Justification for the use of radiation in medicine: Introduction
Justification of medical exposures:

**Level 1** deals with use of radiation in medicine in general
(In practice this is accepted as doing more good than harm, and its justification is taken for granted)

**Level 2** deals with specified procedures with a specified objective
(The aim at this level is to judge whether the procedure will improve diagnosis or provide necessary information about those exposed)

**Level 3** deals with the application of the procedure to an individual
(The particular application should be judged to do more good than harm for the individual patient)

Justification of diagnostic medical exposures, some practical issues: report of an International Atomic Energy Agency Consultation.


Radiation Protection of Patients Unit, Radiation Safety and Monitoring Section, NSRW, International Atomic Energy Agency, Vienna, Austria.

Abstract

Objectives: The Radiation Protection of Patients (RPoP) Unit of the International Atomic Energy Agency (IAEA) is concerned about the effectiveness of justification of diagnostic medical exposures. Recent published work and the report of an initial IAEA Consultation in the area gave grounds for such concerns. There is a significant level of inappropriate usage, and, in some cases, a poor level of awareness of dose and risk among some key groups involved. Methods: The IAEA convened a second group of experts in November 2008 to review practical and achievable actions that might lead to more effective justification. Results: This report summarises the matters that this group considered and the outcome of their deliberations. Conclusions: There is a need for improved communication, both within professions and between professionals on one hand, and between professionals and the patients/public on the other. Coupled with this, the issue of consent to imaging procedures was revisited. The need for good evidence-based referral guidelines or criteria of acceptability was emphasised, as was the need for their global adaptation and dissemination. Clinical audit was regarded as a key tool in ensuring that justification becomes an effective, transparent and accountable part of normal radiological practice. In summary, justification would be facilitated by the "3 As": awareness, appropriateness and audit.
Awareness: efficacy, safety, cost

Daily Mail, 8.9.11

GPs TOLD: RATION CANCER SCANS

By Sophie Dorland

Cancer plan undermined by PCTs

By Stephen Robinson, 08 September 2011

When the government unveiled its £750 million cancer strategy for England in December 2010, the emphasis fell squarely on early diagnosis.


Radiation safety in radiology relies on core principles of justification, optimization and limitation of exposures.

Topics will include:
- Sound contemporary legal and philosophical bases for justification
- Transparent and accountable communication of risks
The need for guidelines globally

Diagnostic radiology in USA accounts for as much radiation than natural causes (15% in 1980 to 48% in 2006)

NCRP 160 http://www.ncrponline.org/

CT exams have increased at 10% pa in USA from 3-80 million since 1980

44% of CT exams not justified in USA

Hadley JL, Agola J, Wong P. AJR 2006; 186: 937-942

Low level of knowledge of dose; only 1/3 doctors received formal training in radiation protection

Soye & Paterson. BJ R. 81 (2008),725-729
http://bjr.birjournals.org/cgi/content/abstract/81/969/725
Per caput annual collective dose /mSv
Hart et al. 2010
Radiation protection legislation

The regulatory basis is the Euratom Treaty (1957)

Article 2 of this Treaty stipulates that "in order to perform its task, the Community shall, as provided for in the Treaty... establish uniform safety standards to protect the health of workers and of the general public and ensure that they are applied".

The requirements for radiation protection are laid down in Title II Chapter 3 "Health and Safety". Articles 30 to 39 of the Euratom Treaty.

Pursuant to the Treaty, a comprehensive set of directives, regulations, recommendations and decisions has been elaborated and adopted. The full texts of all Community-level provisions currently valid in the area of radiation protection are provided.

Specific legislation on Radiation Protection in the medical field was revised in 1997.

Since the first Basic Safety Standards Directive adopted in 1958, this Directive was updated many times. The latest update was in 1996. Other legislation was adopted in the aftermath of the Chernobyl accident, with regard to the exchange of information, and on contamination of foodstuffs and feedstuffs. Further legislation on specific aspects was developed with regard to outside workers, control of radioactive sources and shipment of radioactive waste and substances.

