki Univ.</td>
</tr>
<tr>
<td>MALAYSIA</td>
<td>• Sabah Nuclear Medical Center</td>
</tr>
<tr>
<td>VIETNAM</td>
<td>• Vietnam Atomic Energy Institute</td>
</tr>
</tbody>
</table>

**Orange**: country patriating in WG3 (biodosimetry)

**Bold characters**: hosting institutes
ARADOS kick-off meeting (2015) in Korea

ARADOS kick-off meeting (2015) in Korea

The 2nd Meeting of Asian Radiation Dosimetry Group
Taiyuan 2016.9.20~9.22

Second meeting (2016) in China

Third meeting (2017) in Japan

Fifth annual meeting will be held in Beijing (Nov. 6~8, 2019).

Fourth meeting (2018) in Korea
Outputs from Annual Meeting

Kick-off (first) meeting (2015): hosted by KIRAMS

- Dr. Wi-Ho HA (KIRAMS) proposed a dosimetry network among Asian countries and delegates from China and Japan agreed with this proposal.
- Main missions of ARADOS were discussed.
- Hosting institutes of each country for annual meetings were decided.

Second AM (2016): hosted by CIRP

- The structure of ARADOS was decided through discussion among participants.
- The chairperson and secretary of ARADOS were elected.
- Collaborative projects were launched.

Third AM (2017): hosted by QST

- The results of the collaborative projects (WG1: direct thyroid measurements, WG3: biodosimetry) were presented and discussed.

Fourth AM (2018): hosted by KIRAMS and KHNP/RHI

- Two international researchers were invited to give special talks.
- The result of WG3 (the second round) were discussed.

Date: October 17-19, 2018, Place: Best Western Arirang Hill Hotel, Seoul, Korea

Day 1
Opening Remarks: Osamu Kurihara (QST-NIRS)
Welcome Address: Young Woo Jin (KIRAMS)
Introduction of Participants: All participants

Section 1 (WG1: Internal Dosimetry)
- (Invited Talk) Phantom Study Considering Different Size of the Human Body and Organ for Internal Dosimetry: David Brog gio (IRSN)
- A Reliable and Robust Method for Monitoring Large Populations to Assess Thyroid Internal Exposure from Radio iodine in a Nuclear Accident: A Proposal Based on Experiences of Fukushima: Kazuaki Yajima (QST-NIRS)
- Personalized Internal Dose Assessment for Radioiodine: Tae-Eun Kwon (KIRAMS)
- Conceptual Design of a Portable Thyroid Dose Monitoring System Using Gamma-ray Spectrometer: Yoshihiko Tanimura (JAEA)
- Dose Assessment for Workers Involved in an Internal Contamination Accident with Pu Compounds at JAEA’s Oarai R&D Institute: Eunjoo Kim (QST-NIRS)

Section 2 (WG2: External Dosimetry)
- Retrospective Dosimetry Using Thermoluminescence and Optically Stimulated Luminescence: Jungil Lee (KAERI)
- The First EPR/Alanine Dosimetry Intercomparison Exercise in Korea: Byeong Ryong Park (KIRAMS)
- EPR/Fingernail Dosimetry for Accidental Exposure: Hiroshi Yasuda (Hiroshima Univ.)

Section 3 (WG3: Biological Dosimetry)
- (Invited Talk) Biological Dosimetry: Recent Developments in RENEB and at BfS: David Endesfelder (BfS)
- Biodosimetry Network Activities in Japan: Yumiko Suto (QST-NIRS)
- Biodosimetry Network in China: Jianxiang Liu (NIRP)
- Intercomparison of Dicentric Chromosome Assay (DCA) between KIRAMS and Health Canada: Younghyun Lee (KIRAMS)
- Monitoring Radiation Workers: The Comparison between Dicentric Chromosomes Assay and Cytokinesis-Block Micronucleus Assay: Pham Ngoc Duy (NRI, Vietnam)

