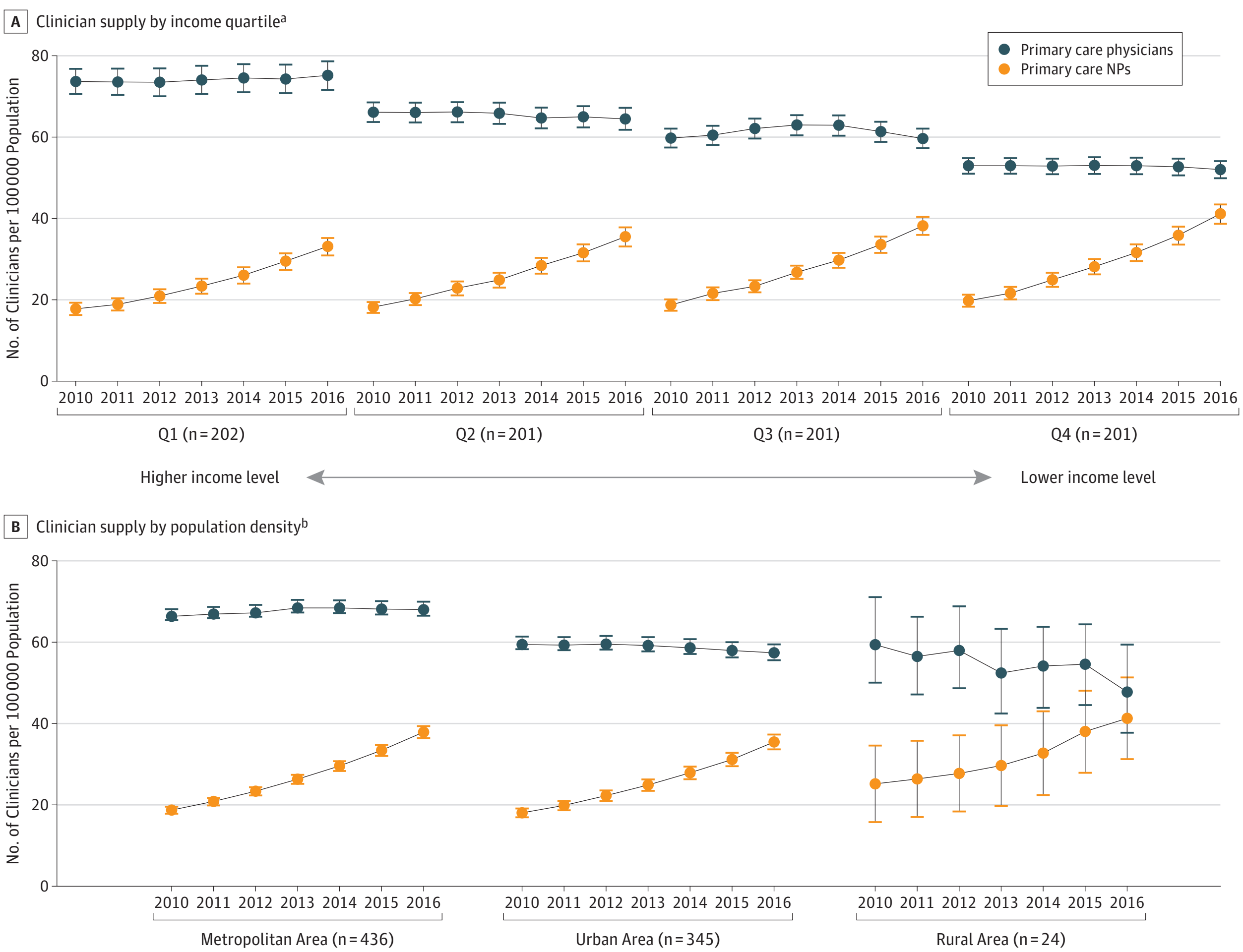
RESEARCH LETTER

Primary Care Nurse Practitioners and Physicians in Low-Income and Rural Areas, 2010-2016

Nurse practitioners (NPs) constitute the largest and fastest growing group of nonphysician primary care clinicians.[1] As the primary care physician (PCP) shortage persists,[1] examination of trends in primary care NP supply, particularly in relation to populations most in need, will inform strategies to strengthen primary care capacity. However, such evidence is limited, particularly in combination with physician workforce trends. We thus characterized the temporal trends in the distribution of primary care NPs in low-income and rural areas compared with the distribution of PCPs.

