

Characteristics of Pulmonary Critical Care Medicine and Pulmonary Medicine Applicants and Fellowships

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ABSTRACT

Background: Little is known about historical and recent application trends for pulmonary critical care medicine (PCCM) or pulmonary medicine (PM) fellowship programs. Describing trends in and characteristics of PCCM and PM applications, applicants, and fellowship programs can help program directors and medical educators understand trainees' interest in and application patterns for these fellowship programs.

Objective: The objective of this study was to use National Residency Match Program data to assess recent trends in PCCM and PM fellowship applications and compare characteristics of applicants and fellowship programs.

Methods: In 2019, we used National Residency Match Program data to evaluate applicant ranking and matching in PCCM and PM fellowship programs and to compare applicant and fellowship program characteristics.

Results: From 2008 through 2019, the majority of applicants (59.1%) matched into PCCM were graduates of U.S. allopathic or osteopathic medical schools, whereas 87% of PM fellows were non-U.S. graduates. PCCM was the preferred specialty for 90.8% of matched applicants versus only 31.6% of matched PM applicants ($P < 0.001$). The match rate for PCCM applicants was 67.2% versus 23.8% for PM applicants ($P < 0.001$). Of PCCM applicants, 36.6% matched into their top choice versus 10.8% of PM applicants ($P < 0.001$). There are far fewer PM fellowship positions ($n = 23$) and programs ($n = 12$) than PCCM positions ($n = 450$) and programs ($n = 131$). The mean fill rates from the 2004 through 2016 appointment years are 94.1% in PCCM and 97.4% in PM ($P = 0.009$).

Conclusion: PCCM is a prevailing specialty choice over PM among residency graduates, with matched applicants more likely to list PCCM than PM as their preferred specialty. Further exploration into applicants' interest in critical care compared with PM may prove beneficial in guiding applicants to programs that will best meet their career goals.

Keywords:

graduate medical education; fellowship; pulmonary and critical care medicine; career development

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Over the last 15 years, numerous authors have projected a looming shortage in the critical care workforce (1–3). As the U.S. population ages and hospitalized patients are increasingly acutely ill (1), the need for trained intensivists will continue to grow (2). A core recommendation to combat this anticipated shortage is to increase training opportunities in critical care.

In the 1970s, the Society of Critical Care Medicine envisioned critical care training as a multidisciplinary endeavor. In the 1980s, however, training and credentialing of intensivists fragmented with separate pathways within anesthesia, surgery, and internal medicine (IM). Although some programs offer stand-alone pulmonary medicine (PM) or critical care medicine (CCM) fellowships, for applicants trained in IM, critical care training is most commonly linked to pulmonary fellowship. This duality of specialization offers benefits, including additional expertise in pulmonary pathophysiology and broadening career options. Some authors, however, have expressed concerns that dual training may take pulmonary critical care medicine (PCCM) physicians out of the intensive care unit (ICU), with time and focus split between ICUs and pulmonary consults or clinics, further contributing to the intensivist workforce shortage (3). In this

context, little is known about trends in applications for PCCM or PM fellowship programs or opportunities for training currently offered to IM residency graduates. Comparing trends in and characteristics of PCCM and PM fellowship programs, applications, and applicants provides program directors, medical educators, and other stakeholders descriptive information that may inform resource allocation and strategic planning for PM and PCCM training programs.

In this investigation, we used National Residency Match Program (NRMP) data to assess recent trends in PCCM and PM fellowship applications, applicants, and fellowship programs (4). CCM fellowships are not part of the NRMP, and therefore data regarding CCM applications, applicants, and fellowship programs were not included in this study. The objective of this study was to compare and contrast similarities and differences between applicants applying to and matching in PCCM and PM fellowships, as well as to contextualize trends in applicants and matching patterns with other IM subspecialty fellowship programs between 2004 and 2019.

