Estimating the size of the clinical medical imaging physics workforce

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Department of Diagnostic and Interventional Imaging
Disclosures

• Author has a patent “Apparatus for Tomography Repeat Rate/Reject Capture”
• Author receives research funding from Imalogix LLC
Outline

• Motivation and background

• Previous efforts
  • 2009 SUNY Albany CHWS Workforce Study
  • 2015 AAPM/SNMMI Joint Task Force on Nuclear Medicine Physics Training

• Current efforts of the DDSPWG
How many imaging physics residency programs do we need?

As of 3/24/2022, I count 38 accredited programs on the CAMPEP website. 12 of these also offer nuclear medicine option.

How many imaging physics residency programs do we need?

Residents admitted

<table>
<thead>
<tr>
<th>Specialty</th>
<th>2019</th>
<th>2020</th>
</tr>
</thead>
<tbody>
<tr>
<td>Therapy</td>
<td>149</td>
<td>147</td>
</tr>
<tr>
<td>Imaging</td>
<td>27</td>
<td>42</td>
</tr>
</tbody>
</table>

Total residents

<table>
<thead>
<tr>
<th>Total # of Residents</th>
<th>2019</th>
<th>2020</th>
</tr>
</thead>
<tbody>
<tr>
<td>Therapy</td>
<td>339</td>
<td>338</td>
</tr>
<tr>
<td>Imaging</td>
<td>64</td>
<td>73</td>
</tr>
<tr>
<td>Nuclear Medicine</td>
<td>5</td>
<td>11</td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td><strong>408</strong></td>
<td><strong>422</strong></td>
</tr>
</tbody>
</table>

How long do AAPM/RSNA need to keep funding new imaging residency slots?

2022 AAPM / RSNA Imaging Physics Residency Grant:

The purpose of the AAPM funding is to provide 50% support of a resident’s salary for two imaging physics residency programs. The awardee institution(s) will provide the other 50% support. After the period of the award is over, the intent is that the awardee institution(s) will continue to fully support this new imaging physics residency position. Demonstration of this intent should be included in the application materials.

History:
On November 29, 2017, the AAPM Board of Directors approved $140,000 in funding for two new imaging physics residency positions, in diagnostic, diagnostic with a nuclear medicine option, or nuclear medicine. With this funding, the selected institution(s) will receive $35,000 per year for two years as matching support for one resident.

The AAPM Board of Directors has approved $420,000 in support over 6-years ($70,000/year starting in 2019) to fund six spots in existing or new imaging residency programs. The RSNA Board of Directors approved $210,000 in funding for 3 additional slots in existing or new imaging residency programs.

How do we answer these questions?

• We need to know how many of us are needed
  • Demand

• We need to know how many of us there are
  • Supply

• Need to know additional details about each, for example...
  • Are there surrogates we can use to predict demand?
  • How many people do we need to train each year to maintain the size of our current workforce?
The DDSPWG

## The DDSPWG (as of 3/24/2022)

### VOTING Appointments

There are 6 voting members.

<table>
<thead>
<tr>
<th>Name</th>
<th>Position</th>
<th>Email</th>
<th>Start Date</th>
<th>End Date</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nicholas B. Bevins, PhD</td>
<td>Member</td>
<td><a href="mailto:nickde@rad.hth.edu">nickde@rad.hth.edu</a></td>
<td>1/1/2019</td>
<td>12/31/2024</td>
</tr>
<tr>
<td>Jaydev K. Dave, PhD</td>
<td>Member</td>
<td><a href="mailto:jaydev.dave@jefferson.edu">jaydev.dave@jefferson.edu</a></td>
<td>1/1/2019</td>
<td>12/31/2024</td>
</tr>
<tr>
<td>David E. Hintenlang, PhD</td>
<td>Member</td>
<td><a href="mailto:David.Hintenlang@osumc.edu">David.Hintenlang@osumc.edu</a></td>
<td>1/1/2019</td>
<td>12/31/2024</td>
</tr>
<tr>
<td>David W. Jordan, PhD</td>
<td>Workgroup Chair</td>
<td><a href="mailto:david.jordan@uhhospitals.org">david.jordan@uhhospitals.org</a></td>
<td>1/1/2019</td>
<td>12/31/2024</td>
</tr>
<tr>
<td>Brad K. Lofton, MS</td>
<td>Member</td>
<td><a href="mailto:b.lofton@campphysics.com">b.lofton@campphysics.com</a></td>
<td>1/1/2019</td>
<td>12/31/2024</td>
</tr>
<tr>
<td>Sean D. Rose</td>
<td>Member</td>
<td><a href="mailto:sean.d.rose@uth.tmc.edu">sean.d.rose@uth.tmc.edu</a></td>
<td>10/4/2021</td>
<td>12/31/2024</td>
</tr>
</tbody>
</table>