Methods | We analyzed trends in 50 states and Washington, DC, from 2010 to 2016. Data on population characteristics and PCPs (definition appears in the legend of the **Figure**)

Figure. Trends in the Geographic Distribution of Primary Care Nurse Practitioner (NP) and Primary Care Physician Supply, 2010-2016



Data on primary care NPs (primary care, adult, family, general gerontology, and general pediatrics, and had an active registration number for full study year) from the National Provider Identifier registry. Data on primary care physicians (nonfederal employees, provided patient care, and held either a doctor of medicine or a doctor of osteopathy degree in general family medicine, general practice, general internal medicine, or general pediatrics) from the American Medical Association Physician Masterfile. The error bars represent 95% CIs.

[a] Income quartile defined by proportion of the population with an income level ≤138% of the federal poverty level ($16 394 for a household with 1 individual per year in 2016). The median household income in 2016 was $64 314 for Q1; $52 270 for Q2; $47 227 for Q3; and $39 109 for Q4.

[b] Population density based on the 2013 US Department of Agriculture Rural-Urban Continuum Codes (metropolitan health service area [HSA] included ≥1 metropolitan county; urban HSA, ≥1 urban county with population >2500; and rural HSA, completely rural status or with population <2500).

Table. Primary Care Nurse Practitioner Supply and Primary Care Physician Supply for 805 Health Service Areas (HSAs), 2010-2016[a]

	Primary Care Nurse Practitioners (NPs)					Primary Care Physicians					NPs vs Physicians	
	Mean (95% CI) per 100 000 Population[b]		Absolute Mean Change (95% CI)[c]	Annual Mean Change (95% CI)[d]	*P* Value[e]	Mean (95% CI) per 100 000 Population[b]		Absolute Mean Change (95% CI)[c]	Annual Mean Change (95% CI)[d]	*P* Value[e]	Annual Mean Change (95% CI)[f]	*P* Value[e]
	2010	2016				2010	2016					
Total No.	59 442	123 316	63 874[g]	12.9%[h]		225 687	243 738	18 051[g]	1.3%[h]			
Supply[i]	18.6 (17.9-19.3)	37.0 (35.8-38.1)	18.3 (17.7-19.0)	3.0 (2.9-3.1)	<.001	63.2 (61.8-64.5)	62.8 (61.4-64.3)	−0.3 (−0.9 to 0.3)	−0.02 (−0.13 to 0.08)	.66	3.1 (2.8-3.3)	<.001
Clinician Supply by Income Quartile												
Q1[j]	17.8 (16.3-19.3)	33.1 (30.9-35.2)	15.3 (14.1-16.4)	2.6 (2.4-2.8)	<.001	73.7 (70.6-76.8)	75.1 (71.6-78.6)	1.5 (0.3 to 2.8)	0.26 (0.03 to 0.48)	.03	2.3 (1.9-2.8)	<.001
Q2	18.2 (16.8-19.5)	35.5 (33.1-37.9)	17.3 (15.8-18.8)	3.0 (2.8-3.2)	<.001	66.2 (63.8-68.6)	64.5 (61.8-67.2)	−0.2 (−1.8 to 1.4)	−0.07 (−0.28 to 0.14)	.53	3.2 (2.8-3.6)	<.001
Q3	18.7 (17.3-20.1)	38.2 (36.0-40.4)	19.3 (17.7-20.9)	3.2 (3.0-3.4)	<.001	59.8 (57.5-62.1)	59.7 (57.3-62.1)	−1.8 (−3.3 to −0.3)	−0.17 (−0.37 to 0.02)	.09	3.1 (2.7-3.4)	<.001
Q4[k]	19.8 (18.3-21.3)	41.1 (38.7-43.4)	21.4 (19.9-22.8)	3.4 (3.2-3.7)	<.001	52.9 (51.0-54.9)	52.0 (49.9-54.1)	−1.5 (−2.8 to −0.3)	−0.16 (−0.35 to 0.04)	.11	3.6 (3.3-4.0)	<.001
Clinician Supply by Population Density												
Metropolitan	18.7 (17.9-19.6)	37.9 (36.4-39.4)	19.2 (18.4-19.9)	3.2 (3.0-3.3)	<.001	66.4 (64.6-68.1)	68.0 (66.0-70.0)	1.6 (1.1 to 2.1)	0.30 (0.22 to 0.39)	<.001	2.9 (2.6-3.1)	<.001
Urban	18.0 (16.9-19.1)	35.5 (33.7-37.3)	17.4 (16.3-18.5)	2.9 (2.7-3.1)	<.001	59.4 (57.4-61.4)	57.4 (55.4-59.5)	−2.0 (−3.1 to −0.9)	−0.33 (−0.51 to −0.16)	<.001	3.2 (2.9-3.5)	<.001
Rural	25.2 (15.8-34.6)	41.3 (31.2-51.3)	16.1 (10.4-21.8)	2.7 (1.7-3.7)	<.001	59.5 (47.9-71.1)	47.8 (36.1-59.4)	−11.7 (−21.5 to −1.9)	−1.53 (−3.21 to 0.16)	.07	4.3 (2.0-6.5)	<.001