Date: October 17-19, 2018, Place: Best Western Arirang Hill Hotel, Seoul, Korea

Day 1 (continued)

Section 4 (WG4: Computational Dosimetry)
- (Invited Talk) ICRP Mesh-type Reference Computational Phantoms (MRCP): Chan Hyeong Kim (Hanyang University)
- EURADOS Intercomparison on ICRP Voxel-type Reference Computational Phantom: Han Sung Kim (KIRAMS)
- The Method of Accident Exposed Dose Reconstruction Based on MC Method: Qinjian Cao (CIRP)
- A Simulation Approach Using the Mesh Phantom to Evaluate the Effective Dose from Mobile Phone Glasses: Min Chae Kim (KAERI)

Discussions: All participants

Day 2
- Invited Talk by David Broggio (IRSN)
- Invited Talk by David Endesfelder (BfS)
- Discussion on the progress of the intercomparison exercise and future plan: All participants
- Presentation of WG Meeting Results: All participants
- Closing Remark of the 4th ARADOS Meeting: Osamu Kurihara (QST-NIRS)
- Announcement of Next ARADOS Meeting: Qinjian Cao (CIRP)

Day 3 Technical tour (KHNP/RHI, KNHP, KAERI)
Structure of ARADOS

Chairperson
Dr. Kurihara (QST)

Secretary
Dr. Ha (KIRAMS)

Host institute(s) of AM

Annual Meeting

WG1
Internal Dosimetry

WG2
External Dosimetry

WG3
Biological Dosimetry

WG4
Computational Dosimetry

Participants can freely join annual meeting (no charge).
**WG1: Internal Dosimetry**

**Harmonizing direct thyroid measurements**

---

### Direct thyroid measurements

- **Radioiodine (e.g., $^{131}$I)** is rapidly localized in the thyroid after intake.

![Diagram](image)

- **Sensitive region**
- **Detector**
- **$\gamma$-ray**

### Intercomparison exercise 2017

- The exercise was performed by delivering the same neck phantoms with the unknown sources (vials) to 8 participants; two vials with different activity ($^{131}$I and blank) were sent to each participant.

- The participants measured the phantoms in accordance with their own standard procedure and reported their results.

---

### Relevant international activities after Fukushima

- IAEA EPR-NPP (2013 published)
- HPA-CRCE-044 (2013 published)
- CAThyMARA project 2015-2017
- SHAMISEN project 2015-2017

Also many relevant studies have been reported.

---

Source preparation was made by KIRAMS

From presentation by Dr. Wi-Ho Ha (3rd ARADOS meeting)
WG1: Internal Dosimetry

Harmonizing direct thyroid measurements (cont’d)

The results were found to be within the acceptable range (ISO 28218) for most of the participants, although their techniques were different each other.

Several participants used a different de-facto phantom (ORINS) from the phantom tested (ANSI), resulting in the relatively-large discrepancy in the thyroid activity.

Some problems were found regarding the transportation of the phantoms (including the sources) overseas.

Findings

Examples of the detectors used by participants
11 NaI(Tl), 3 HPGe, 3 CeBr₃

From presentation by Dr. Wi-Ho Ha (3rd ARADOS meeting)
WG1: Internal Dosimetry
Research activities by ARADOS members

Publications related to WG1 (thyroid meas. and iodine biokinetics)

WG1: Internal Dosimetry

QST’s research on the population monitoring in a nuclear accident

Conventional NaI(Tl) survey meters (TCS-171/172, Hitachi) would be difficult to be used for measuring small children.

A new concept thyroid monitor has been developed.

Developing the training course

Calibration using age-specific phantoms

The studies have been partly supported by NRA, Japan.
WG3: Biodosimetry

“Gold-Standard” for accidental external dose assessment

Radiation accident
Blood collection
Lymphocyte separation

Cell culture

5 h
PCDC (Cell fusion-mediated prematurely condensed dicentric chromosome) assay
Rapid procedure by PNA-FISH

Dose assessment

Harvesting and preparation
Dicentric chromosome assay

Slide aging (1 day)
3-color FISH assay
M-FISH analysis is performed if necessary.

