MRI in Resource-Limited Settings

Samuel A. Einstein, Ph.D.

2022 AAPM Annual Meeting

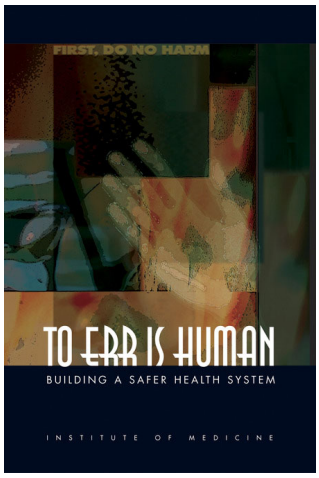
12 July 2022

Questions to be answered

- What is equity in medical imaging?
- How available is MR imaging in rural areas?
- How do pacemakers and other implants affect MR accessibility?
- How can physicists help?

What is equity in medical imaging?

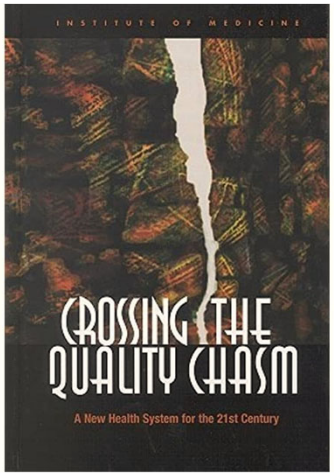
A landmark report



- "Even when using the lower estimate, deaths due to medical errors exceed the number attributable to the 8th-leading cause of death. More people die in a given year as a result of medical errors than from motor vehicle accidents, breast cancer, or AIDS."

Donaldson, Molla S., Janet M. Corrigan, and Linda T. Kohn, eds. "To err is human: building a safer health system." (2000).

The sequel



- "That all health care constituencies… commit to a national statement of purpose for the health care system as a whole and to a shared agenda of six aims for improvement that can raise the quality of care to unprecedented levels."

Institute of Medicine (US) Committee on Quality of Health Care in America. "Crossing the Quality Chasm: A New Health System for the 21st Century." (2001).

The six aims

- Safe
- Effective
- Patient-centered
- Timely
- Efficient
- Equitable

- Equitable-providing care that does not vary in quality because of personal characteristics such as gender, ethnicity, geographic location, and socioeconomic status.

Institute of Medicine (US) Committee on Quality of Health Care in America. "Crossing the Quality Chasm: A New Health System for the 21st Century." (2001).

The importance of healthcare equity

"And, most important, we must build a 21st century health care system that is more equitable and meets the needs of all Americans without regard to race, ethnicity, place of residence, or socioeconomic status, including the nearly 43 million people who currently lack health insurance."

Institute of Medicine (US) Committee on Quality of Health Care in America. "Crossing the Quality Chasm: A New Health System for the 21st Century." (2001).

JAMA Network Open

Original Investigation | Health Policy

Racial and Ethnic Disparities in the Use of Prostate Magnetic Resonance Imaging Following an Elevated Prostate-Specific Antigen Test

Nino Abashidze, PhD; Chad Stecher, PhD; Andrew B. Rosenkrantz, MD, MPA; Richard Duszak Jr, MD; Danny R. Hughes, PhD

ORIGINAL ARTICLE HEALTH SERVICES RESEARCH AND POLICY | VOLUME 16, ISSUE 1, P15-23, JANUARY 01, 2019

Geographic Access to CT for Lung Cancer Screening: A Census Tract-Level Analysis of Cigarette Smoking in the United States and Driving Distance to a CT Facility

Survey of Experiences of Transgender and Gender Nonbinary Patients During Imaging Encounters and Opportunities for Improvement

Frances W. Grimstad[1]
Justin T. Stowell[2]
Monica Gaddis[3]

OBJECTIVE. The purpose of this study was to assess the inclusivity of imaging centers for transgender and gender nonbinary (TGNB) patients and those patients' level of comfort during imaging center visits.