### NON-VOTING Appointments

There are 1 non-voting members and guests.

<table>
<thead>
<tr>
<th>Name</th>
<th>Position</th>
<th>Email</th>
<th>Start Date</th>
<th>End Date</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pankaj Patel Ph.D.</td>
<td>Guest (nonvoting)</td>
<td><a href="mailto:pankajp@rad.hth.edu">pankajp@rad.hth.edu</a></td>
<td>7/29/2020</td>
<td>12/31/2022</td>
</tr>
</tbody>
</table>

Some efforts that get at demand via staffing


AAPM-ACMP Recommendations (1993)

Cypel and Sunshine (2004)


<table>
<thead>
<tr>
<th>Equipment</th>
<th>PTE's per Equipment</th>
<th>Recommended PTE Physicists</th>
</tr>
</thead>
<tbody>
<tr>
<td>15 general x-ray rooms</td>
<td>0.015/room</td>
<td>0.225</td>
</tr>
<tr>
<td>4 FF rooms</td>
<td>0.05/room</td>
<td>0.20</td>
</tr>
<tr>
<td>3 special procedures rooms</td>
<td>0.08/room</td>
<td>0.24</td>
</tr>
<tr>
<td>2 digital systems</td>
<td>0.04/system</td>
<td>0.28</td>
</tr>
<tr>
<td>1 CT scanner</td>
<td>0.08/room</td>
<td>0.28</td>
</tr>
<tr>
<td>5 radiographic portable units</td>
<td>0.015/unit</td>
<td>0.675</td>
</tr>
<tr>
<td>2 portable fluoroscopic units</td>
<td>0.03/unit</td>
<td>0.66</td>
</tr>
<tr>
<td>2 nuclear medicine imagers</td>
<td>0.10/unit</td>
<td>0.20</td>
</tr>
<tr>
<td>1 image processing computer</td>
<td>0.25/unit</td>
<td>0.25</td>
</tr>
<tr>
<td>1 SPECT unit</td>
<td>0.25/unit</td>
<td>0.25</td>
</tr>
<tr>
<td>4 ultrasound units</td>
<td>0.015/unit</td>
<td>0.06</td>
</tr>
</tbody>
</table>

Total........................................1.72

Practical Staffing: 2.0 FTE Physicists and 2.6 (1.5 x 1.75) FTE Support Staff

AAPM Report 301 (2017) and the LoS model
Some efforts that get at supply

**SUNY Albany Center for Health Workforce Studies (CHWS) 2009 Workforce Study (also created a demand model)**

**Workforce Study and Professional Survey Validation | AAPM Professional Council**

April 14, 2011

Dear colleagues,

In January 2009, the AAPM sponsored two studies to be conducted by the Center for Health Workforce Studies at the School of Public Health at the State University of New York – Albany (SUNY).

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<table>
<thead>
<tr>
<th>Source</th>
<th>NM</th>
<th>NM+DX</th>
<th>NM+TX</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>CRCPP/ABR</td>
<td>184</td>
<td></td>
<td>9</td>
<td>294</td>
</tr>
<tr>
<td>CRCPP/ABSNM</td>
<td>185</td>
<td></td>
<td>99</td>
<td>294</td>
</tr>
<tr>
<td>ABR</td>
<td></td>
<td>9</td>
<td>10</td>
<td>294</td>
</tr>
</tbody>
</table>

Outline

• Motivation and background

• Previous efforts
  • 2009 SUNY Albany CHWS Workforce Study
  • 2015 AAPM/SNMMI Joint Task Force on Nuclear Medicine Physics Training

• Current efforts of the DDSPWG
The CHWS reports and models are freely available to AAPM members!