For the implementation of the requirements in primary legislation (Chapter 3 of the Euratom Treaty), non-binding legislation was adopted on the radiation protection provisions in the Euratom Treaty.
Referral Guidelines: Making the best use of clinical radiology services

• The Royal College of Radiologists has published guidelines for >20 years since 1989. 7th edition 2012
• The guideline development process is accredited by NHS Evidence
Helpful imaging: role for referral guidelines

A useful investigation is one in which the result - positive or negative - will inform clinical management and / or add confidence to the clinician’s diagnosis. A significant number of radiological investigations do not fulfil these aims and may add unnecessarily to patient irradiation. In order to avoid the wasteful use of radiology, the important questions to be asked are as follows:

0. HAS IT BEEN DONE ALREADY?
  Repeating investigations that have already been done: such as at another hospital, in an outpatient department, or in an emergency department. Every attempt should be made to obtain previous images and reports. Transfer of digital data through electronic links will assist in this respect. Although guidelines may not directly address this question, there are other initiatives that do.

0. DO I NEED IT?
  Undertaking investigations when results are unlikely to affect patient management or over-investigating: because the anticipated positive finding is usually irrelevant – eg, degenerative spinal disease – or because a positive finding is unlikely. Some clinicians and patients tend to rely on investigations more than others for reassurance.

0. DO I NEED IT NOW?
  Investigating too early: for example, before the disease could have progressed or resolved, or before the results could influence treatment. The need for investigation and treatment should be reviewed at a more appropriate time.

0. IS THIS THE BEST INVESTIGATION?
  Doing the wrong investigation: imaging techniques undergo rapid change. It is often helpful to discuss an investigation with a specialist in clinical radiology or nuclear medicine before it is requested.

0. HAVE I EXPLAINED THE PROBLEM?
  Failing to provide appropriate clinical information and questions that the imaging investigation should answer:
# Advances: apps

## Referral guidelines: Making the best use of clinical radiology

**Version 7**

<table>
<thead>
<tr>
<th>MBUR7 Reference:</th>
<th>-</th>
</tr>
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<tbody>
<tr>
<td>Clinical/Diagnostic problem</td>
<td>Investigation</td>
</tr>
<tr>
<td>Chronic lumbar back pain with no clinical or serological indicators of infection or neoplasia (ie, no red flags) <em>(For children see P11)</em></td>
<td>MRI</td>
</tr>
<tr>
<td></td>
<td>XR</td>
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<tr>
<td></td>
<td>CT</td>
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<td></td>
<td>NM</td>
</tr>
</tbody>
</table>

## MeSH terms / keywords used for literature search

- (back pain) OR (lower back pain) OR (low back pain) OR (backache)

## Literature search:

- Search Period: 1999-2009
- Refs Found: 130
- Refs Used: 9
- Refs from Previous Eds: 0

## Literature search & Delphi Questionnaires *(not for publication):*

- M01 M06 back pain - literature search.doc
- M04 Round 1 Delphi Questionnaire.doc
- M04 Delphi Round 2 Questionnaire philde
- Delphi Response Table M04.xls

## Composition of review panel *(not for publication):*

- Dr A Pope (MSK)
- Dr J Bell (MSK)
- Dr J Rankine (MSK)
- Dr P Wilson (MSK)
- Dr H El-Madbouh (MSK)
- Dr M Warren (MSK)
- Dr R Seymour (MSK)

## Existing NICE, SIGN & ACR Appropriateness Criteria:

- Low back pain

## Highest level of evidence:

ACR Appropriateness Criteria®

The ACR Appropriateness Criteria® are evidence-based guidelines to assist referring physicians and other providers in making the most appropriate imaging or treatment decision for a specific clinical condition. Employing these guidelines helps providers enhance quality of care and contribute to the most efficacious use of radiology.

**June 2012 update:** The ACR Appropriateness Criteria cover 180 topics with over 850 variants. Expert panels in diagnostic imaging, interventional radiology and radiation oncology develop the guidelines. Please see the sections below for additional details.

About the ACR Appropriateness Criteria

Learn about the key program elements and components, such as guiding principles, composition of the expert panels, and process for criteria development and review.

Abstract

The newly revised medical exposure directive (97/43/EC) lays down the general principles of radiation protection of individuals in relation to medical exposure. Member States had to transpose it into national legislation until 13 May 2000. Article 6(2) of the directive requires Member States to ensure that recommendations concerning referral criteria for medical exposure are available to the practitioners of medical exposure.

This booklet sets out referral guidelines that can be used by health professionals qualified to refer patients for imaging, in order to ensure that all examinations are well justified and optimised.