[a] For a given HSA, income quartile rank may change but population density status remains the same. The population with an income level ≤138% of the federal poverty level (FPL), defined as $16 394 for a household with 1 individual per year in 2016. The HSA income quartile rank in 2016 was 16% for Q1 (highest income level; median, $64 314); 22% for Q2 ($52 270); 26% for Q3 ($47 227); and 33% for Q4 (lowest; $39 109).

[b] Except for the numbers in the first row.

[c] Indicates change in clinician supply between 2010 and 2016 per 100 000 population.

[d] From mixed-effects model: $Y = \beta_0 + \beta_1 year$.

[e] Corresponds to annual mean change.

[f] From mixed-effects model $Y = \beta_0 + \beta_1 year + \beta_2 clinician\ group + \beta_3 year \times clinician\ group$.

[g] Data are total number from 2016 minus total number from 2010.

[h] Refers to the annual growth rate. Calculated as $(end\ value/beginning\ value)^{(1/No.\ of\ years)} - 1$.

[i] Supply is the number of clinicians per 100 000 population in an HSA in a given study year.

[j] Highest income level and has the lowest proportion of population with ≤138% of the FPL.

[k] Lowest income level and has the highest proportion of population with ≤138% of the FPL.

were from the Area Health Resources File, a national data set compiled from multiple validated sources including the US Census Bureau and the American Medical Association.[2] Data on primary care NPs (definition appears in the legend of the Figure) were from the National Provider Identifier registry, which contains information on health care professionals who had financial transactions with the Centers for Medicare & Medicaid Services.[3] These data sources have demonstrated convergent validity in prior studies involving primary care workforce estimates.[1,4] We further validated the NP estimates by obtaining comparable results with data from the National Sample Survey of NPs.[5] We selected health service area (HSA) as the geographic unit of analysis because it was developed to measure the availability of health care resources (eg, health care professionals). Annual clinician supply was measured as the number of clinicians per 100 000 population in an HSA. Income level in the HSA was assessed by quartile rank of the proportion of population at or below 138% of the federal poverty level; HSA metropolitan, urban, and rural status also was determined.

We calculated clinician supply with 95% CIs and examined the temporal trends in supply across income quartiles and metropolitan, urban, and rural areas, comparing trends between clinician groups using 2-level mixed-effects models that specified intercept and year as random effects and controlled for clustering by HSA. Analyses were performed using SAS version 9.4 (SAS Institute Inc). A 2-sided P<.05 was considered statistically significant. The study was exempted by the University of Rochester institutional review board.

Results | From 2010 to 2016, the number of primary care NPs increased from 59 442 to 123 316, and the number of PCPs increased from 225 687 to 243 738. The number of NPs per 100 000 population increased by a mean of 15.3 (95% CI, 14.1-16.4) in the highest income quartile to 21.4 (95% CI, 19.9-22.8) in the lowest income quartile (**Table**). In contrast, physician supply remained relatively constant (Figure, part A). Overall, NP supply increased more than physician supply (annual change, 3.0 vs −0.02, respectively; difference of 3.1 [95% CI, 2.8-3.3] per 100 000 population per HSA; P < .001). By 2016, NP supply was 33.1 (95% CI, 30.9-35.2) per 100 000 population in the highest income quartile and increased to 41.1 (95% CI, 38.7-43.4) in the lowest income quartile, whereas physician supply declined from 75.1 (95% CI, 71.6-78.6) in the highest income quartile to 52.0 (95% CI, 49.9-54.1) in the lowest income quartile (Table). Similar trends were observed in metropolitan, urban, and rural HSAs (Figure, part B). Primary care NP supply increased more than physician supply by an annual mean of 2.9 (95% CI, 2.6-3.1; P < .001) per 100 000 population in metropolitan areas, 3.2 (95% CI, 2.9-3.5; P < .001) in urban areas, and 4.3 (95% CI, 2.0-6.5; P < .001) in rural areas (Table). By 2016, the highest NP supply was observed in rural HSAs (41.3 [95% CI, 31.2-51.3] per 100 000 population), whereas the highest physician supply was in metropolitan HSAs (68.0 [95% CI, 66.0-70.0] per 100 000 population) (Table).