METHODS

In 2019, we used publicly available data for this study from the NRMP Results and

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Data Specialties Matching Service (4). The NRMP categorizes applicants as graduates of U.S. allopathic medical schools, graduates of U.S. osteopathic medical schools, U.S. citizen graduates of international medical schools, non-U.S. citizen graduates of international medical schools, and graduates of fifth-pathway programs (graduates of a non-U.S. medical school who completed additional clinical work in a U.S. medical school). We included U.S. graduates of both allopathic and osteopathic medical schools as “U.S. graduates” and all other categories as “non-U.S. graduates” (4).

We limited our study to IM-trained applicants, and we defined possible specialties for fellowship training as delineated in Table 1. We did not include fellows matching into interventional pulmonology. Fill rate was assessed by dividing the number of matches by the total number of available positions. Fill rate by U.S. graduates per specialty was calculated by dividing the number of total positions by the number of matched U.S. graduates. Match rate for preferred specialty was the match rate into a specialty among those who listed that specialty as their first choice.

Table 1. Applicants to internal medicine subspecialty fellowships for the 2019 appointment year (4)

Specialty	Number of Positions	Number of Programs	Applicants per Position	Preferred Specialty (Percentage of Applicants to That Specialty)	Fill Rate	Fill Rate by U.S. Graduates	Percentage of Applicants Unmatched	Number of Unfilled Programs
Allergy and immunology	137	89	1.26	98.3	97.1	71.5	22.1	4
Cardiovascular disease	951	222	1.38	99.8	99.3	52.2	27.3	5
Endocrinology	326	146	1.11	95.0	93.9	35.6	14.0	16
Gastroenterology	525	199	1.53	99.0	97.9	62.3	34.9	9
Geriatrics	419	148	0.58	88.9	50.8	17.7	5.3	101
Hematology	14	3	5.5	28.6	100.0	92.9	2.6	0
Hematology and oncology	573	143	1.32	96.0	99.0	60.0	20.6	5
Hospice and palliative care	355	148	0.96	94.2	80.3	49.9	11.7	42
Infectious disease	401	156	0.89	94.7	81.3	42.1	6.2	49
Nephrology	464	163	0.70	88.6	62.7	17.2	7.1	92
Oncology	10	5	6.00	6.7	100.0	0.00	31.7	0
Pulmonary	27	14	4.19	38.1	100.0	3.7	35.4	0
Pulmonary and critical care	601	166	1.41	94.8	99.0	51.9	24.8	4
Rheumatology	236	114	1.55	97.8	98.7	50.8	33.3	3

The NRMP provides data by appointment year, which is the year that applicants begin their fellowship training program. We compared data from the 2004 through 2019 appointment years, with the exception of preferred specialty, because those data were only available from 2008 onward. The most popular specialties were those receiving over 500 applicants per year. This study was reviewed and exempted by our institutional review board.

Statistical Analyses

Data were imported into Excel software (Microsoft Corporation) and grouped, organized, visually inspected, and exported to IBM SPSS Statistics version 21.0 software (IBM Corporation). Comparative analyses of all parameters were performed using the Mann-Whitney *U* test for independent samples. When indicated, effect size (ES) and confidence interval (CI) were determined for between-group comparisons by Hedges' *g*. A *P* value less than 0.05 was considered statistically significant.

RESULTS

For 2019 appointments, 87.0% of U.S. allopathic medical school graduates who applied for fellowships through the NRMP matched into a fellowship position (4). PCCM is the second most popular choice of IM subspecialty fellowships among U.S. applicants (*see* Figure E1 in the data supplement). PM was the third least popular, with 1.84% of all applicants selecting PM as their first choice. Table 1 outlines characteristics of applications to subspecialty fellowships for 2019. For programs with over 500 applicants in 2019, PCCM was the second most competitive specialty after gastroenterology and preceding cardiovascular medicine (Table 2). Cardiovascular disease was more competitive than hematology and oncology ($P=0.006$) but not PCCM ($P=0.08$). PCCM was more competitive than hematology and oncology ($P=0.03$).