This booklet has evolved from that previously published by the UK Royal College of Radiologists in 1995 and entitled Making the best use of a department of clinical radiology: guidelines for doctors. These referral guidelines have been adapted by experts representing European radiology and nuclear medicine, in conjunction with the UK Royal College of Radiologists, and may now be adopted as models for the Member States.

These referral guidelines are not binding on Member States, and form part of a number of technical guidelines drawn up to facilitate implementation of the medical exposure directive. Local variations may be required according to healthcare practice and provision.

Continued use of recommendations of this kind should improve clinical practice and lead to a reduction in the number of referrals for investigation and consequently to a reduction in associated medical radiation exposure.
Guidelines: for whom?

• For referring practitioners: General Practitioners, doctors-in-training & non-medically qualified health professionals
• For radiology practitioners: ICRP level 2 justification
• For patients: reinforcement of advice “no decision about me without me”
• For healthcare organisations / ministries of health: decision support, planning and provision
Appropriateness and justification: barriers to clinician involvement

- Overloaded knowledge base
  - Medical and technical advances
  - Competition for inclusion in curricula/CPD
- Time challenged
  - Fastest test with shortest wait best?
- Mixed messages
  - Different guidance from different sources?
- Patient expectations
  - Historical or geographical bias
  - Unreliable evidence base from the web
### Justification and clinician involvement: possible solutions

<table>
<thead>
<tr>
<th>Education</th>
<th>Undergraduate, postgrad and CPD. Communication: <em>requests</em> not orders.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Referral Guidelines</td>
<td>Freely available from a trusted source, Concordant with clinical guidelines, +/- clinical decision support</td>
</tr>
<tr>
<td>Monitoring</td>
<td>Local internal audit (bottom up)</td>
</tr>
<tr>
<td></td>
<td>External audit (top down)</td>
</tr>
<tr>
<td>External control</td>
<td>Legislation</td>
</tr>
<tr>
<td></td>
<td>By payers / insurers</td>
</tr>
</tbody>
</table>

Referring Medical Practitioners

Radiological imaging is a major and increasing source of radiation exposure worldwide. Computed tomography (CT) is the largest contributor to medical radiation dose patients receive. Typically, CT scans impart doses to organs that are 100 times higher than doses imparted by other lower dose modalities such as chest X-rays. In general, CT examinations may involve doses (typically an average of 8 mSv) which may be equal to the dose received by several hundreds of chest X-rays (about 0.02 mSv/each chest X-ray).

During an IAEA consultation on justification in 2007, it was estimated that up to 50% of examinations may not be necessary. It should be anticipated that part of the increase in global annual mean dose that has been observed recently is due to unjustified radiological procedures. Direct epidemiological data suggest that medical exposure to low doses of radiation even as low as 10-50 mSv might be associated with a small risk of cancer induction in the long term [Brenner et al., 2003]. The fact that a considerable percentage of people may undergo repeated high dose examinations, such as CT (sometimes exceeding 10 mSv per examination) [Mettler et al., 2008], dictates that caution should be used when referring a patient for radiological procedures in order to make sure the patient is substantially benefited from the procedure and risk is kept minimal. However, ensuring maximum benefit to risk ratio for the patient is not a trivial task. Referring medical practitioners, in a large part of the world, lack training in radiation protection and in risk estimation. 97% of practitioners who participated in a study underestimated the dose the patient would receive from diagnostic procedures. The average mean dose was about 8 times higher than the physicians had estimated [Shiralkar et al., 2003].

The fundamental principles of radiation protection in medicine are justification and optimization of radiological protection. Referring medical practitioners have a major role in justification. They are responsible in terms of weighing the benefit versus the risk of a given radiological procedure.

1. What is justification and what is the framework?
2. Is the referring medical practitioner responsible for justification of radiological procedures?
3. How should justification be practiced and what knowledge is required for proper justification of a radiological procedure?
4. Is the acquisition of patients’ consent important?
5. When is an investigation useful and what are the reasons that cause unnecessary use of radiation?
6. What are the reasons for over-investigating?
7. Is there any guidance available?
Evidence for referral guidelines

• Following RCR guidelines, overall referrals fell 13%.
  BMJ. 1993 Jan 9;306(6870):119-1

• RCGP Randomized controlled trial showed fewer referrals and better conformance.

• Randomised trial Routine educational reminder messages in reports is effective in reduction by up to 20% & does not affect quality of referrals.

