Going the Extra Mile? How Provider Network Design Increases Consumer Travel Distance, Particularly for Rural Consumers

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Abstract

Context: The practical accessibility to medical care facilitated by health insurance plans depends not just on the number of providers within their networks but also on distances consumers must travel to reach the providers. Long travel distances inconvenience almost all consumers and may substantially reduce choice and access to providers for some.

Methods: The authors assess mean and median travel distances to cardiac surgeons and pediatricians for participants in (1) plans offered through Covered California, (2) comparable commercial plans, and (3) unrestricted open-network plans. The authors repeat the analysis for higher-quality providers.

Findings: The authors find that in all areas, but especially in rural areas, Covered California plan subscribers must travel longer than subscribers in the comparable commercial plan; subscribers to either plan must travel substantially longer than consumers in open networks. Analysis of access to higher-quality providers show somewhat larger travel distances. Differences between ACA and commercial plans are generally substantively small.

Conclusions: While network design adds travel distance for all consumers, this may be particularly challenging for transportation-disadvantaged populations. As distance is relevant to both health outcomes and the cost of obtaining care, this analysis provides the basis for more appropriate measures of network adequacy than those currently in use.

Keywords Affordable Care Act, health care access, provider networks, cardiac surgeons, pediatricians

Insurance coverage, whether through the Affordable Care Act marketplaces, Medicaid expansion, or Medicare-for-All, continues to be the primary focus of health policy debate. Insurance certainly plays an essential

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role in facilitating access to health care by making it more financially feasible. However, between insurance coverage and provider care there is an important aspect of insurance that in practice reduces consumer choice: networks of providers participating in plans. Recent scholarly attention on provider networks has largely focused on their effects on premiums (Dafny et al. 2017; Polsky, Cidav, and Swanson 2016) as well as on their narrowness (Giovannelli, Lucia, and Corlette 2015; Haeder, Weimer, and Mukamel 2015a, 2015b; Polsky and Weiner 2015). Several studies have even begun to explore the relationship between provider quality and network design (Haeder, Weimer, and Mukamel 2015a; Haeder 2019b, 2019c, 2020; Yasaitis, Bekelman, and Polsky 2017). While premiums and the number of in-network providers are important to consumers, insurers can impose another potentially challenging barrier to consumer access through decisions about which providers to include in their networks. Importantly, travel distance, a crucial determinant of health care access (Syed, Gerber, and Sharp 2013) has almost completely been excluded from assessments of provider networks.

In this analysis, we seek to remedy this lack of attention by introducing a broadly applicable consumer-focused approach to assessing the effect of network design on consumer access to medical services. Specifically, we answer two important albeit understudied questions. First, what are the effects of provider network design by insurers on travel distances for consumers? That is, how many miles do restrictions imposed by networks add to consumers' travel to access medical services? Relatedly, what percentage of consumers' total travel distance is the result of network design? Second, how much distance would be added to consumer travel if networks were to focus selectively on higher-quality providers? That is, how much farther would consumers have to travel if either they seek out higher-quality providers or if regulators required insurers to favor higher-quality providers in creating their networks?

We illustrate our broadly applicable approach by comparing travel distances to cardiac surgeons and pediatricians for Californians obtaining health insurance through their Affordable Care Act insurance marketplace with the travel distances they would have faced if enrolled in commercially available alternatives or a potential open-network plan, that is, an unrestricted network such as the one available to traditional Medicare recipients. We focus on these specific specialties for two reasons. First, the two specialties lie at opposite ends of the spectrum in terms of supply and the distribution of the supply. One has a relatively small number of providers who tend to cluster around hospitals (cardiac surgeons) while the other one has a large number of providers whose practice locations are more widely dispersed (pediatricians). This bracketing approach facilitates generalization of our findings. Second, focusing on these two specialties allows us to overcome concerns about inaccurate provider directories by utilizing databases that were developed to assess the quality of all actively practicing providers in a specialty (Haeder, Weimer, and Mukamel 2016; GAO 2015). As an added benefit, these databases allow us to explore the potential for incorporating provider quality into network composition through either insurer discretion or regulatory requirement. However, even if one rejects the particular quality measures we employ, our approach shows how to introduce a geographic dimension to network analysis without consideration of quality or with an alternative quality measure preferred by the analyst.

Distance as an Important Dimension in Assessing Access to Medical Services

Research indicates that longer distances between providers and consumers can often have negative consequences. Making access to health care services more costly in terms of travel time decreases utilization with a corresponding increase in negative health outcomes (Arcury et al. 2005; Baren et al. 2001; Borders et al. 2011; McGrail, Humphreys, and Ward 2015; Syed, Gerber, and Sharp 2013; Zgibor et al. 2011). Yet there are also broader societal implications. Various studies have found that lower levels of health access add significant costs to the health care system and to society as a whole (Grant et al. 2016; Wallace et al. 2005).

Yet longer travel distances affect the health of some consumers more than that of others. Negative effects may be particularly pronounced for "transportation-disadvantaged" populations, that is, those unable to provide independently for their own transportation needs (GAO 2014: 4). These populations are disproportionately female, poorer, older, less educated, and of minority status (Blumenberg and Agrawal 2014; Goins et al. 2006; Kim, Norton, and Stearns 2009; Wallace et al. 2005). Many suffer from chronic diseases (Grant et al. 2016; Starbird et al. 2019; Thomas and Wedel 2014). Notably, both urban (Peipins et al. 2011) and rural populations (Arcury et al. 2005; Bellamy et al. 2003; McGrail, Humphreys, and Ward 2015) are experiencing access restrictions because of transportation limitations.

Although researchers have recognized transportation barriers as an important social determinant of health, the magnitude of their impact is uncertain. Estimates put the number of Americans unable to obtain medical care because of transportation issues at 3.6 million, but there may be as many as 15.5 million (Wallace et al. 2005). Analogously, 10% to 51% of respondents in various studies have reported transportation as a barrier to accessing medical care (Syed, Gerber, and Sharp 2013). Some public and private insurers have recognized the implications of transportation barriers and have incorporated nonemergency medical transportation into their plan designs. These insurers include, for example, some Accountable Care Organizations (Fraze et al. 2016), Medicare Advantage plans (Pope 2016), as well as Medicaid (Adelberg and Simon 2017). Overall, there are more than 40 federal programs providing some sort of transportation benefit for medical services (GAO 2014).