The majority of applicants matched into PCCM are graduates of U.S. allopathic medical schools, whereas 96.7% of PM fellows are non-U.S. graduates (Figure 1). The highest fill rate for U.S. graduates matching into PM fellowships

Table 2. Applicants to pulmonary critical care and pulmonary fellowships for the 2004–2019 appointment years

Parameter	Pulmonary Critical Care Medicine	Pulmonary Medicine	<i>P</i> Value	Effect Size (Confidence Interval)
Total applicants per year, mean (IQR)	643 (561 to 745)	93 (84 to 100)	–	N/A
Applicants with preferred specialty, %	90.8	31.6	<0.001	6.65 (6.62 to 6.68)
Match rate per applicant, %	67.2	23.8	<0.001	16.44 (16.43 to 16.45)
Match rate for preferred, %	75.0	77.0	0.99	0.00 (–0.16 to 0.16)
Matched in first choice, %	36.6	10.8	<0.001	7.62 (7.60 to 7.63)
Matched in third or higher ranked program, %	9.5	5.7	0.003	1.51 (1.50 to 1.52)
Matched in another specialty, %	4.3	36.4	<0.001	–5.40 (–5.42 to –5.38)
Did not match, %	25.6	35.1	<0.001	–1.75 (–1.78 to –1.73)

Definition of abbreviations: IQR = interquartile range; N/A = not applicable.

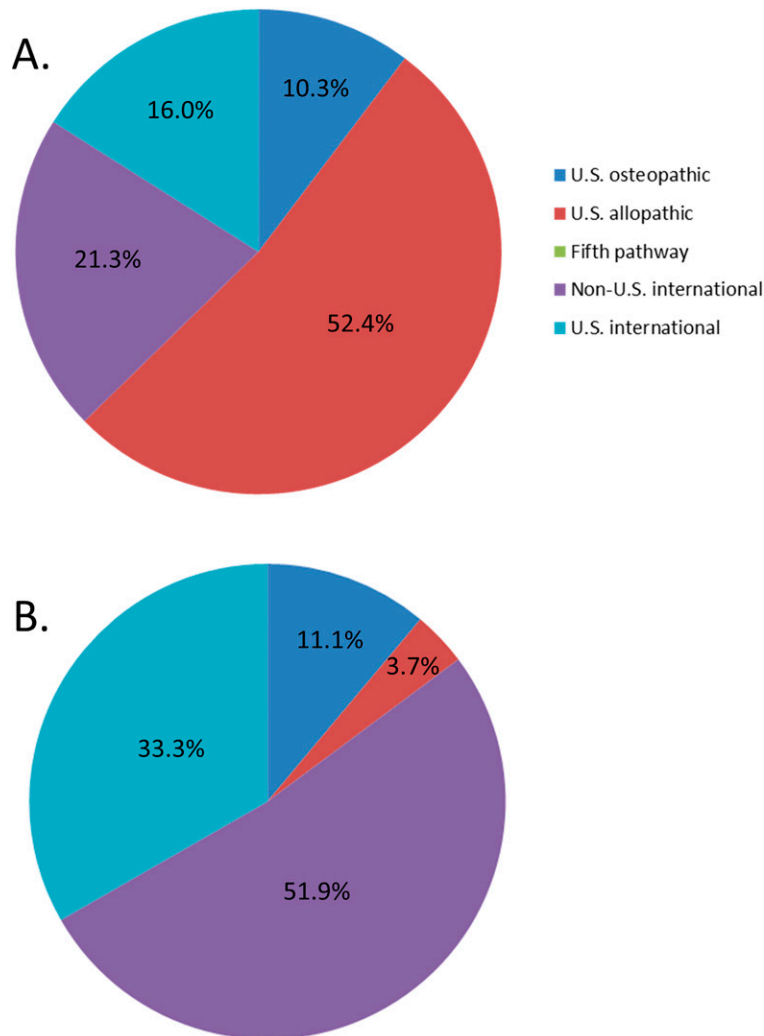


Figure 1. Medical school characteristics of (A) matched pulmonary and critical care medicine fellows and (B) pulmonary medicine fellows for appointment year 2019 (4).