• Over 12 consecutive months no evidence of the effect of the intervention wearing off.

• Emerging evidence to show 2-20% improvement in conformance with clinical decision support tools.
Audit for guideline dissemination

Clinical Audit in Radiology: 100+ Recipes. RCR 1996.

88

RCR Guideline Distribution

THE AUDIT

Distribution of Royal College of Radiologists’ Guidelines to hospital staff.

BACKGROUND

- Why this audit is worth doing

The Royal College of Radiologists’ guidelines, Making the Best Use of a Department of Clinical Radiology (Ref. 1) are based on a multidisciplinary approach. However, they can only be effective if they are distributed and brought to the attention of referring clinical staff. This audit will determine whether distribution has occurred.
Audit: lumbar x-ray reduced 70%

GP Lumbar Spine Radiography referrals: an audit of current practice
Dr Kyriacos Patatas
Radiology Department, York Hospitals NHS Trust

OBJECTIVE:
To assess whether (1) GP lumbar spine radiography (LSR) referrals comply with RCR guidelines, and (2) to evaluate diagnostic yield of GP-referred LSRs

Background

LOW BACK PAIN IS VERY COMMON!
On any single day, 15% to 19% of UK adults report experiencing symptoms of low back pain (1).
Lumbar spine radiographs are commonly used to aid the diagnostic process.
There are 3 main concerns regarding the use of lumbar spine radiography:
1. Effectiveness (LSR is neither sensitive nor specific enough in the detection of many serious conditions, and may be falsely reassuring).
2. Cost (LSR is only likely to be defined as cost-effective when satisfaction is valued relatively high) (2)
3. Radiation risk (radiation dose 65 times that of a chest x-ray)

The recommendation from the Royal College of Radiologists (RCR) is that...

Results

There was significant reduction in the GP-requests for LSR (average 23 per month compared to 60 in 2006, when methods were introduced to reduce demand and first audit was conducted).

92% of referrals conformed to the RCR guidelines and were therefore performed. In 8% of the referrals there was no clear indication and were returned to the GP, but 6% of those were subsequently done after discussion with a radiologist.
EC guidelines on clinical audit for medical radiological practice

Acceptance of radiological clinical decision support

Adoption and meaningful use of computerized physician order entry with an integrated clinical decision support system for radiology: ten-year analysis in an urban teaching hospital.

Ip IK, Schneider LI, Hanson R, Marchello D, Hultman P, Viera M, Chiang E, Andriole KP, Menard A, Schade S, Seltzer SE, Khorasani R.
Center for Evidence-Based Imaging, Brigham and Women’s Hospital, Boston, MA 02120, USA. ljp@partners.org

Abstract

PURPOSE: The aim of this study was to assess whether an integrated imaging computerized physician order entry (CPOE) system with embedded decision support for imaging can be accepted clinically.

METHODS: The study was performed in a health care delivery network with an affiliated academic hospital. After pilot testing and user feedback, a Web-enabled CPOE system with embedded imaging decision support was phased into clinical use between 2000 and 2010 across outpatient, emergency department, and inpatient settings. The primary outcome measure was meaningful use, defined as the proportion of imaging studies performed with orders electronically created (EC) or electronically signed by an authorized provider. The secondary outcome measure was adoption, defined as the proportion of imaging studies that were ordered electronically, irrespective of who entered the order in the CPOE system. Univariate and multivariate regression analyses were performed to estimate trends and the significance of practice settings, examination modality, and body part to outcome measures. Chi-square statistics were used to assess differences across specialties.

RESULTS: A total of 4.1 million imaging studies were performed during the study period. From 2000 to 2010, significant increases in meaningful use (for EC studies, from 0.4% to 61.9%; for electronically signed studies, from 0.4% to 92.2%; P < .005) and the adoption of CPOE (from 0.5% to 94.6%, P < .005) were observed. The use of EC studies was greatest in the emergency department and inpatient settings. Meaningful use varied across specialties; surgical subspecialties had the lowest rates of EC studies.

CONCLUSIONS: Imaging CPOE with embedded decision support integrated into the IT infrastructure of the health care enterprise and clinicians' workflow can be broadly accepted clinically.
Referral Guidelines for Imaging

Referral Guidelines for Imaging – EC Tender

In April 2011 the EC published an invitation to tender for the implementation of Council Directive 97/43/Euratom requirements concerning referral criteria for medical imaging in the European Union. The objective of this tender is to review the situation in the EU Member States regarding the fulfillment of their obligations under the Medical Exposure Directive Article 6.2 (97/43/EURATOM). The ESR successfully applied for this Tender together with a consortium of organisations experienced in guideline work.