Original Article

Disparities in the Use of Screening Magnetic Resonance Imaging of the Breast in Community Practice by Race, Ethnicity, and Socioeconomic Status

Jennifer S. Haas, MD, MSc[1]; Deirdre A. Hill, PhD[2]; Robert D. Wellman, MS[3]; Rebecca A. Hubbard, PhD[4]; Christoph I. Lee, MD, MSHS[5,6]; Karen J. Wernli, PhD[3]; Natasha K. Stout, PhD[7]; Anna N.A. Tosteson, ScD[8]; Louise M. Henderson, MSPH, PhD[9]; Jennifer A. Alford-Teaster, MA, MPH[9]; and Tracy L. Onega, PhD, MA, MS[10]

ORIGINAL ARTICLE CLINICAL PRACTICE MANAGEMENT | VOLUME 16, ISSUE 2, P185-193, FEBRUARY 01, 2019

Access to Interventional Radiology Services in Small Hospitals and Rural Communities: An ACR Membership Intercommission Survey

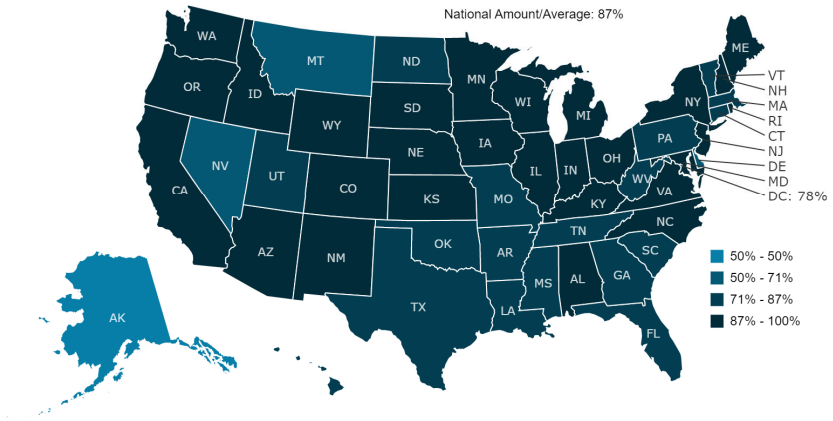
Eric B. Friedberg, MD • David Corn, MS • J. David Prologo, MD • ... Robert Pyatt, MD • Richard Duszak, MD • Phil Cook, MD • Show all authors

Assessment of Racial/Ethnic Disparities in Volumetric MRI Correlates of Clinical Disability in Multiple Sclerosis: A Preliminary Study

Carlos A. Pérez, Alireza Salehbeiki, Liang Zhu, Jerry S. Wolinsky, and John A. Lincoln

How available is MR imaging in rural areas?

The availability of MRI



Harvey L. Neiman Health Policy Institute, American College of Radiology

Geography matters

- ~20% of the US population (~60 million) resides in rural areas.
- Critical access hospitals (CAHs) are often the most important (if not the only) source of health care.
- As of 2014, less than half of CAHs offered MRI.
- In no state was MRI available at all CAHs.

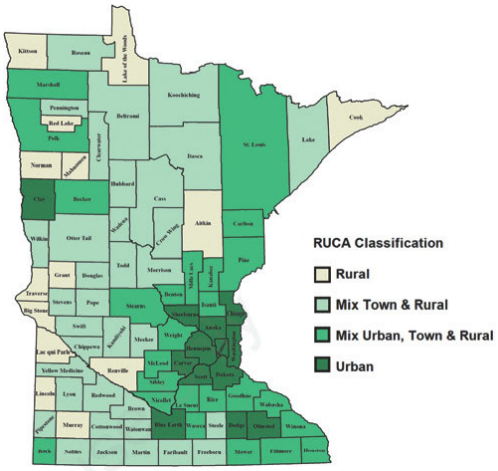
Khaliq, Amir A., et al. "The scope and distribution of imaging services at critical access hospitals." Journal of the American College of Radiology 11.9 (2014): 857-862.

What about ERs?

- 262 randomly selected EDs were telephoned.
- On-site MRI was available at 66% institutions and mobile MRI for 20%.
- Smaller, rural, and critical access hospitals had lower MRI availability.

Ginde, Adit A., et al. "Availability and quality of computed tomography and magnetic resonance imaging equipment in US emergency departments." *Academic emergency medicine* 15.8 (2008): 780-783.