The Role of Provider Networks

Access limitations resulting from network design first reached prominence during the managed care debates of the 1990s (White 1999). However, the implementation of the Affordable Care Act has brought renewed attention to the topic, as insurers have often offered relatively narrow networks to consumers through its marketplaces (Giovannelli, Lucia, and Corlette 2015; Haeder, Weimer, and Mukamel 2015a, 2015b, 2019a; Polsky and Weiner 2015). To be sure, narrower networks have helped hold down premium costs for consumers (Dafny et al. 2017; Polsky, Cidav, and Swanson 2016). Assessments of the overall quality of provider networks have come to mixed conclusions (Haeder, Weimer, and Mukamel 2015a; Haeder 2019b; Yasaitis, Bekelman, and Polsky 2017). However, to the dismay of many consumers, prominent providers have often been left out of networks (Haeder, Weimer, and Mukamel 2015a). Moreover, the overall state of confusion about provider networks has led to a dramatic increase in the frequency of financial surprises, or so-called balance billing (Cooper and Scott Morton 2016; Garmon and Chartock 2016). Finally, some studies have also begun to incorporate travel distance in their assessment of provider networks (Haeder, Weimer, and Mukamel 2015a, 2019a; Haeder 2019b). We build and expand on these studies to develop a methodology, described below, to assess the effect of provider network design by insurers on travel distance for consumers. For illustrative purposes, we also assess how much distance would be added for consumers if networks selectively focused on higher-quality providers.

Data and Methods

As studies have shown, the accuracy of provider directories offered by insurers is often rather dismal (Haeder, Weimer, and Mukamel 2016; GAO

2015). The hands-off approach of many regulators gives insurers much leeway in setting up networks for specialties. However, insurers do not deserve the full blame. Providers often move or leave networks, and it can be hard for insurers to track these changes. To account for these problems, we only include cardiac surgeons and pediatricians in our analysis who are actively practicing in their field. We identified these providers by utilizing quality data from two databases described below in more detail. As an added benefit, we also obtain information on provider quality, which we use in additional analyses to explore the potential for integrating provider quality into the assessment on provider networks.

Coronary artery disease affects millions of Americans and accounts for billions of dollars in annual medical costs, which are expected to escalate to $215 billion annually by 2035 (American Heart Association 2017). While less invasive procedures such as percutaneous coronary intervention (PCI) have become more common, coronary artery bypass graft (CABG) surgery and heart valve surgery still account for more than 340,000 procedures per year (iData Research 2018). Both procedures are inherently costly, averaging $75,000 for CABG surgery (Papanicolas, Woskie, and Jha 2018) and $60,000 for heart valve surgery (Robinson 2011). In most cases, surgeries are scheduled in advance and require significant consultation and testing before and after the procedure (American College of Emergency Physicians 2012; Schumer et al. 2016). In view of their frequency and high costs (Papanicolas, Woskie, and Jha 2018), both surgeries have become targets of quality control and cost containment efforts. In the United States, beginning in the 1990s, a number of states introduced report cards that published risk-adjusted mortality rates for surgeons conducting CABG and related procedures. For cardiac surgeons we thus relied on the California Office of Statewide Planning and Development (OSHPD), which provides quality ratings on all 263 cardiac surgeons in the state. OSHPD collected data on operative mortality for CABG or CABG and valve surgeries across the state. It then utilized a sophisticated risk-adjustment methodology to make the data comparable across surgeons (Office of Statewide Health Planning and Development 2017, 2019).

Unlike cardiac surgery, which has among the fewest providers of the major specialties, pediatrics is one of the three most common specializations in the United States (American Association of Medical Colleges 2018). Moreover, unlike cardiac surgeons, whose practices are hospital-clustered, pediatricians practice more widely in their communities. Thus, these two specialties provide contrasting cases for the geographic assessment of networks. For pediatricians, we utilize data from the now defunct

California Healthcare Performance Information System (CHPI),[1] a 501(c)(4) nonprofit, public benefit corporation. CHPI previously collected data based on claims filed to a number of private and public payers in California, including UnitedHealthcare, Anthem Blue Cross, and Blue Shield of California. CHPI presented certain quality measures based on how well doctors follow established medical guidelines. These measures are based on recommendations by the Physician Advisory Group, whose members have appropriate levels of expertise. The measures are also endorsed by the National Quality Forum and the National Committee for Quality Assurance. For this analysis, we are utilizing their measure on *Well-Child Visits for Children Ages 3–6*.

With regard to measures of provider quality we note three things. First, we do not include the assessment of provider quality in the first part of our analysis. Instead, we focus solely on establishing the true supply of providers in California. Second, we utilize the quality component to illustrate the potential effects of accounting for provider quality in network design in additional analyses. We are aware of the controversy surrounding quality measures for medical providers in particular and quality measure in general (Gormley and Weimer 1999). As we noted above, even if one rejects the particular quality measures we employ, our approach nonetheless illustrates how quality measures could easily be included in geographic assessments of provider networks. Third, our own reading of the literature gives us confidence in the utilization of risk-adjusted mortality rates for cardiac surgery. Despite concerns about skimming (Green and Wintfeld 1995), CABG and other health report cards appear to have contributed to improvements in care (Fung et al. 2008; Mukamel, Haeder, and Weimer 2014).[2] For example, risk-adjusted mortality rates in New York, one of the earliest adopters, declined faster than the national average after introduction of its report card (Peterson et al. 1998). Cases of surgical teams radically changing processes in response to poor reports show a mechanism through which improvements could be achieved (Gormley and Weimer 1999). Further, published risk-adjusted mortality rates appear to have had impacts on the inclusion of surgeons in managed care panels (Mukamel et al. 2002) and choices of surgeons by patients (Mukamel et al. 2004). We hold less confidence in the measure for pediatricians

1. All information on the California Healthcare Performance Information System used to be available at www.chpis.org. As the organizations is now defunct, see Haeder, Weimer, and Mukamel 2019a; Haeder 2019b; and Haeder 2020 for more details on CHIS and the corresponding data.

2. We note that the findings with regard to skimming and patient sorting are mixed. See Mukamel, Haeder, and Weimer 2014.

(Sachdeva, McInerny, and Perrin 2014; Schuster 2015), which is based on *Well-Child Visits for Children Ages 3–6*. However, research has established the importance of well-child visits (Freed et al. 1999; Hakim and Bye 2001; Wakai et al. 2018). With these limitations in mind, incorporating the pediatric measure facilitates comparative analysis of application of the method to the two specialties.