What was the purpose of the 2009 study?

The first study was a comprehensive study of the medical physics workforce to better understand current supply and demand for the profession. The study was designed to guide future policy initiatives related to education, training, and credentialing of medical physicists. The SUNY Center for Health Workforce Studies conducted interviews and focus groups, surveyed thousands of medical physicists, and developed simulation models to project supply and demand over the next two decades under various scenarios. They considered the evolving nature of education and training programs, including the requirement for residency training for clinical medical physicists. They also developed a simulation model for non-clinical medical physicists.


• This was before the 2012/2014 changes to ABR certification requirements
• At least partially motivated by wanting to understand the impact the change would have on supply/demand
What was the purpose of the 2009 study?

The first study was a comprehensive study of the medical physics workforce to better understand current supply and demand for the profession. The study was designed to guide future policy initiatives related to education, training, and credentialing of medical physicists. Studies conducted interviews and focus groups, surveyed the workforce present at AAPM meetings to understand supply and demand over the next two decades, and used regression models to project supply and demand. The study also examined the evolving nature of education and training programs, including the growing number of physicists co-habiting with medical physicists. They also developed a simulation model of workforce supply and demand.

They also conducted a study to validate the accuracy of the annual AAPM Professional Survey conducted by AIP.


• This was before the 2012/2014 changes to ABR certification requirements

• At least partially motivated by wanting to understand the impact the change would have on supply/demand
What did they do?

- a literature review and background report including a longitudinal analysis of historical trend data;
- interviews and focus groups with nearly 80 individuals knowledgeable about the medical physics profession;
- a survey of all currently active MPs including students, residents, educators, consultants, and employed MPs conducted in 2009 (N=5,487, response rate 48.1%); and
- development of simulation models to project supply and demand for MPs over the next 20 years under a number of training scenarios using data collected in the annual AAPM American Institute of Physics and the 2009 Center surveys.

They did a lot; details are available in the reports on the AAPM website

Here we’re going to focus on the stuff pertinent to the simulation models

The survey noted above was of the AAPM membership
So how does their model work?

CHWS Supply and Demand Projections

The demand model

The demand model

• Ties demand for FTEs ($d_{FTE}$) to US Census Bureau population projections ($p$) assuming we had the “right” number of imaging physicists in 2009 ($t_0$)

• In 2009, they estimated we had 1 FTE per 736,000 people, thus

$$d_{FTE}(t_0) = \frac{p(t_0)}{736000}$$

• They then modeled 2 demand scenarios
  • Baseline scenario (demand grows to maintain 1 FTE per 736000 people)

$$d_{FTE}(t_{k+1}) = \frac{p(t_{k+1})}{736000}$$

  • “Under pressure” scenario (demand grows at half baseline rate)

$$d_{FTE}(t_{k+1}) = d_{FTE}(t_k) + \frac{1}{2} \times \frac{p(t_{k+1}) - p(t_k)}{736000}$$

i.e., demand proportional to population!
The supply model

Figure 20 – Projected Diagnostic Imaging Physicist and Physicist FTE Supply, 2009-2030

The supply model

• Modeled number of physicists in 3 career “phases”

The supply model... in math

\[ f_1(t_{k+1}) = f_1(t_k) + g(t_k) - (c_1 + a_1)f_1(t_k) \]
\[ f_2(t_{k+1}) = f_2(t_k) + c_1 f_1(t_k) - (c_2 + a_2)f_2(t_k) \]
\[ f_3(t_{k+1}) = f_3(t_k) + c_2 f_2(t_k) - (c_3 + a_3)f_3(t_k) \]

\[ t_k \text{ runs from 2009 to 2030 in steps of 1 year} \]
The supply model... in math

Physicists in career phase 1 at beginning of year $t_{k+1}$

\[ f_1(t_{k+1}) = f_1(t_k) + g(t_k) - (c_1 + a_1)f_1(t_k) \]
\[ f_2(t_{k+1}) = f_2(t_k) + c_1 f_1(t_k) - (c_2 + a_2)f_2(t_k) \]
\[ f_3(t_{k+1}) = f_3(t_k) + c_2 f_2(t_k) - (c_3 + a_3)f_3(t_k) \]
The supply model... in math