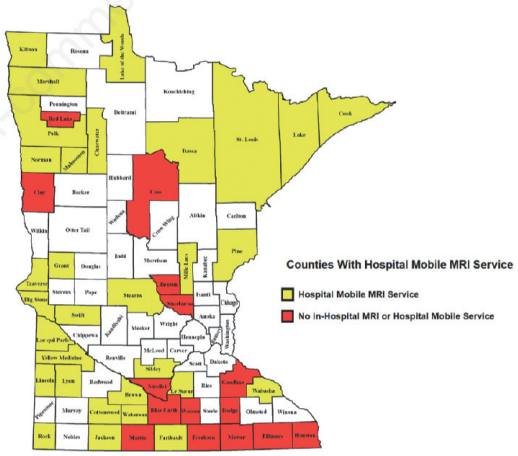
Minnesota as an example



Burdorf, Benjamin T. "Comparing magnetic resonance imaging and computed tomography machine accessibility among urban and rural county hospitals." Journal of Public Health Research 11.1 (2022).

Minnesota as an example

County	Hospitals with Mobile MRI
Big Stone	2
Brown	1
Clearwater	1
Cook	1
Cottonwood	2
Faribault	1
Grant	1
Itasca	1
Jackson	1
Kittson	1
Lac qui Parle	2
Lake	1
Lake of the Woods	1
Le Sueur	1
Lincoln	2
Lyon	1
Mahnomen	1
Marshall	1
Mille Lacs	1
Norman	1
Pine	1
Polk	1
Rock	1
St. Louis	1
Sibley	1
Stearns	1
Swift	2
Traverse	1
Wabasha	1
Watonwan	1
Yellow Medicine	2



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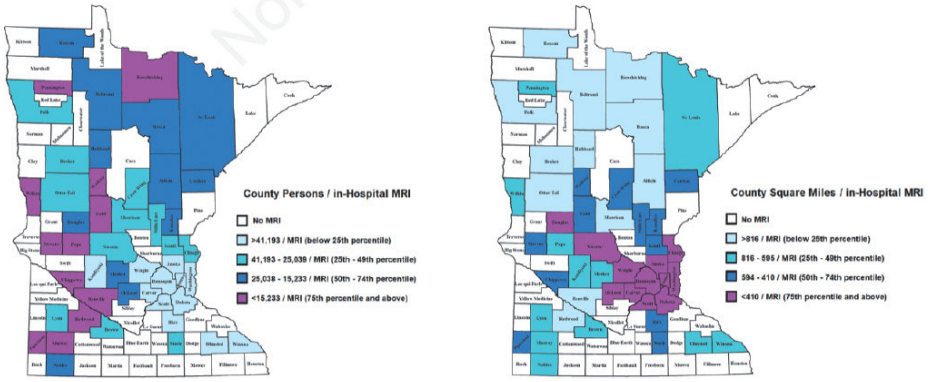
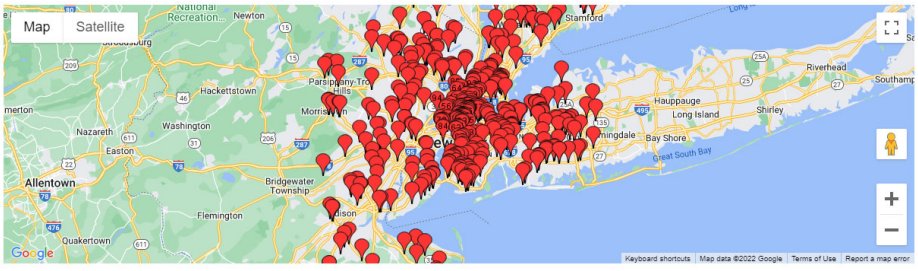
Minnesota as an example



Burdorf, Benjamin T. "Comparing magnetic resonance imaging and computed tomography machine accessibility among urban and rural county hospitals." Journal of Public Health Research 11.1 (2022).

Manhattan



434 Accredited facilities | 3 Facilities in process

https://www.acraccreditation.org/accredited-facility-search

Northern Wisconsin

There are no facilities within or near 54806. Please try again ...

https://www.acraccreditation.org/accredited-facility-search

How do CIEDs and other implants affect MR accessibility?

Most CIEDs are low risk in MRI

- Cardiovascular implantable electronic devices (CIEDs) are broadly classified as MR-conditional or non-MR conditional (aka 'legacy').
- The large body of research to date has demonstrated that both types of devices are low-risk from a physics/radiology perspective if proper procedures are followed.
- The Centers for Medicare & Medicaid Services (CMS) now reimburses for scanning both conditional and non-conditional devices.
- Emerging research demonstrates that scanning abandoned pacing leads is likely safer than extracting pacing leads though this is still not covered by CMS.

Russo, Robert J. "Removing Obstacles to Magnetic Resonance Imaging for Patients With a Pacemaker or a Defibrillator." *JAMA cardiology* 6.5 (2021): 556-557.