As already noted, studies have shown that provider directories are often extensively flawed and overstate the true access for consumers (Haeder, Weimer, and Mukamel 2016). With the true supply of cardiac surgeons and pediatricians so established, we retrieved data on insurance plans from Covered California, the state's ACA marketplace for the 2017 plan year. We then obtained data for products sold in the commercial market that correspond to each product sold on the marketplace.[3] While this restricts the number of insurers in our data set to those offering both ACA and commercial products simultaneously, we nonetheless account for more than 90% of ACA enrollment (Covered California 2016). We then utilize network data provided by Vericred to establish the respective provider networks for each plan. Finally, we also include in our analyses an open-network plan essentially analogous to traditional Medicare, which does not impose any access restrictions and includes all of the state's cardiac surgeons or pediatricians. We note that this also holds important policy implications given the current discussion of Medicare-for-All.

To assess the distances added from network design decisions, we refined an approach utilized by scholars to connect geospatial information to provider networks (Haeder, Weimer, and Mukamel 2015a; Haeder 2019b). Specifically, we resort to the centroids of census tracts, each accounting for roughly 4,000 individuals, to serve as proxies for the location of consumers.[4] We determine whether particular insurance products are available in each of the state's census tracts. We then determine the distance to the closest cardiac surgeon or pediatrician who is in-network for that respective census tract. As a sensitivity analysis, and to account for consumer choice as well as situations where providers are not accepting new patients, we also determine the distance to the three closest providers. We then repeat this two-step process for the census tract for both the corresponding commercial plan as well as the potential open-network plan. The

3. We follow this procedure to match ACA to commercial plans established elsewhere (Haeder, Weimer, and Mukamel 2015a, 2019a) by manually matching ACA plans to their closest commercially available counterpart as presented by the respective insurance carrier.

4. This compares to the individual-level approach taken by other studies (e.g., Drake 2019). However, our assessment of potential access based on census tracts is more fine-grained than reliance on zip code–level data.

resulting data allow for dyadic comparisons between ACA and commercial plans, ACA and open-network plans, and commercial and open-network plans. Comparing dyads allows us to hold constant all plan characteristics other than network differences. We can hence rely on simple statistical tests of differences.[5] Finally, to illustrate the potential effect of accounting for provider quality, we repeat the just-described process first for the distance to the closest provider with a quality rating above the state average, and then for the three closest providers in this higher quality category.

Particular challenges confront consumers in accessing care in rural health care markets (Arcury et al. 2005; Bellamy et al. 2003; McGrail, Humphreys, and Ward 2015). While the dyadic approach allows us to hold constant important local characteristics, and thus allows us to make simple statistical comparisons, it is prudent to account for such diversity. We hence follow the categorization used by the Centers for Medicare and Medicaid Services (CMS), which develops regulations based on the degree of rurality (CMS 2016). Specifically, we differentiate in our analyses census tracts in large metropolitan, metropolitan, and micropolitan and rural areas based on a combination of population and population density.

Results

Distance to Closest Providers

Table 1A shows the results for t-tests comparing the mean minimum travel distance between ACA, commercial, and open-network plans for the three different degrees of rurality. It also shows the results from the quantile regressions for the differences in median travel distances. Not surprisingly, mean distances are shortest in large metropolitan areas and longest in micropolitan and rural areas. Notably, the distances are particularly large in micropolitan and rural areas. We also note that differences between ACA and commercial plans, ACA and open-network plans, and commercial and open-network plans are all statistically different from one another. In all cases, ACA plans exhibit the longest mean distances, while open-network plans exhibit the shortest. The same patterns are apparent for median travel distances. However, in all cases, median travel distances are significantly smaller than mean travel distances. Moreover, focusing on medians substantively reduces the differences between the three types of plans. Importantly, particularly outside of micropolitan and rural areas, it virtually eliminates differences between ACA and commercial plans,

5. Specifically, we resort to difference of means tests (Haeder, Weimer, and Mukamel 2019a) and difference of medians tests (Conroy 2016).

Table 1A Mean and Median Distance in Miles to Cardiac Surgeons

	Large metro			Metro			Micro and rural		
	ACA	COM	ALL	ACA	COM	ALL	ACA	COM	ALL
Closest: mean distance	79.0	46.7	5.6	95.6	68.3	12.3	187.9	134.6	47.9
Closest: median distance	13.7	12.0	4.1	30.3	26.0	6.8	136.5	109.6	40.5
Closest three: mean distance	90.4	57.2	7.00	111.6	82.6	15.2	210.3	155.2	66.4
Closest three: median distance	17.8	15.0	5.6	45.5	38.6	10.2	166.6	143.2	61.0
Closest high quality: mean distance	82.2	47.8	6.8	100.2	69.7	13.1	190.1	137.5	61.5
Closest high quality: median distance	15.1	12.9	5.1	35.0	29.3	8.1	137.3	115.0	51.1
Closest three high quality: mean distance	99.1	68.7	8.1	120.5	93.8	18.6	220.4	160.6	79.4
Closest three high quality: median distance	20.7	15.8	6.6	51.8	44.2	13.0	176.0	147.7	67.0

Notes: Differences between ACA and COM, COM and ALL, and ACA and ALL are all statistically significant at least at $p \leq 0.003$. We relied on t-tests to assess differences of means and quantile regression to assess differences in medians. ACA indicates ACA marketplace plan, COM indicates commercially available plan, and ALL indicates an unrestricted open network. There are x observations for large metropolitan areas, x observations for metropolitan areas, and x observations for micropolitan and rural areas. There are 24,772 observations for large metropolitan areas, 18,485 observations for metropolitan areas, and 1,383 observations for micropolitan and rural areas. Based on authors' calculations.

Table 2A Percentiles for Mean Distance in Miles to Closest Cardiac Surgeon

	Large metro			Metro			Micro and rural		
Percentile	ACA	COM	ALL	ACA	COM	ALL	ACA	COM	ALL
25%	5.44	4.54	2.29	8.82	7.25	3.54	76.20	60.15	18.81
50%	13.67	11.97	4.14	30.28	26.02	6.79	136.48	109.59	40.48
75%	91.67	64.68	7.37	120.35	100.02	15.73	256.45	191.58	72.20
90%	378.71	174.79	11.45	330.14	224.60	27.09	448.81	274.54	101.50
95%	403.77	196.92	15.08	446.51	262.53	37.65	514.80	312.87	109.11
99%	430.60	223.85	23.30	530.33	320.60	86.06	611.84	359.27	149.60

Notes: ACA indicates marketplace plan networks, COM indicates their corresponding commercial networks, ALL indicates an unrestricted open network. Based on authors' calculations.

though differences between both and the open networks are apparent, albeit smaller than for the comparisons of means.