was in 2016, with U.S. graduates comprising 21.7% of matched fellows. By comparison, the highest fill rate for U.S. graduates for PCCM programs was 64.6% in 2017. The mean fill rate for U.S. graduates from 2009 to 2019 for PCCM was 59.8% versus 12.8% for PM (ES, 9.36 [CI, 9.34–9.38]; $P < 0.001$). Characteristics of fellowship applicants are outlined in Table 2 and Figure 2.

For those applying to PCCM from the 2009 through 2019 appointment years, 90.8% selected PCCM as their preferred specialty. Conversely, only 31.6% selected PM as their preferred specialty (ES, 6.65

[CI, 6.62–6.68]; $P < 0.001$). The match rate for PCCM applicants is far higher than for PM applicants, and a larger percentage of PCCM applicants than PM applicants matched into their top choice. Only 4.3% of PCCM applicants matched into another specialty, compared with 36.4% of PM applicants (ES, –5.40 [CI, –5.42, –5.38]; $P < 0.001$). Both groups had considerable rates of not matching.

There are far more PCCM fellowship positions and programs than PM (Table 3 and Figure 3), with a mean of 449 versus 23 positions offered annually

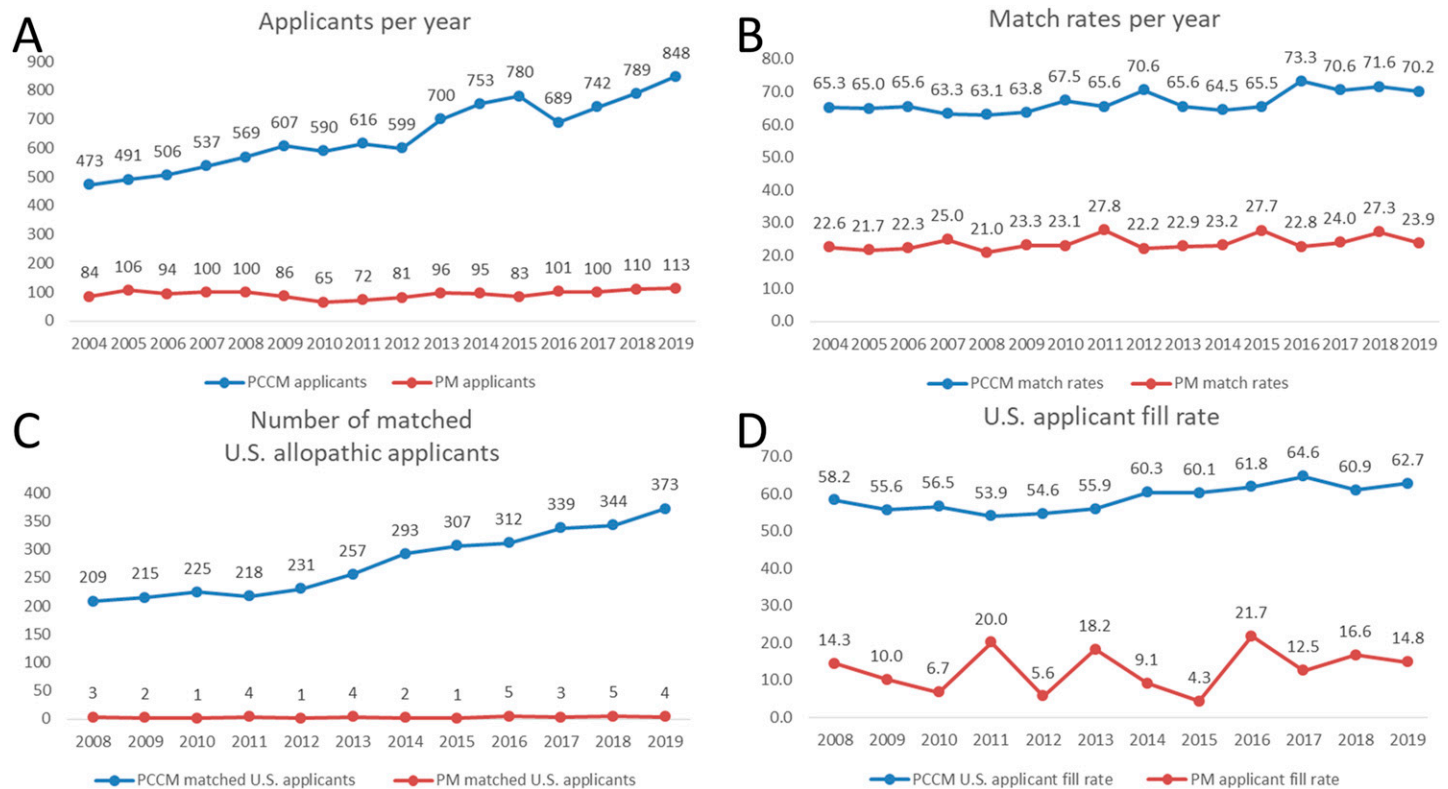


Figure 2. (A) Application and (B–D) match trends in pulmonary and critical care medicine (PCCM) and pulmonary medicine (PM) fellowship programs (4).

(interquartile range [IQR], 386–517 vs. 21–24, respectively; $P < 0.001$). The number of PCCM positions has increased since 2004, with a total of 281 new positions created (17.6 new positions/yr; IQR, 10.0 to 25.3), whereas there have been only 8 new positions in PM fellowship positions since 2004 (0.5 new positions/yr; IQR, –1.5 to 2.5; ES, 1.90 [CI, –1.13 to 4.93]; $P < 0.001$). There have been 57 new PCCM programs created since 2004 as compared with only 4 new PM programs ($P = 0.003$). The median number of new PCCM programs created per year was 3.0 programs/yr (IQR, 1.5 to 5) versus 0.0 new programs/yr (IQR, –0.5 to 1) for PM fellowship programs. The mean fill rate per available fellowship position from 2004 through 2019 was 97.8% in PCCM and