Patients w/ CIEDs need MRIs

- Patients with CIEDs often have co-morbidities and have a greater need for MRI access.
- 50-75% of pacemaker patients will need an MRI in their lifetime.

Mar, Philip L., et al. "Cost-effectiveness analysis of magnetic resonance imaging–conditional pacemaker implantation: Insights from a multicenter study and implications in the current era." *Heart Rhythm* 15.11 (2018): 1690-1697.

Are 'legacy' devices going away?

- No, non-MR conditional CIEDs are still being implanted.
- As of 2018, about 25% of implanted pacemakers were not MR-conditional.

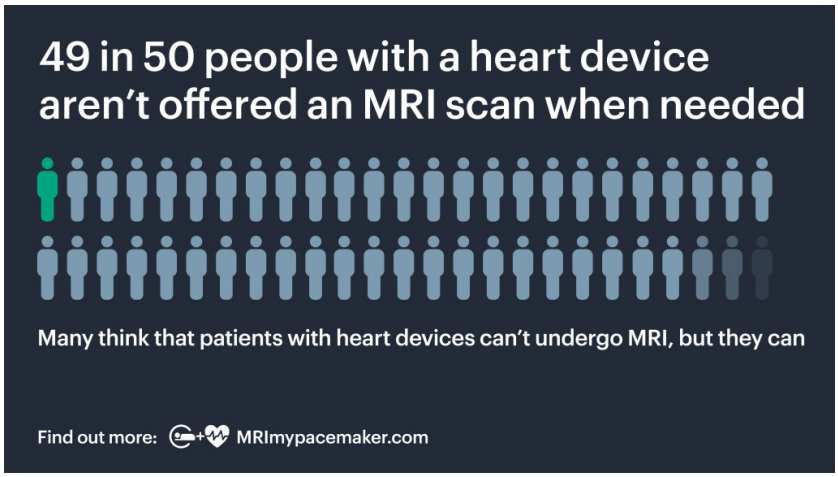
Gopinathannair, Rakesh, et al. "Incidence and predictors of MRI scan utilization in MRI-conditional pacemaker recipients: A multicenter experience." *Pacing and Clinical Electrophysiology* 41.11 (2018): 1519-1525.

How do CIEDs and other implants affect MR accessibility?

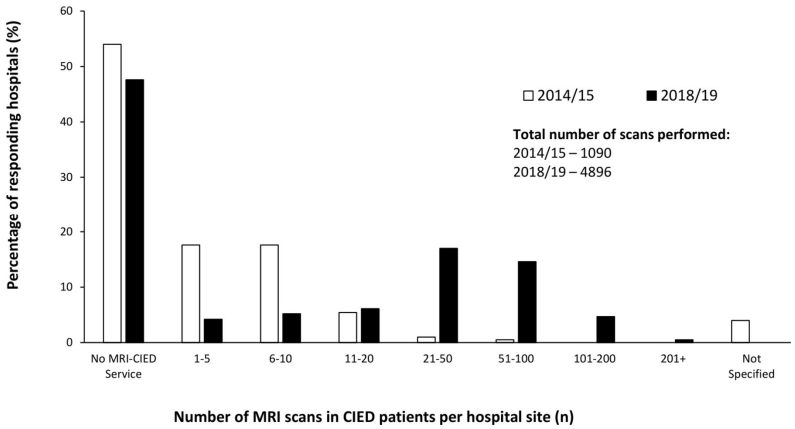
???

- ???

In the UK


49 in 50 people with a heart device aren't offered an MRI scan when needed
Many think that patients with heart devices can't undergo MRI, but they can
Find out more: MRImypacemaker.com

In the UK



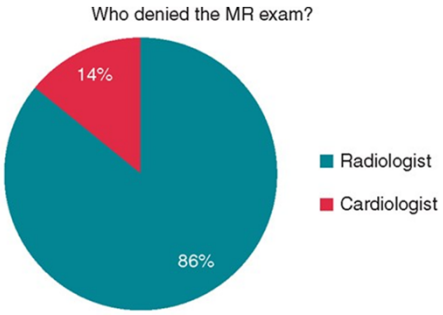
Pieri, Christopher, et al. "Access to MRI for patients with cardiac pacemakers and implantable cardioverter defibrillators." Open Heart (2021).