The differences between comparisons of means and medians indicate a number of outlier plans are likely to exert substantive influence on the overall findings. The distribution of percentiles for travel distances illustrates this nicely (table 2A). For one, substantive differences between ACA and commercial plans are not present up to the 50th percentile, but become apparent at the 75th percentile and above. That is, for about half of the observations there are only limited differences in travel distance present. At the same time, about 25 percent of observations for ACA plans differ substantively from commercial plans. Moreover, all three types of plans are relatively similar for 25 percent of the observations in large and other metropolitan areas while substantial differences are present for virtually all observations in rural and micropolitan areas. We note that in large metropolitan areas, all census tracts have access to a cardiac surgeon within 53 miles. The number increases to 149 miles in other metropolitan areas and 160 miles in micropolitan and rural areas in open network plans. The numbers are 463 miles, 594 miles, and 672 miles for ACA plans, and 254 miles, 444 miles, and 394 miles for commercial plans, respectively.

Finally, we show the distribution of distances to cardiac surgeons by decile graphically in figures 1A–C. Figure 1A presents the data for large metropolitan areas, figure 1B for standard metropolitan areas, and figure 1C for micropolitan and rural areas.[6] The graphical presentations

6. We note that the data are rather similar for access to the three closest providers, the closest high-quality provider, and the three closest high-quality providers. We hence omit these from this presentation.

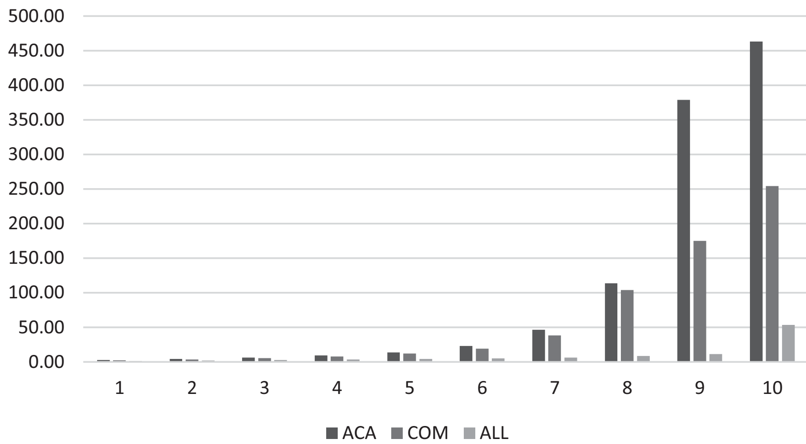

Figure 1A Distance to closest cardiac surgeon by deciles for large metropolitan areas.

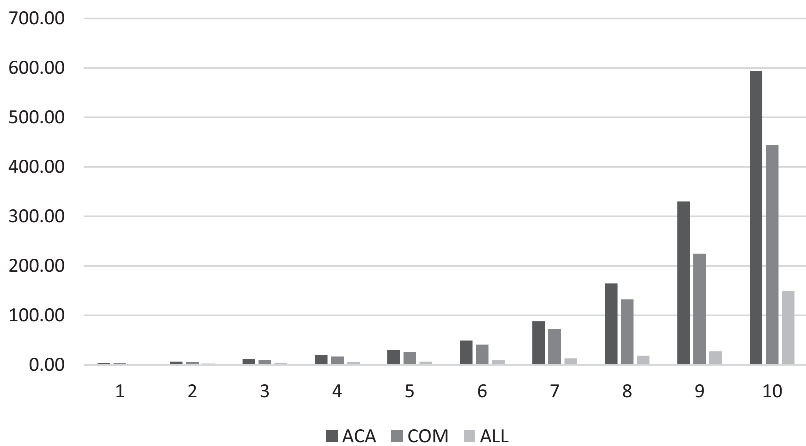

Figure 1B Distance to closest cardiac surgeon by deciles for metropolitan areas.

reemphasize important nuances of our analyses described above. First, for a significant number of observations, particularly outside of micropolitan and rural areas, there is relatively good access close to consumers. However, at the same time, there are significant outliers at the higher-level deciles. Second, stark differences are apparent between open-network

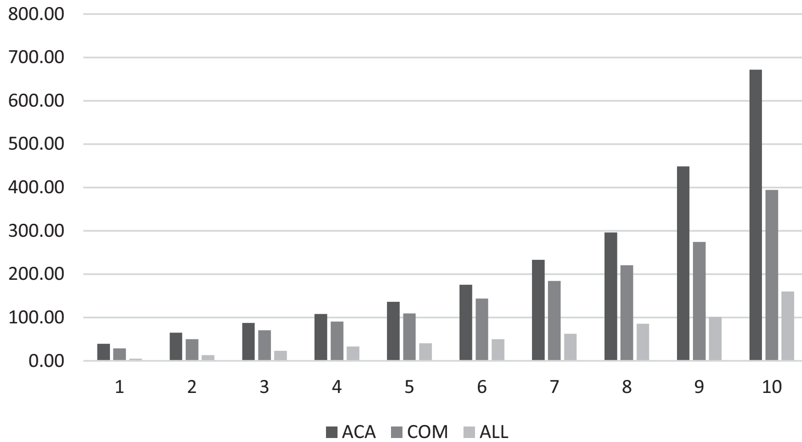

Figure 1C Distance to closest cardiac surgeon by deciles for micropolitan and rural areas.

access and the two restricted forms of access via ACA and commercial plans for certain deciles. In micropolitan and rural areas, these differences emerge across all deciles. Third, access between commercial and ACA plans is similar for a number of deciles but significant differences emerge. Lastly, access limitations and differences across plan types are amplified with increases in rurality.