Consortium Partners

- European Society of Radiology (ESR) - Project Coordinator
- Royal College of Radiologists (RCR)
- Société Française de Radiologie (SFR)
- Cardiovascular and Interventional Radiology Society of Europe (CIRSE)
- European Society of Paediatric Radiology (ESPR)

In addition, an advisory board was composed of representatives of relevant professional disciplines, as well as experts from the World Health Organisation, the International Atomic Energy Agency and various national authorities.

The project started in December 2011. The kick-off meeting with the European Commission took place in Luxembourg on January 19, 2012.

Steering Committee Members

Dr. Denis Remedios, ESR
Mag. Monika Hierath, ESR
Dr. Peter Cavanagh, RCR
Dr. Jean-Francois Chatell, ESPR
Prof. Mario Bezzi, CIRSE
Prof. Philippe Grenier, SFR
Mr. Georgi Smanov, EC
The image gently Campaign is an initiative of the Alliance for Radiation Safety in Pediatric Imaging. The campaign is to change practice by increasing awareness of the opportunities to promote radiation protection in the imaging of children.

Image Gently Impact

The image gently campaign launched 1/22/08. This is a snapshot of what has happened since:

- 18,180 medical professionals have taken the pledge
- This website has been visited 391,142 times
- The CT protocol has been downloaded over 26,425 times

Click here to take the image gently pledge.

Recent News

http://www.pedrad.org/associations/5364/ig/
RECENT DEVELOPMENTS

New Manufacturer and Model-Specific CT Protocols Available

The American Association of Physicists in Medicine (AAPM) has added Routine Adult Abdomen/Pelvis CT to its set of scan protocols for frequently performed CT examinations.

>> Learn More

New Computed Tomography Radiation Dose Education Slides

The AAPM recently posted new Computed Tomography Radiation Dose Education slides in its CT Scan Protocols

http://www.imagewisely.org/
# International Workshop on Justification of Medical Exposure in Diagnostic Imaging

2-4 September 2009  
Albert Borschette Conference Centre (CCAB)  
36, rue Froissart, Brussels, Belgium  

## PROGRAMME

### Wednesday, 2 September 2009

<table>
<thead>
<tr>
<th>Time</th>
<th>Session 1</th>
<th>Speaker/Institution</th>
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</table>
| 14:00h| Opening Statements and Welcome | Eliana Amaral (IAEA)  
Augustin Janssens (EC) |
| 14:30h| SCENE SETTING | Chair: John Mayo (CAN)  
Rapporteur: G. O’Reilly (IRL) |
| 14:50h| Justification: The IAEA Initiative | Ola Holmberg (IAEA) |
| 15:20h| Scene Setting for the Workshop | Jim Malone (IAEA) |
| 15:50h| Re-examining Ethical Issue: Philosophical Considerations | Santiago Sia (IRL) |
| 16:10h| Tea/Coffee |  |
| 16:10h| Legal Basis and Consent Issues | Ciaran Craven (IRL) |
| 16:40h| Health Economics Considerations | Isabelle Durand-Zalenski (FRA) |
| 17:05h| Addressing Over-utilization in Medical Imaging: Ideas from the 2009 ABRF/ABR/NIBIB Workshop | William Hendee (USA) |
| 17:30h| Plenary Discussion* |  |
| 18:00h-19:00h| Informal get-together |  |

### Thursday, 3 September 2009

<table>
<thead>
<tr>
<th>Time</th>
<th>Session 2</th>
<th>Speaker/Institution</th>
</tr>
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| 09:00h| REFERRAL GUIDELINES | Chair: Maria Neira (WHO)  
Rapporteur: Dieter Regulla (DEU) |
| 09:00h| Referral Guidelines: Why, How and for Whom? | Denis Remedios (GBR) |
| 09:30h| Radiology Guidelines in Ice and Snow: A Topic Clinicians are Warming to | John Mayo (CAN) |
## Agenda