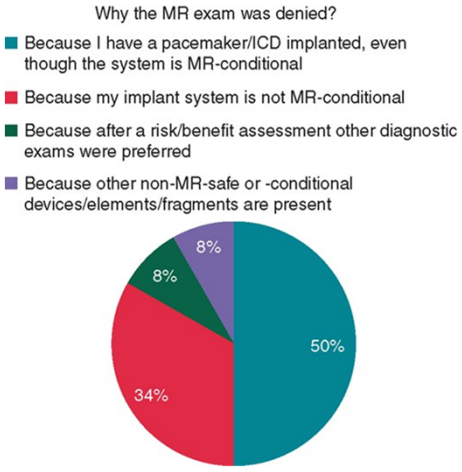
In Italy

- Study looked at patients with MR-conditional devices implanted at 21 sites.
- Within one year, 6% of patients were referred for MRI.
- 17% and 71% of patients with pacemakers and ICDs, respectively, were denied.

Celentano, Eduardo, et al. "Access to magnetic resonance imaging of patients with magnetic resonance-conditional pacemaker and implantable cardioverter-defibrillator systems: results from the really ProMRI study." *EP Europace* 20.6 (2018): 1001-1009.

In Italy





Celentano, Eduardo, et al. "Access to magnetic resonance imaging of patients with magnetic resonance-conditional pacemaker and implantable cardioverter-defibrillator systems: results from the really ProMRI study." *EP Europace* 20.6 (2018): 1001-1009.

In Australia

- 35 tertiary referral public hospitals were surveyed.
- 86% offered MRI for MR-conditional CIEDs.
- 9% offered MRI for non-conditional CIEDs.
- The principal barrier was the absence of national guidelines, followed by lack of formal training and/or logistical device support.

Page, N., et al. "Assessing access to MRI in patients with cardiac implantable electronic devices in Australia." *European Heart Journal-Cardiovascular Imaging* 22.Supplement_2 (2021): jeab090-041.

How can physicists help?

More research

- We can't fix the problem until we understand it.
- We need in-depth information regarding MR access in rural areas-especially for patients with implants.
- We need to know what barriers exist to equitable MR access.
- We need to know what policies break down these barriers.

Improve policies

- Review MR safety policies during annual evaluations of MR scanners.
- Improving the policies can both prevent injury and increase access.
- If you need to brush up on your MR safety knowledge: ISMRM Workshop on MR Safety October 21-23 at NYU.

CIED policies

- Implementation of a 'one-stop' service model can help.[1]
- Remote programming of CIEDs may be a good option for smaller programs.[2]
- Example SOPs and patient education can be found on MRImyPacemaker.com

1. Bhuva, Anish N., et al. "MRI for patients with cardiac implantable electronic devices: simplifying complexity with a 'one-stop'service model." *BMJ Quality & Safety* 28.10 (2019): 853-858.
2. Siddamsetti, Sisir, Alexander Shinn, and Sandeep Gautam. "Remote programming of cardiac implantable electronic devices: A novel approach to program cardiac devices for magnetic resonance imaging." *Journal of Cardiovascular Electrophysiology* 33.5 (2022): 1005-1009.

Improve reimbursement

- Additional work related to safely scanning implants is not currently reimbursed.
- Off-label scanning may require hours of personnel effort (e.g. see TU-D1000-IePD-F6-5 Time Cost of Off-Label MR Scanning of Patients with Active Implants by Panda et al).
- We need CPT codes to compensate technologists, physicists, and physicians for performing this essential service.

Develop low-cost, portable MRI

- Initial cost and ongoing maintenance is a large barrier to MR service.
- Low-field, head-only systems are a potential solution for increasing MR access including for those with implanted devices.
- There are ethical issues related to the development of these systems.

Contents lists available at ScienceDirect

NeuroImage

journal homepage: www.elsevier.com/locate/neuroimage

Emerging ethical issues raised by highly portable MRI research in remote and resource-limited international settings

Francis X. Shen[o,*], Susan M. Wolf[s,#], Supriya Bhavnani[a], Sean Deoni[b], Jed T. Elison[c], Damien Fair[d], Michael Garwood[e], Michael S. Gee[f], Sairam Geethanath[g], Kendrick Kay[h], Kelvin O. Lim[i], Georgia Lockwood Estrin[j], Monica Luciana[k], David Peloquin[l], Karen Rommelfanger[m], Nicoline Schiess[n], Khan Siddiqui[p], Efraín Torres[q], J. Thomas Vaughan[r]

Time for a new program?

image ❤ everyone

Thank you!