Table 1B illustrates our findings for access to pediatricians. Because of the large supply and more decentralized distribution of pediatricians, mean and median travel distances are substantially lower as compared to cardiac surgeons. Moreover, there are no substantive differences between ACA and commercial plans in large and standard metropolitan areas. However, larger differences exist in micropolitan and rural areas amounting to about 16 percentage points and 18 percentage points for medians in comparisons of plans and open networks. Similar to the case of the cardiac surgeons, the differences between mean and median travel times indicates the existence of outliers in pediatric access, which is also reflected in the distribution of percentiles for travel distance (table 2B). The graphical illustrations of the data (figure 2A–C) show analogous patterns to those for cardiac surgeons. We note, however, that discrepancies between plan types are smaller and emerge in higher-level deciles. Specifically, the differences between commercial and ACA plans appear to be substantively small. Moreover, the absolute travel distance is much lower than for cardiac surgeons.

Table 1B Mean and Median Distance in Miles to Pediatricians

	Large metro			Metro			Micro and rural		
	ACA	COM	ALL	ACA	COM	ALL	ACA	COM	ALL
Closest: mean distance	10.8	7.3	1.8	25.3	22.3	4.3	95.1	78.9	16.3
Closest: median distance	4.6	3.5	1.5	12.0	9.0	2.4	76.0	58.0	10.7
Closest three: mean distance	16.0	10.5	2.5	31.9	27.5	5.6	110.4	88.5	22.6
Closest three: median distance	8.6	6.6	2.1	18.6	15.3	3.5	85.2	65.8	16.8
Closest high quality: mean distance	18.8	10.9	2.4	30.5	25.1	5.9	127.6	91.5	26.4
Closest high quality: median distance	7.7	5.6	2.0	15.8	12.2	3.2	83.7	70.3	18.0
Closest three high quality: mean distance	23.4	14.6	3.2	39.8	34.3	7.2	143.8	105.7	34.9
Closest three high quality: median distance	11.5	8.4	2.7	22.1	19.1	4.5	101.6	82.1	27.1

Notes: Differences between ACA and COM, COM and ALL, and ACA and ALL are all statistically significant at least at $p \leq 0.003$. We relied on t-tests to assess differences of means and quantile regression to assess differences in medians. ACA indicates ACA marketplace plan, COM indicates commercially available plan, and ALL indicates an unrestricted open network. There are 24,772 observations for large metropolitan areas, 18,485 observations for metropolitan areas, and 1,383 observations for micropolitan and rural areas. Based on authors' calculations.

Table 2B Percentiles for Mean Distance in Miles to Closest Pediatrician

	Large metro			Metro			Micro and rural		
Percentile	ACA	COM	ALL	ACA	COM	ALL	ACA	COM	ALL
25%	2.06	1.63	0.85	3.52	2.67	1.34	24.64	21.25	3.09
50%	4.62	3.47	1.49	11.98	8.98	2.41	75.96	57.96	10.68
75%	12.67	9.88	2.33	39.09	35.10	4.45	148.16	131.14	24.29
90%	27.61	16.62	3.39	69.04	63.49	9.03	216.74	190.46	39.35
95%	41.14	21.79	4.27	81.89	74.71	14.05	249.11	219.40	52.55
99%	79.60	60.49	8.26	128.09	113.44	33.91	297.01	271.80	75.43

Notes: ACA indicates marketplace plan networks, COM indicates their corresponding commercial networks, ALL indicates an unrestricted open network. Based on authors' calculations.

Travel Distance Added by Networks

As open-network plans include all available providers, offering the maximum possible level of access, the open network can serve as a benchmark. The comparison between ACA and open-network and commercial and open-network plans allows us to determine what percentage of travel distance is the result of network design. Table 3A presents the results of t-tests comparing ACA and commercial plans with regard to the travel distance in miles added due to network design as well as the percentage of travel distances attributable to network design for cardiac surgeons. On average, network design adds 73 miles of mean travel distance in large metropolitan areas, 83 miles in other metropolitan areas, and 140 miles in micropolitan and rural areas for ACA plans. The distance added for commercial plans is about 30 miles less than for ACA plans in the former two and just over 50 miles less than ACA plans in the latter. In percentage terms, network design accounts for 51% to 55% of the mean travel distance in ACA plans and about 7 to 9 percentage points less in commercial plans. We also present the contribution of provider networks in terms of the median miles added to travel distance. Once more, the medians are substantially smaller than means. Moreover, the differences between ACA and commercial plans are very small in large metropolitan areas and around 6 miles in metropolitan areas. While they are also smaller in micropolitan and rural areas, they still approach 20 miles. Notably, in terms of percentages of travel distances, means and medians are remarkably similar.

For pediatricians (table 3B), overall distances added are once more substantially smaller than for cardiac surgeons. ACA plans on average add 9, 21, or 79 miles to the mean travel distance (3, 7, 62 miles to the median

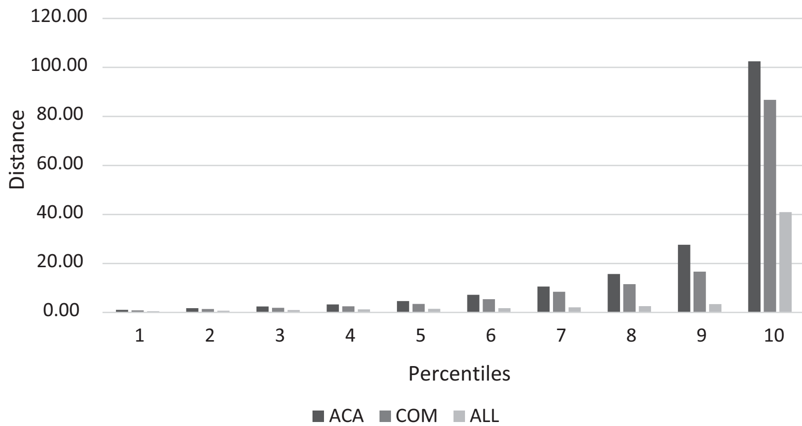

Figure 2A Distance to closest pediatrician by deciles for large metropolitan areas.