98.2% in PM ($P = 0.59$), with 94.1% of programs in PCCM filling all positions and 97.4% of programs in PM filling all positions ($P = 0.009$).

DISCUSSION

In this analysis of NRMP match data, PCCM is among the leading subspecialty choices for U.S. IM graduates. In contrast, PM is one of the least popular. For those applying to PCCM, over 95% selected PCCM as their preferred specialty, whereas only approximately one-third of PM applicants selected PM as their first choice. Although popularity can be assessed fairly easily by reviewing match data, assessing competitiveness is more complicated. Prior studies have measured competitiveness in residency programs by assessing the

Table 3. Characteristics of pulmonary critical care and pulmonary programs for the 2004–2016 appointment years

Parameter (2004–2016)	Pulmonary Critical Care Medicine	Pulmonary Medicine	P Value	Effect Size (Confidence Interval)
Number of programs, median (IQR)	131 (122 to 140)	12 (11 to 13)	<0.001	8.39 (–8.49 to 25.26)
Number of positions, median (IQR)	449 (386 to 517)	23 (21 to 24)	<0.001	16.20 (13.73 to 18.67)
Applicants per position, median	1.46	4.14	<0.001	–9.93 (–10.02 to –9.84)
Fill rate per position, %	97.8	98.2	0.59	0.00 (–0.01 to 0.01)
Unfilled programs, %	5.9	4.0	0.009	0.94 (0.93 to 0.95)

Definition of abbreviation: IQR = interquartile range.

percentage of residency spots filled by U.S. allopathic graduates (5) or the percentage of spots filled by total U.S. graduates (6). However, these definitions not only favor U.S. graduates but also ignore potential applicant factors (7). The data in this study demonstrate conflicting findings regarding comparative competitiveness of specialties, depending on the parameter assessed. PM has far more applicants per position than PCCM; however, fewer applicants select

PM as their preferred specialty. In addition, the overall match rate for PCCM applicants is higher, and a larger percentage of PCCM applicants than PM applicants matched into their top choice.