Physicists in career phase 1 at beginning of year $t_k$

\[
\begin{align*}
  f_1(t_{k+1}) &= f_1(t_k) + g(t_k) - (c_1 + a_1)f_1(t_k) \\
  f_2(t_{k+1}) &= f_2(t_k) + c_1f_1(t_k) - (c_2 + a_2)f_2(t_k) \\
  f_3(t_{k+1}) &= f_3(t_k) + c_2f_2(t_k) - (c_3 + a_3)f_3(t_k)
\end{align*}
\]
The supply model... in math

Physicists entering career phase 1 during year $t_k$
(from residencies or other pathways)

\[
\begin{align*}
    f_1(t_{k+1}) &= f_1(t_k) + g(t_k) - (c_1 + a_1)f_1(t_k) \\
    f_2(t_{k+1}) &= f_2(t_k) + c_1f_1(t_k) - (c_2 + a_2)f_2(t_k) \\
    f_3(t_{k+1}) &= f_3(t_k) + c_2f_2(t_k) - (c_3 + a_3)f_3(t_k)
\end{align*}
\]
The supply model... in math

Fraction of physicists in phase 1 moving to phase 2 each year

\[ f_1(t_{k+1}) = f_1(t_k) + g(t_k) - (c_1 + a_1)f_1(t_k) \]
\[ f_2(t_{k+1}) = f_2(t_k) + c_1f_1(t_k) - (c_2 + a_2)f_2(t_k) \]
\[ f_3(t_{k+1}) = f_3(t_k) + c_2f_2(t_k) - (c_3 + a_3)f_3(t_k) \]
The supply model... in math

Fraction of physicists in phase 1 leaving the field entirely each year

\[ f_1(t_{k+1}) = f_1(t_k) + g(t_k) - (c_1 + a_1)f_1(t_k) \]
\[ f_2(t_{k+1}) = f_2(t_k) + c_1f_1(t_k) - (c_2 + a_2)f_2(t_k) \]
\[ f_3(t_{k+1}) = f_3(t_k) + c_2f_2(t_k) - (c_3 + a_3)f_3(t_k) \]
The supply model... in math

Things you have to provide the model

\[ f_1(t_{k+1}) = f_1(t_k) + g(t_k) - (c_1 + a_1)f_1(t_k) \]
\[ f_2(t_{k+1}) = f_2(t_k) + c_1 f_1(t_k) - (c_2 + a_2)f_2(t_k) \]
\[ f_3(t_{k+1}) = f_3(t_k) + c_2 f_2(t_k) - (c_3 + a_3)f_3(t_k) \]
\[ f_n(t_0) \text{ for } n = 1, \ldots, 3 \]
Initial conditions and parameters informed by survey results

Figure 8 – 2009 Counts of Medical Physicists by Career Phase and Specialty

End result

Figure 30 – Projected Diagnostic Imaging Physicist Supply and Demand, 2009-2030

Outline

• Motivation and background

• Previous efforts
  • 2009 SUNY Albany CHWS Workforce Study
  • 2015 AAPM/SNMMI Joint Task Force on Nuclear Medicine Physics Training

• Current efforts of the DDSPWG
Purpose of the joint task force

- Estimate the demand for board-certified nuclear medicine physicists in the next 5–10 years,
- Identify the critical issues related to supplying an adequate number of physicists who have received the appropriate level of training in nuclear medicine physics, and
- Identify approaches that may be considered to facilitate the training of nuclear medicine physicists.


• Here we’ll focus on their effort to determine the number of board-certified nuclear medicine physicists
Data sources for estimating number of nuclear medicine physicists

CRCPD maintains a database of physicist certified through ABHP, ABMP, ABR, CCMP, and ABSNM


Additionally looked at # respondents indicating they were board certified in Nuclear Medicine on 2012 AAPM Professional Survey
Joint Task Force results

• CRCPD data
  • They also got a list of board-certified physicists from the ABR (bottom row)
  • 8 individuals were both ABR and ABSNM certified
  • Total estimate was 287+61-8=340 board certified Nuclear Medicine physicists

<table>
<thead>
<tr>
<th>Source</th>
<th>Specialty</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>NM</td>
<td>NM+DX</td>
</tr>
<tr>
<td>CRCPD/ABR</td>
<td>184</td>
<td>94</td>
</tr>
<tr>
<td>CRCPD/ABSNM</td>
<td>185</td>
<td>99</td>
</tr>
<tr>
<td>ABR</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Joint Task Force results

- AAPM Professional survey results shown below
  - Correction for 61% response rate gives \( \frac{206}{0.61} \approx 340 \) board certified physicists again! …but...