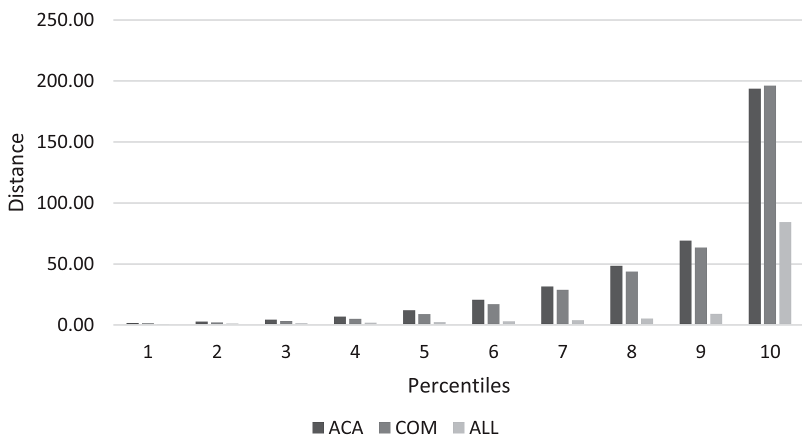

Figure 2B Distance to closest pediatrician by deciles for metropolitan areas.

travel distance) while commercial plans add 6, 18, or 63 miles (1, 3, or 39 miles to the median travel distance). However, in terms of percentage of travel time added, the two specialties are remarkably similar (although the percentage added is a bit larger in micropolitan and rural areas for pediatrics). For both cardiac surgeons and pediatricians, distributions of travel distance added are in line with those presented for overall travel times (omitted).

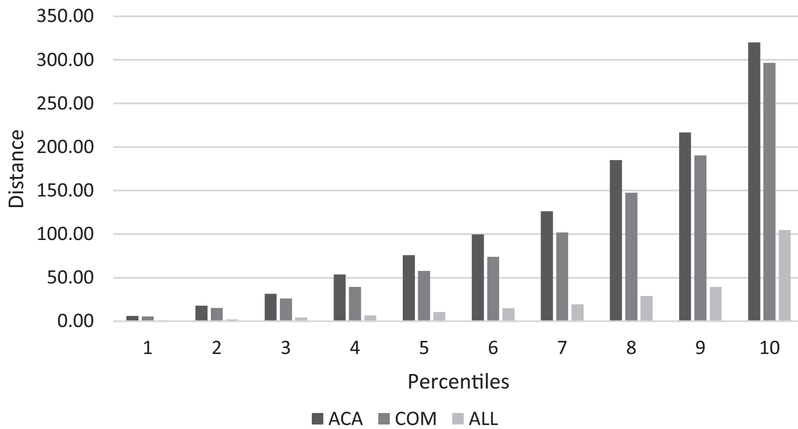

Figure 2C Distance to closest pediatrician by deciles for micropolitan and rural areas.

Distance to Three Closest Providers

As a sensitivity analysis, and to account for patient choice, we extended our analysis by assessing the mean distance to the three closest providers (also in table 1A). Naturally, the distance increases as compared to the previous analyses, but our findings are substantively similar. The increases are comparable in both types of metropolitan areas, about 10 to 20 miles for ACA and commercial plans. The increase for open-network plans is negligible. Once more, increases are substantially larger in rural areas. This also holds for open-network plans, which is a direct result of the limited overall number of cardiac surgeons practicing in rural areas. In terms of median travel distances, the increases are more muted and relatively small in large metropolitan areas. Across degree of rurality, the increases are largest for ACA plans followed by commercial plans. For pediatricians (table 1B), the increases compared to access to the closest provider in large and standard metropolitan areas are limited to less than 6 miles in terms of either mean or median travel distance. Moreover, the differences between ACA and commercial plans continue to be relatively small in absolute miles. The increases are larger in micropolitan and rural areas (about 15 miles for ACA plans and 10 miles for commercial plans), and the differences between ACA and commercial plans becomes apparent with roughly 20 additional miles in mean and median travel distances.

Table 3A again presents the additional distance added by network design for access to the three closest cardiac surgeons. Overall, accounting for

Table 3A Additional Distance to Closest Cardiac Surgeon due to Network Design in Miles and as a Percentage of Total Distance

		Large metro		Metro		Micro and rural	
		ACA	COM	ACA	COM	ACA	COM
Closest surgeon	Mean miles added	73.4	41.2	83.0	56.0	140.0	87.0
	Percentage	51.7	45.0	51.0	44.0	55.0	46.0
	Median miles added	5.2	3.3	13.1	7.2	79.9	60.4
	Percentage	58.3	38.2	59.8	40.3	66.4	53.9
Closest three surgeons	Mean miles added	83.4	50.2	96.0	67.0	144.0	89.0
	Percentage	54.9	47.0	58.0	49.0	57.0	46.0
	Median miles added	8.2	3.7	29.1	18.4	108.6	68.0
	Percentage	60.2	40.7	68.9	56.1	62.3	54.1
Closest high-quality surgeon	Mean miles added	75.5	41.0	87.2	56.7	128.6	76.0
	Percentage	51.6	44.2	53.4	46.1	50.0	41.3
	Median miles added	5.8	3.5	19.6	10.1	73.6	59.2
	Percentage	56.5	36.5	67.0	48.2	56.6	46.5
Closest three high-quality surgeons	Mean miles added	91.0	60.6	102.0	75.0	141.0	81.2
	Percentage	56.3	47.2	57.0	47.0	53.9	41.8
	Median miles added	10.5	4.5	31.2	21.4	91.4	66.2
	Percentage	63.4	43.4	65.8	55.7	54.3	46.7

Notes: For both ACA and commercial plans, the reference point is the unrestricted, open network, which serves as the maximum possible level of access.

Differences between ACA and COM plans are all statistically significant at least at $p \leq 0.003$. We relied on t-tests to assess differences of means and quantile regression to assess differences in medians. ACA indicates ACA marketplace plan. COM indicates commercially available plan. There are 24,772 observations for large metropolitan areas, 18,485 observations for metropolitan areas, and 1,383 observations for micropolitan and rural areas. Based on authors' calculations.

Table 3B Additional Distance to Closest Pediatrician due to Network Design in Miles and as a Percentage of Total Distance

		Large metro		Metro		Micro and rural	
		ACA	COM	ACA	COM	ACA	COM
Closest	Mean miles added	8.9	5.5	21.0	18.0	78.8	62.6
	Percentage	52.1	41.2	52.4	43.1	57.5	52.0
	Median miles added	2.5	1.1	6.6	2.5	62.2	38.5
	Percentage	64.9	44.9	69.4	47.5	80.4	71.4
Closest three	Mean miles added	13.5	8.0	26.3	21.9	87.8	66.0
	Percentage	59.4	47.4	57.6	48.5	60.6	54.9
	Median miles added	5.9	3.3	12.6	7.2	60.8	41.5
	Percentage	72.7	56.2	72.2	53.2	76.4	68.1
Closest high quality	Mean miles added	16.4	8.5	24.6	19.2	101.2	65.1
	Percentage	56.8	44.8	50.8	40.5	53.4	49.4
	Median miles added	5.0	2.4	8.6	2.8	51.4	38.8
	Percentage	72.7	55.9	67.4	40.5	69.5	60.8
Closest three high quality	Mean miles added	20.2	11.4	32.6	27.1	108.9	70.8
	Percentage	61.6	48.4	57.2	47.8	58.6	48.0
	Median miles added	8.1	4.5	14.1	8.6	56.2	42.9
	Percentage	74.9	59.5	69.7	54.5	68.0	61.2

Note: For both ACA and commercial plans, the reference point is the unrestricted, open network, which serves as the maximum possible level of access.