**Thursday, April 22, 2010**

<table>
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<tr>
<th>Time</th>
<th>Event</th>
<th>Speaker and Details</th>
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<tbody>
<tr>
<td>7:30-8:00</td>
<td>Welcome Coffee</td>
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<tr>
<td>8:00-8:15</td>
<td>Greetings</td>
<td><strong>Dr. Martin Reed</strong>, Symposium Chair and Chair, CAR Guidelines Working Group</td>
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<tr>
<td>8:15-9:15</td>
<td>The World of Guideline Development: Sharing the Issues, Developing the Solutions Together</td>
<td><strong>Dr. Sara Twaddle</strong>, President of Guidelines International Network (GIN)</td>
</tr>
<tr>
<td>9:15-10:00</td>
<td>The ACR Appropriateness Criteria: Aims, Scope, Methods and Utilization</td>
<td><strong>Dr. Michael Bettmann</strong>, Chair of the Appropriateness Criteria Committee, American College of Radiology</td>
</tr>
<tr>
<td>10:00-10:30</td>
<td>Mid-morning Coffee Break</td>
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<tr>
<td>10:30-11:15</td>
<td>Referral Guidelines in the UK: Making the Best Use of Clinical Radiology Services</td>
<td><strong>Dr. Denis Remedios</strong>, Chair of the Guidelines Working Party, Royal College of Radiologists, UK</td>
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<tr>
<td>11:15-12:00</td>
<td>Diagnostic Imaging Pathways: An Australian Experience</td>
<td><strong>Dr. Richard Mendelson</strong>, Editor, Diagnostic Imaging Pathways, Australia</td>
</tr>
<tr>
<td>12:00-13:15</td>
<td>Lunch</td>
<td></td>
</tr>
<tr>
<td>13:15-14:00</td>
<td>The French Guidelines for the Clinical Use of Medical Imaging</td>
<td><strong>Dr. Philippe Grenier</strong>, Professor of Radiology and Chair of the Committee for Referral Guidelines Société Française de Radiologie, France</td>
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</table>
Medical imaging specialists call for global referral guidelines

Key representatives of the world's leading medical imaging societies have recommended that a common set of global referral guidelines for appropriate use of medical imaging be produced, in the first such global meeting of experts convened under WHO auspices in nearly two decades.

Experts from international, regional and national professional societies as well as the International Atomic Energy Agency and the European Commission, met in the WHO-hosted consultation in Geneva, 1-3 March, 2010. The consultation, “Referral Guidelines for Appropriate Use of Radiation Imaging”, was held in the context of the WHO Global Initiative on Radiation Safety in Health Care Settings (Global Initiative), launched in December 2008.
Radiology’s Role in Enhanced International Health Care

Inherent in our human nature is a sense of common identity with mankind. When we perceive severe disparities in that common identity, human nature, at least among charitable people, directs us to address those disparities and provide whatever effort is possible to eliminate them. There clearly are significant disparities in the ability of individuals throughout the world to have access to excellent, or in many cases even adequate, health care. There currently are myriad individuals and organizations providing variable levels of effort to eliminate those disparities. Since radiology and medical imaging now play such a central and indispensable role in health care delivery, it behooves us to know what efforts are being made, co-planned program will include two days of both didactic and hands-on training, focused on plain film and ultrasound. The Foundation has not limited its efforts to Haiti but has also awarded four Goldberg-Reeder resident travel grants through which US residents can spend at least one month providing educational aid to facilities in Nigeria, Kenya, Bangladesh, and Uganda.

Similar efforts are being fostered by radiologists in other developed nations but thus far there has been no central coordination of this process. Therefore I have made a proposal, which was accepted by the International Society of Radiology (ISR), to create a method for such coordination. Under the leadership of Dr. Borgstede, and with participants from economically privileged regions such as the United States and Western Europe may not be readily applied in countries with fewer economic resources. Therefore, the ACR has created the concept of an annual Global Summit on Radiological Quality and Safety (GSRQS). Under the leadership of James Brink, MD, the ACR has engaged the European Society of Radiology and the ISR as co-conveners of this summit, which intends to create an innovative alliance and network of regional, national, and world health organizations, governmental agencies, nongovernmental organizations, and corporations that share a dedication to radiological quality and safety for economically disadvantaged nations.
Justification for the use of radiation in medicine:
Awareness, appropriateness and audit

- **Faster** justification (with clinical decision support) for the best test first
- **Higher** level of appropriateness; lower dose
- **Stronger** collaboration between 3Rs, referrers, radiologists & regulators for better outcomes