### TABLE 2. Number of AAPM Professional Survey respondents indicating they were board certified in Nuclear Medicine and median years’ experience.

<table>
<thead>
<tr>
<th>Degree/Certification</th>
<th>#</th>
<th>Median Yrs Experience</th>
</tr>
</thead>
<tbody>
<tr>
<td>MS-ABR(NM)</td>
<td>49</td>
<td>28</td>
</tr>
<tr>
<td>MS-ABS(NM)</td>
<td>20</td>
<td>19</td>
</tr>
<tr>
<td>MS-ABR(Radiologic)</td>
<td>16</td>
<td>36</td>
</tr>
<tr>
<td>PhD-ABR(NM)</td>
<td>64</td>
<td>30</td>
</tr>
<tr>
<td>PhD-ABR(ABS(NM)</td>
<td>24</td>
<td>25</td>
</tr>
<tr>
<td>PhD-ABR(Radiologic)</td>
<td>33</td>
<td>37</td>
</tr>
<tr>
<td>MS-ABR Diagnostic</td>
<td>200</td>
<td>22</td>
</tr>
<tr>
<td>PhD-ABR Diagnostic</td>
<td>199</td>
<td>22</td>
</tr>
<tr>
<td>Total ABR(NM)</td>
<td>162</td>
<td>22</td>
</tr>
<tr>
<td>Total ABS(NM)</td>
<td>44</td>
<td>22</td>
</tr>
<tr>
<td>Total NM Certified</td>
<td>206</td>
<td></td>
</tr>
</tbody>
</table>

\(^a\) The sum of all ABR(NM) and ABS(NM)


Appears to include ABR (Radiologic) as well
Joint Task Force results

Final estimate

The data clearly show that nuclear medicine physicists comprise a small fraction of the total number of QMPs. This Task Force was not able to accurately determine the total number of board-certified nuclear medicine physicists. However, it is likely the number is in the range of about 350–450, or slightly less than 10% of those receiving the AAPM Professional Survey.

Outline

• Motivation and background

• Previous efforts
  • 2009 SUNY Albany CHWS Workforce Study
  • 2015 AAPM/SNMMI Joint Task Force on Nuclear Medicine Physics Training

• Current efforts of the DDSPWG
To project anything, we first need to estimate how many of us there are currently

- Set out to estimate the size of the clinical imaging physics workforce as of 2019-2020
- Compared this with CHWS projections and estimates of the AAPM/SNMMI Joint Task Force
- Ideally will use these as initial conditions to adapt CHWS model for future projections
Potential data sources

- There is no single comprehensive dataset cataloging the number of clinical imaging physicists, but there are a bunch of options
  - AAPM membership database
  - Annual AAPM Professional Survey
  - CRCPD QMP database
  - State radiation control programs
AAPM Membership database

• Advantages
  • Can exclude those that reside, and therefore likely work, outside the US
  • Can separate retirees and trainees based on membership category
  • Readily available

• Limitations
  • Specialties are self-reported, may not be reliable
  • Difficult to reliably distinguish clinical physicists from those working in research, regulatory, or other non-clinical functions
  • Some retirees choose to maintain full membership
  • Doesn’t capture unknown number of non-AAPM members working in medical physics
AAPM Professional Survey

• Advantages
  • Annually performed
  • Collects information about employment, subspecialty, and mix of clinical/non-clinical work

• Limitations
  • Respondents are self-selected
  • Not designed for representative sampling
  • Doesn’t capture unknown number of non-AAPM members working in medical physics
CRCPD QMP database