Time

48 h

96 h

Frequency of aberration

Dose response curve

QST’s protocol for biodosimetry
WG3: Biodosimetry

Intercomparison exercise 2018

- Metaphase images of the unknown dose were delivered to each participant from the coordinating institute.
- The participants analyzed the images and performed the dose estimation using their own calibration curve.

Biodosimetry network is effective for the response to a large-scale RN accident.

From presentation by Dr. Abe (Fukushima Medical Univ.)
CAPABILITIES OF THE ARADOS-WG03 REGIONAL NETWORK FOR LARGE-SCALE RADIOLOGICAL AND NUCLEAR EMERGENCY SITUATIONS IN AISA

S. Jang¹,*, Y. Suto², J. Liu³, Q. Liu³, Y. Zuo⁴, P. N. Duy⁵, T. Miura⁶, Y. Abe⁷, K. Hamasaki⁸, K. Suzuki⁹ and S. Kodama¹⁰

¹Korea Institute of Radiological and Medical Sciences (KIRAMS), Seoul, South Korea
²National Institute of Radiological Sciences (NIRS), National Institute for Quantum and Radiological Science and Technology (QST), Chiba, Japan
³National Institute of Radiation Protection (NIRP), China CDC, Beijing, China
⁴China Institute of Radiation Protection (CIRP), China National Nuclear Corporation (CNNC), Taiyuen, China
⁵Nuclear Research Institute (NRI), Viet Nam Atomic Energy Commission, VINATOM, Dalat, Viet Nam
⁶Hirosaki University, Hirosaki, Japan
⁷Fukushima Medical University, Fukushima, Japan
⁸Radiation Effects Research Foundation (RERF), Hiroshima, Japan
⁹Nagasaki University, Nagasaki, Japan
¹⁰Osaka Prefecture University, Osaka, Japan

*Corresponding author: sjsjj@kirms.re.kr

In 2015, the Asian Radiation Dosimetry Group established a regional network of biological dosimetry laboratories known as the ARADOS-WG03 (Working Group 03; Biological Dosimetry). A survey was conducted in 2017 to evaluate the capabilities and capacities of the participating laboratories for emergency preparedness and responses in large-scale nuclear and/or radiological incidents. The results of this survey were identified and assessed. The data provide important information on the current state of emergency cytogenetic biological dosimetry capabilities in the Asian region.
Future collaboration research topics

**Internal Dosimetry**
- Computational calibration in direct measurements (Thyroid, WBC, …)
- Biokinetic model calculations based on new OIR series by ICRP
- Review of past RN accidents in each country

**External Dosimetry**
- Dosimeter intercomparison exercise
- Scenario-based external dose calculations
- Exchanging information on medical/occupational exposure situations of each country

**Biodosimetry**
- Intercomparison of various techniques (MN assay, FISH, …)

*Endo and Yamaguchi (2003)*

Nuclear/radiological emergency preparedness (including radiation monitoring and communication with the public), educational material packages, and so on would be potential collaboration items...
Future collaboration with ASEAN


(Coordinated by RCA/RCARO)
ARADOS was established with the aim at a platform for the dosimetry network among Asian countries. The past annual meetings were valuable occasions to share information on activities of each institute/country.

To the present, two intercomparison exercises (thyroid meas. and biological dosimetry) have been conducted. These activities were effective to harmonize and improve the relevant techniques of participating institutes.

The issues recognized in the past experiences of ARADOS (e.g., financial resources, communications, transportation, constitutions) would be necessary to be solved.

The next step of ARADOS is to expand the network and further activate collaborations among the members. The role of the core countries (China, Republic of Korea and Japan) would become more important for this.

The website of ARADOS has just opened. 
Please provide me with any information useful for ARADOS members!!
Asian Radiation Dosimetry Group

Thank you for your attention!