Three specialties evaluated, hematology, oncology, and PM, have more than two applicants per position. Notably, each of these specialties also represents a component of a more comprehensive combined training program. Given that a

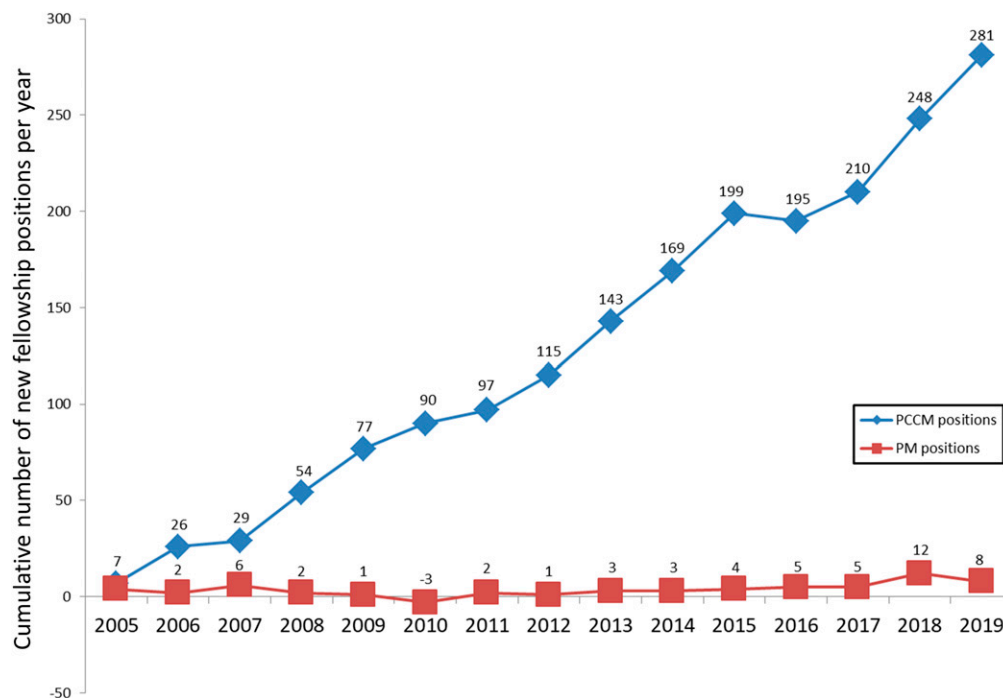


Figure 3. Cumulative change in number of new fellowship positions per year from 2005 through 2019 for pulmonary and critical medicine (PCCM) and pulmonary medicine (PM).

minority of applicants to each of these specialties chose them as their preferred specialty, this may reflect that applicants to combined programs are applying to the component subspecialties.

The differential selection of PCCM and PM by U.S. graduates was an unexpected finding in our study. Non-U.S. medical graduates clearly bring a wealth of experience and diversity to programs (8) and are therefore valuable members of fellowships. Since 2000, multiple reports have called for an increase in the intensivist workforce (2, 9), and non-U.S. medical graduates are an important means of increasing the needed workforce numbers (9). In addition, non-U.S. medical graduates are more likely to work in rural or underserved areas (10, 11). However, an interesting question is why U.S. graduates seem to be less drawn to PM than to other specialties, especially as compared with PCCM. Prior surveys have found that the factor most strongly associated with a career in an IM subspecialty is graduation from a non-U.S. medical school (12), but we are unaware of any prior studies specifically exploring the specialty selection by U.S. IM residency graduates.