• Advantages
  • Updated at least annually
  • Captures ABR, ABMP, ABHP, CCPM, and ABSNM certification
  • Certification category provided in each listing (e.g., Diagnostic Medical Physics)
  • Individuals with multiple certifications are appropriately captured with multiple listings

• Limitations
  • Can contain entries for physicists no longer working
  • Can contain physicists who don’t do any clinical work
  • Doesn’t capture physicists without board certification
State radiation control programs

• Advantages
  • Typically require renewal every one to three years; not likely to contain retired individuals
  • Often include both board-certified and non-certified individuals

• Limitations
  • Have to avoid double counting people who are registered or licensed in multiple states
  • State regulations differ, so data can capture different subpopulations of the imaging physics workforce
  • Physicist exclusively working with ultrasound and MRI aren’t captured
DDSPWG approach

• Collected registration/licensure data from 11 states
• Estimated # of X-ray imaging physicists, nuclear medicine physicists, and exclusively nuclear medicine physicists
• Discard names from state lists if address is out-of-state to avoid counting duplicates
• Filter state lists with the CRCPD database to determine number of board-certified physicists practicing in each state
• Extrapolate state estimates to national estimates using ratio estimator

\[ n_{US} = n_{sample} \times \frac{x_{US}}{x_{sample}} \]

- Number of physicists in sampled states
- Total population of US
- Total population of sampled states
## State data and inclusion criteria

<table>
<thead>
<tr>
<th>State</th>
<th>Data</th>
<th>Criteria for Inclusion in Nuclear Medicine Physicist Supply Estimate</th>
<th>Criteria for Inclusion in Diagnostic (X-Ray) Physicist Supply Estimate</th>
</tr>
</thead>
<tbody>
<tr>
<td>CA</td>
<td>Individuals authorized to conduct mammography surveys [17 CCR § 30315.52]</td>
<td>N/A</td>
<td>All included</td>
</tr>
<tr>
<td>CO</td>
<td>Individuals approved to perform evaluations of radiation machines, facilities, and operators for compliance. [6 CCR 1007-1 Part 02, 2.4.4.1]</td>
<td>N/A</td>
<td>Qualified inspectors authorized to perform certification evaluations in CT, fluoroscopy, or mammography.</td>
</tr>
<tr>
<td>FL</td>
<td>Individuals with temporary or full licensure in either Diagnostic Radiological Physics or Medical Nuclear Physics. This includes all individuals able to provide nuclear or radiological physics services [FS Title XXXII § 483.901]</td>
<td>Full licensure in medical nuclear physics.</td>
<td>Full licensure in diagnostic radiological physics.</td>
</tr>
<tr>
<td>IL</td>
<td>Registered diagnostic imaging specialists in mammography and/or general radiography. Hospitals performing CT or mammography are required to have a radiation protection program overseen by such an individual [32 Ill. Adm. Code 410]</td>
<td>N/A</td>
<td>All included</td>
</tr>
<tr>
<td>IN</td>
<td>List of approved physicists and inspectors. Routine testing of diagnostic X-ray equipment must be performed by these individuals [410 IAC 5-6.1-118(c)]</td>
<td>N/A</td>
<td>Individuals qualified as diagnostic imaging physicists or X-ray machine inspectors.</td>
</tr>
<tr>
<td>MD</td>
<td>List of state licensed private inspectors. This license allows individuals to inspect X-ray equipment as part of the State's certification process [COMAR 26.12.02].</td>
<td>N/A</td>
<td>All included</td>
</tr>
<tr>
<td>State</td>
<td>Data</td>
<td>Criteria for Inclusion in Nuclear Medicine Physicist Supply Estimate</td>
<td>Criteria for Inclusion in Diagnostic (X-Ray) Physicist Supply Estimate</td>
</tr>
<tr>
<td>-------</td>
<td>------</td>
<td>---------------------------------------------------------------</td>
<td>---------------------------------------------------------------</td>
</tr>
<tr>
<td>MA</td>
<td>List of consultants for health physics services in the areas of (1) diagnostic radiology (excluding mammography) and (2) mammography [105 CMR 120]</td>
<td>N/A</td>
<td>All included</td>
</tr>
<tr>
<td>NJ</td>
<td>Qualified medical physicists for the supervision of quality assurance programs for computed tomography, diagnostic X-ray, and/or mammography equipment [NJAC 7:28-22.12 and 7:28-15.4]. Qualified medical physicist assistants in radiography and fluoroscopy were not included.</td>
<td>N/A</td>
<td>All included</td>
</tr>
<tr>
<td>NY</td>
<td>Individuals with full licensure in either diagnostic radiological physics or medical nuclear physics. This includes all individuals able to provide nuclear or radiological physics services [8 EDN § 166]</td>
<td>Full licensure in medical nuclear physics.</td>
<td>Full licensure in diagnostic radiological physics.</td>
</tr>
<tr>
<td>OH</td>
<td>Opt-in lists of certified radiation experts available to perform cone beam CT testing and shielding design and area surveys. Certified radiation experts can serve as the individual responsible for radiation protection for an imaging provider [Ohio Adm. Code 3701:1-66-03]</td>
<td>N/A</td>
<td>All included</td>
</tr>
<tr>
<td>TX</td>
<td>Individuals with temporary or full licensure in either Diagnostic Radiological Physics or Medical Nuclear Physics. This includes all individuals able to provide nuclear or radiological physics services [22 TAC §160]</td>
<td>Full licensure in medical nuclear physics</td>
<td>Full licensure in diagnostic radiological physics</td>
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</table>
Results – X-ray imaging physicists