Differences between ACA and COM plans are all statistically significant at least at $p \leq 0.003$. We relied on t-tests to assess differences of means and quantile regression to assess differences in medians. ACA indicates ACA marketplace plan. COM indicates commercially available plan. There are 24,772 observations for large metropolitan areas, 18,485 observations for metropolitan areas, and 1,383 observations for micropolitan and rural areas. Based on authors' calculations.

patient choice, that is, access to the three closest providers, adds about 10 to 15 miles in distance and somewhat less in micropolitan and rural areas as compared to our findings for access to the closest provider in terms of mean travel distance. Additionally, the percentage of total distance increases a few percentage points as well. The pattern is similar for increases in median travel time. In terms of percentage, mean and median travel times are again rather similar. For pediatricians (table 3B), patterns are similar with increases in absolute miles being once again even more muted.

Distance to Closest High-Quality Providers

Some scholars have proposed that we should encourage insurance carriers to either selectively contract with higher quality providers or to at least establish incentives for consumers to seek out such providers (Haeder, Weimer, and Mukamel 2015b). While there are certain limitations associated with all measures of provider quality, CABG risk-adjusted mortality scores, as described above, may serve as a best-case scenario to explore the effect of including provider quality into network design decision or regulations (Epstein 2010; Wang et al. 2011). As we pointed out before, there are some limitations associated with the quality measure for pediatricians. How much farther would consumers have to travel if networks selectively focused on providers who perform better than the state average?

As the bottom of table 1A illustrates, the effect of focusing access on high-quality cardiac surgeons would be limited to less than 5 additional miles, on average, for mean and median travel distances compared to access without regard to provider quality for all three types of plans, with the exception of open-network plans in micropolitan and rural areas. Here the increase exceeds 10 miles for ACA plans but remains below 5 miles for commercial plans. If we once more add a degree of patient choice to the analysis (table 1A) by assessing the mean distance to the three closest high-quality surgeons, the distance increases by generally no more than 10 miles, again with the exception of open-network plans in micropolitan and rural areas. The patterns at lower overall levels are evident for median travel distances. The distribution in terms of percentiles is similar to our previous analyses (omitted). Notably, while the overall travel distance increases as just described, the distance as a result of network design as well as the percentage of travel distance due to network design holds steady or even declines when measured for the closest higher-quality surgeon (bottom of table 3A). For the three closest higher-quality surgeons, the former increases slightly for large and other metropolitan areas and declines for micropolitan and rural areas in terms of miles, and holds steady or declines in percentage terms. Once more, median travel times are lower in terms of absolute value but similar in percentage terms. Median travel times added actually decrease in micropolitan and rural areas.

For high-quality pediatricians (table 1B), increases in distance compared to access to the closest pediatrician are small in absolute terms across ACA and commercial plans outside of the most rural areas, where differences may exceed 10 miles. Increases in mean and median travel distance remain below or around 10 miles for both mean and median travel times, except for ACA plans in micropolitan and rural areas, where they exceed 20 miles in terms of mean travel distance. In terms of distance added (table 3B), increases are also generally below 10 miles for both access to the closest high-quality surgeon as well as the three closest high-quality surgeons. ACA plans in micropolitan areas again exceed this number for mean travel distance added. However, median travel times decrease in these areas. Once again, the percentage of distance added remains stable. We note that overall, the percentage of distance added is consistently larger for pediatrics than for cardiac surgery.

Discussion

The objective of this study was to determine the effect of network design on consumer travel. We developed a replicable methodology, which compares travel distances between census tracts and in-network providers to the travel distance between census tracts and the overall supply of providers. We illustrate the application of this methodology to CABG surgeons, who have been extensively studied in the context of insurance coverage for vulnerable populations, access to care, and access to high-quality care (Epstein 2010; Glance et al. 2008; Romano et al. 2011) as well as access to pediatricians. We thus add to the burgeoning literature on incorporating travel distance into the assessment of provider networks. Crucially, this is the first study to provide concrete estimates of the travel burden imposed on consumers by network design. Furthermore, by relying on public quality report cards to establish the supply of providers, we were able to address common concerns about the inaccuracy of provider directories by limiting our analysis to providers known to be actively practicing.

To illustrate our innovative methodology, we utilized plans offered through Covered California, an Affordable Care Act marketplace, comparable commercial plans, and unrestricted open-network plans. We found that network design adds travel distance for consumers in all areas, including large metropolitan areas, but especially in rural areas (see figures 1A and

1B). Overall, we found that Covered California plan subscribers must generally travel longer distances to the nearest, or three nearest, cardiac surgeons or pediatricians than subscribers in the comparable commercial plan. However, often the differences between commercial and ACA-marketplace consumers are relatively insubstantial, particularly in terms of comparisons based on median travel distances. At the same time, subscribers to either plan type must travel substantially longer distances than consumers whose choices are unrestricted by a network. However, the diversity in travel times with each plan type deserves particular note here; that is, a large number of ACA and commercial plans show relatively small travel distances. However, there are significant outliers, with ACA-marketplace plans showing a larger number and larger degree of these outliers. ACA-marketplace plans likewise do worse in this regard because their networks tend to be on average narrower. Finally, we repeated the analysis for distance to high-quality cardiac surgeons and pediatricians. This analysis shows somewhat larger in-network travel distances than the analysis without quality.