Discussion | This analysis demonstrated a narrowing gap between primary care NP and physician workforce supply over time, particularly in low-income and rural areas. These areas have higher demand for primary care clinicians and larger disparities in access to care.[6] The growing NP supply in these areas is offsetting low physician supply and thus may increase primary care capacity in underserved communities. Study limitations include the use of different data sources for NPs and physicians; and it is unknown if observed trends have changed from the most recent data in 2016. Continued monitoring of these trends is warranted.

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Drafting of the manuscript: Xue.
Critical revision of the manuscript for important intellectual content: All authors.
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COMMENT & RESPONSE

Laryngeal Tube Insertion vs Endotracheal Intubation for Out-of-Hospital Cardiac Arrest

To the Editor Dr Wang and colleagues[1] found that a strategy of initial laryngeal tube (LT) insertion vs endotracheal intubation (ETI) in patients with out-of-hospital cardiac arrest (OHCA) was associated with greater survival. We have some concerns regarding the results and the applicability of the conclusions.

First, the training level and experience of the paramedics participating in the trial were not categorized. Endotracheal intubation is technically more demanding and requires more experience compared with LT insertion. On occasion, LT ventilation is inadequate, which can be difficult to assess even by experienced anesthesiologists and especially in arrested patients. There was a significantly lower initial ETI success rate in this trial (51.6% with ETI vs 90.3% with LT), which may be caused by different criteria in judging airway failure, less advanced equipment used, or less experienced paramedic participants.

Second, emergency medical service (EMS) response time is closely associated with clinical outcome of patients with OHCA. A higher survival rate with good neurological outcome is reported with shorter response time,[2] and comparing the EMS institutions with matched average ambulance response time minimizes this potential bias. In this trial, there was a higher percentage of early EMS arrival (28.3% with LT vs 21.7% with ETI) and shorter mean response time (5.0 minutes in the LT group vs 5.3 minutes in the ETI group) in the LT vs ETI groups. These differences potentially affected the results of return of spontaneous circulation, 72-hour survival rate, and survival rate to hospital discharge.

Third, airway classification may affect the choice of airway management techniques. An experienced paramedic or medical professional may quickly assess the airway and the potential airway difficulty level and take different approaches to airway management accordingly.

Fourth, in the ETI group compared with the LT group, there was a significantly higher rate of unrecognized airway misplacement (1.8% vs 0.7%), a higher percentage of nonshockable arrhythmias (79.9% vs 77.1%), and more pneumothoraces (7.0% vs 3.5%) and rib fractures (7.0% vs 3.3%). All of these factors could have significantly affected the outcome.

We believe the primary airway management in patients with OHCA should be determined by the EMS team's experience and training, the paramedics' preliminary assessment of the airway, and the patient's airway status and overall physical status (age, weight and habitus, noticeable airway pathology). As video intubation tools are more readily available, EMS personnel may have higher success rates with ETI with less interruption of cardiopulmonary resuscitation.

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In Reply As Dr Huang and colleagues note, there were small differences in patient and response characteristics between the initial LT and initial ETI groups. However, in predefined subgroup analyses, including cardiac rhythm and response times, these variations were not associated with the observed treatment effects (eFigure 5 in Supplement 2).[1] Among the 3004 patients, 116 received LT placement by basic life support personnel; most of the remaining airways were managed by advanced life support paramedics (eTable 3 in Supplement 2). We could not further characterize rescuer airway training and experience. While rescuers reported slightly higher rates of inadequate ventilation with LT than ETI (1.8% vs 0.6%), in cardiac arrest, it is difficult to ascertain ventilatory quality with either technique. Huang and colleagues suggest that paramedics may have altered airway management strategies based on physical findings, but in the challenging setting of cardiac arrest, only limited airway assessment is possible.

The objective of the Pragmatic Airway Resuscitation Trial (PART) was to test 2 strategies of airway management, not the specific airway devices. Organized coordination of rescuer efforts (the "pit crew" approach) is important in OHCA resuscitation.[2] In this context, the challenges associated with ETI may distract rescuers from other resuscitation priorities such as chest compression continuity and drug administration.[3] We suspect that the simpler initial LT strategy may have eased overall resuscitation dynamics. Secondary observations, such as the shorter median airway initiation time (LT vs ETI, 9.8 vs 12.5 minutes), higher initial insertion success (90.3% vs 51.6%), fewer multiple (≥3) insertion efforts (4.5% vs 18.9%), and lower airway misplacement rate (0.7% vs 1.8%), support potential efficiencies with the initial LT approach.