<table>
<thead>
<tr>
<th>State</th>
<th># Physicists on CRCPD Registry</th>
<th># Physicists on State List</th>
<th># Board Certified Physicists in State</th>
<th>2019 State Population</th>
<th>Total Physicists Per Million Residents</th>
<th>Board Certified Physicists Per Million Residents</th>
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<td>1.63</td>
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</table>

National estimate of total X-ray imaging physicists: 1737 (SD=155)

National estimate of board-certified X-ray imaging physicists: 1073 (SD=52)
Results – X-ray imaging physicists

Projections from 2009 CHWS Workforce Study

Figure 30 – Projected Diagnostic Imaging Physicist Supply and Demand, 2009-2030

New estimates from the DDSPWG

National estimate of total X-ray imaging physicists: 1737 (SD=155)

National estimate of board certified X-ray imaging physicists: 1073 (SD=52)

Why the discrepancy?

Potential reasons

• Events between 2009 and 2019 that likely impacted per-capita demand
  • Medicare Improvements for Patients and Providers Act (MIPPA) accreditation requirement started in 2012
  • Changes in requirements of The Joint Commission in 2015 and 2019
• Initial conditions for CHWS study were based on survey of AAPM membership
• CHWS assumptions for # of physicists entering field through residencies and other pathways
Results – Nuclear medicine physicists

National estimate of nuclear medicine physicists: 859 (SD=120)

National estimate of board-certified nuclear medicine physicists: 460 (SD=60)

For comparison:
AAPM/SNMMI Joint Task Force estimated 350-450 board certified in 2015
Results – Exclusively Nuclear medicine physicists

National estimate of exclusively nuclear medicine physicists: 239 (SD=101)

National estimate of board certified exclusively nuclear medicine physicists: 155 (SD=85)
Summary of estimates

**All Physicists**
- 1976 total
- 1117 provide X-ray Physics Services
- 620 provide Nuc Med Physics Services
- 239 provide both

**Board Certified Physicists**
- 1228 total
- 768 provide X-ray Physics Services
- 305 provide Nuc Med Physics Services
- 155 provide both
Some Limitations

• Differences between state credentialing programs
• National estimates based off states with defined licensure or registration requirements
  • Could bias estimates, particularly for board certified physicists
• Excluded individuals residing outside of the state they were registered/licensed in
  • Avoids double counting, but we would miss a person who isn’t licensed/registered in the state they live in
• Didn’t get at FTEs
Big thanks to everyone involved

**DDSPWG**
- Nicholas Bevins
- Jaydev Dave
- David Hintenlang
- David Jordan
- Brad Lofton
- Pankaj Patel

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- Dustin Gress
- Steven Jackson
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- Megan Lipford
- Jianqiao Luo
- Osama Malawi
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- Thomas Nishino
- Robert Pizzutiello
- Lei Qin
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