It is important to recognize that longer travel distances affect society in three ways. First, they have clinical effects that occur because patients have greater difficulty accessing care when they need it. A number of studies have shown that larger travel distances are associated with decreases in utilization and, ultimately, negative health outcomes across a wide variety of medical conditions (Arcury et al. 2005; Baren et al. 2001; Borders et al. 2011; McGrail, Humphreys, and Ward 2015; Syed, Gerber, and Sharp 2013; Zgibor et al. 2011). Conversely, larger travel distances also increase the use of emergency departments (Kim, Norton, and Stearns 2009). Importantly, the effect of travel distance may differ depending on specialties and the type of medical conditions that confront consumers (Syed, Gerber, and Sharp 2013). Particularly affected, of course, are those with chronic conditions in need of frequent care (Grant et al. 2016; Starbird et al. 2019; Thomas and Wedel 2014).

Second, longer travel distances impose an opportunity cost on consumers through the lost time that they could use in other ways. Of course, consumers also bear other opportunity costs when seeking care, including finding a provider that accepts their insurance and accepts new patients, setting up appointments, and waiting at the provider's office to be seen. In many cases, these costs may exceed out-of-pocket costs associated with the visit (Ray et al. 2015). At times, these costs may push consumers into delaying or even avoiding care altogether, potentially leading to complications, and higher costs, later on (Grant et al. 2016; Wallace et al. 2005).

Although the health care system often ignores these opportunity costs, they nonetheless are relevant costs to society—other things equal, reductions in travel distance increase social welfare.

Third, beyond these efficiency impacts, longer travel distances exacerbate inequalities in health care access. Poorer consumers are generally less able to overcome the barriers imposed by distance, limiting their choices within networks or even preventing access altogether (Blumenberg and Agrawal 2014; Kim, Norton, and Stearns 2009). Delaying or even forgoing care can have significant negative implications down the road. The consequences are borne by both the individual consumer and society at large, for example, in the form of public assistance outlays or uncompensated care (Haeder 2019a). Crucially, network-imposed travel requirements potentially further exacerbate other social determinants of health, such as access to healthy food or employment (Dillahunt and Veinot 2018). We also note that in addition to the many widely recognized public health benefits that may arise from improved built environments that reduce the need for travel, access to medical care is also relevant. Environments that enable people to access medical care more conveniently through walking or public transportation have health benefits. Finally, even small increases can add prohibitive costs for some consumers.

The study has limitations. For one, our application focuses on only two specialties, cardiac surgeons and pediatricians, in one state, which may limit the generalizability of the findings. However, our stratification into different degrees of rurality should soften the geographic concerns. Moreover, our approach analyzes two diverse specialties that are at different ends of the spectrum of the medical care. Moreover, certain factors present in California are common throughout the United States. Arguably, the factors and incentive structures affecting rural California are present, to a large degree, across rural areas in the United States. The same holds for the other classifications. Moreover, market incentives confronting insurers and providers are broadly similar across different insurance markets. Nonetheless, future studies should examine these issues in other insurance programs, specialties, and states. We also assess potential access as compared to actual individual-level choices (Drake 2019). However, this allows for a more fine-grained analysis at the census-tract level. While we include an analysis of access to the three closest providers, we also do not fully incorporate network breadth into our analyses. Other analyses that have done so indicate analogous findings to ours with regard to access (Haeder 2019b, 2019c, 2019d; Haeder, Weimer, and Mukamel 2019a). We also cannot connect our network data to actual utilization data. Finally, we rely on travel distance (as compared to time) and geodesic distance (as compared to actual roads). This likely introduces a conservative bias into our findings, that is, it leads us to underestimate access restrictions, particularly in highly rural areas (Boscoe, Henry, and Zdeb 2012; Phibbs and Luft 1995).

Conclusion

Consumers may bear long travel distances to access providers because of geography. As our analysis shows, network design can substantially add to these travel distances, especially in terms of increasing distances for plans offered through ACA marketplaces. Crucially, our approach relies on simplification and should be considered as a conservative, best-case scenario for consumer access to providers. As the effect of distance between providers and consumers on health care access is well recognized, our findings are cause for concern. In particular, we add to the growing evidence illustrating access issues, particularly for rural consumers. Yet our findings also show a significant degree of diversity as finer-grained analyses of our data indicate that a large number of plans appear to provide access relatively close to consumers, with a number of significant outliers severely limiting access.

The question emerges why networks often add significant amounts of travel distance for consumers. As shown by the open-network findings, access issues can be severely curtailed theoretically, and are only to a very limited degree the result of the distribution of providers. One potential explanation includes excessive payment demands by monopolistic providers, particularly in rural areas. This means that insurance carriers must make decisions on whether to pay those prices, which would inevitably lead to higher premiums for consumers, or whether to create areas without access to any providers. Given our findings, there are potential indications they are often opting for the latter. Alternatively, our findings may be indicative of backdoor approaches by insurers to push sicker consumers out of their plans by limiting access to important specialists. That is, they seek to alter their risk pool by disproportionately seeking out healthier consumers. These important questions deserve more scholarly and political attention.

The question of trade-offs deserves particular attention. We already mentioned the potential trade-off between travel distance and costs in the form of premiums. Evidently, particularly healthier individuals may benefit from the current approach, as opposed to sicker individuals who would likely favor better access even if it entailed slightly higher premiums. Another potential trade-off apparent from our analysis is between travel distance and provider quality. On average, refocusing provider networks on higher-quality providers often adds only a small amount of travel distance. This should encourage regulators and insurance to consider moving in this direction. Of course, there is an indication that higher volumes are directly connected to higher quality, adding additional societal benefits to concentrating on a more limited number of providers (Shahian et al. 2010). Finally, we should mention that in the real world, these trade-offs have significant implications for individuals and their health. This particularly holds for cases of emergencies.

While more research is necessary on the connection between provider networks and health outcomes, our findings suggest certain policy responses. For one, regulators in California currently already include network adequacy in their plan requirements. Our findings point to the need for better oversight procedures. Of course, network regulation is a complex issue that does not lend itself to simple solutions (Haeder, Weimer, and Mukamel 2019b). Importantly, our findings for the open network indicate that for most consumers, access close to home is theoretically possible. Hence, the silver lining of the findings about network design is that networks may be more amenable to policy interventions than provider location. Alternatively, regulators or health plans could move to incorporate non-medical transportation into benefit design as some Medicare Advantage plans have begun to do. With regard to large reforms of the US healthcare system, our findings illustrate a benefit of Medicare-for-All proposals: provider networks, and the access limitations they impose, would be eliminated. For now, consumers should be mindful of the provider networks available to them during open enrollment. When confronted with limited healthcare access they should seek help from consumer advocates and, in the case of California, the Office of the Patient Advocate.

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