The differences noted between PCCM and PM regarding preferred specialty selection are likely complex and multifactorial. One potential explanation for this difference in the rates at which applicants indicate PCCM (90.8%) as compared with PM (31.6%) as their preferred specialty could be that PCCM includes critical care training and thereby postfellowship CCM practice and career opportunities. Further research delineating applicants' interest in CCM compared with PM may be beneficial in guiding applicants to programs that will best meet their career goals. Data regarding application characteristics of CCM fellowship programs are limited because

CCM fellowship positions are filled outside the NRMP. A prior study demonstrated that despite increases in the number of 3-year PCCM programs and fellowship positions, 2-year CCM training programs and fellowship numbers have decreased (13).

Non-U.S. medical graduates clearly bring a wealth of experience and diversity to programs (8) and are therefore valuable members of fellowships.

There are currently three pathways for IM physicians to obtain critical care certification: a 3-year PCCM fellowship, a 2-year CCM fellowship, and a 1-year CCM fellowship track after completion of another Accreditation Council for Graduate Medical Education–accredited fellowship, which may be used after completion of a PM fellowship (13). It is unknown how many PM applicants may also complete CCM training as a separate fellowship, and further research assessing PM fellowship graduates' interest and subsequent training in CCM could provide more detail and context about the relationship between PM and CCM training outside of combined PCCM fellowship training programs.

Over the time period studied, the number of PCCM fellowship programs and positions increased substantially, whereas PM fellowship programs and positions did not. The reason for this difference may stem from developments in the 1980s and 1990s, during which time reports indicated that the U.S. healthcare system would soon have an excess of pulmonologists (14, 15). Authors began urging a reduction in PM fellowship positions (14–16), which may have spurred concomitant adoption of CCM training.

To increase the supply of critical care providers (17, 18), increasing the number

of training options for PCCM is an important step because most physicians who practice CCM are trained in PCCM (13, 17). However, PCCM-trained physicians spend only about 25% of their clinical time in the ICU (19). With calls for PCCM-trained intensivists to shift their clinical time to the ICU to address the intensivist shortage, this may lead to a shortage of trained pulmonologists (3). This gap may be filled by PM fellowship graduates, thereby further elevating the esteem and desirability of PM without CCM.

The NRMP data in this study provide no information regarding applicants' qualifications in any program, nor do they reflect any information about applicants' future clinical or academic success in their chosen fields. Importantly, for applicants matched in PCCM, we have no data regarding their future division of clinical time between pulmonary and critical care practice. Our results demonstrating fewer overall applications to PM and fewer U.S. graduates applying to PM programs do not reflect clear cause and effect. Although we suspect that the CCM component of training and practice may drive persistent interest in PCCM programs, this cannot be definitely demonstrated with the available data.

Limitations

Many of this study's limitations are attributable to the nature of database reviews. Because applicants may simultaneously apply in more than one specialty, applications do not necessarily translate into the total number of applicants. We used NRMP data as our source; fellowship positions offered outside of the match are not included in these analyses, which may disproportionately affect the data regarding PM applicants, because a higher

proportion of PM programs may not participate in the NRMP match. CCM fellowships are not part of the NRMP, and therefore we are unable to obtain any systematic data regarding these fellowship programs. In addition, although the NRMP collects data on applicants' medical school education, we have no data about applicants' residency training. We focused this analysis on fellows training in IM-based fellowships and do not include critical care training through anesthesia, surgery, or pediatrics. Despite the limitations, this analysis is the only recent assessment of applicants to pulmonary and critical care fellowship programs.

Conclusions

We describe temporal trends in applications to PCCM and PM fellowship programs using NRMP data. PCCM programs vastly outnumber PM programs, and the number of PCCM fellowship positions has increased substantially over the past decade, whereas the number of PM fellowship positions has remained relatively stagnant. Applicants are more likely to list PCCM as their preferred specialty, and it is the third most popular specialty choice among IM residency graduates. PM remains relatively unpopular as a specialty choice, and it is comprised predominantly of international medical school graduates. Further research is needed to investigate the causes of these disparities.

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