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## Economic and Health Benefits of a PPE Stockpile\*

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The COVID-19 pandemic has exposed tragic shortcomings in California's preparedness for infrequent but catastrophic public health threats. This failure has caused serious health consequences—in addition to being financially myopic. One specific type of prevention investment that is widely recognized to be crucial is the stockpiling of personal protective equipment (PPE) for essential workers. California Senate Bill 275 as amended in July 2020 would require the state to create a PPE stockpile sufficient to protect healthcare and other essential workers for at least 90-days of a future pandemic or health emergency. Drawing on what we have learned from the current pandemic, in this issue brief we outline the potential economic and health benefits of such a PPE stockpile.

### Key Findings

- **Potential savings from averting high-priced emergency PPE contracts dwarf the budgetary cost of creating a PPE stockpile at normal non-pandemic prices.** Procuring an adequate PPE stockpile in advance at non-pandemic prices would cost only 17% of the projected amount needed to procure it at current pandemic-inflated prices. Maintaining the stockpile would be cheaper than real-time purchases even if it was not needed for another 35 years, and even if we were fortunate enough to not need the stockpile for longer than that, it would be a highly financially prudent form of insurance.
- **Healthcare access was severely affected in the early months of the COVID-19 pandemic, with 251,100 California healthcare workers receiving unemployment benefits, in part due to lack of adequate PPE.** For every week earlier that this number of workers could return to work in the next pandemic if PPE were readily available at the start, the state would save approximately \$93 million in unemployment insurance payments. This would also have substantial benefits in terms of improved healthcare access for routine non-emergent care including preventive services.
- Over 50,000 healthcare and other essential workers in California have likely tested positive for COVID-19. The available research on COVID-19 to-date suggests that adequate and appropriate use

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of PPE can largely mitigate the spread of COVID-19 among healthcare workers. ***We conservatively estimate that at least 20,860 essential worker-related COVID-19 cases may have been avoidable if proper PPE had been available.*** It is likely that dozens of deaths among essential workers could have been avoided with proper use of PPE had an adequate stockpile been in place prior to the pandemic start.

### **1. Savings from Procuring PPE at Normal Non-Pandemic Pricing**

Since the start of the pandemic, PPE prices have increased dramatically as demand has far exceeded the normal supply of PPE. With healthcare providers and governments scrambling to secure PPE to protect workers, purchasers have been forced to pay exorbitant costs. For example, New York State, the hardest hit area in the U.S. early in the pandemic, agreed<sup>1</sup> to pay \$7.50 each for critically important N95 masks that have pre-pandemic prices typically in the \$1 range depending on quality. The federal government, despite its bulk purchasing power, reportedly placed no-bid contracts for N95 masks at an average of 6 times normal prices, with higher prices for earlier delivery (e.g. \$7.50/mask for early April delivery, and \$5.90/mask for a large contract promising late April delivery).<sup>2</sup> On April 7, 2020, California signed a bulk contract with an unproven supplier for 300 million NIOSH-approved N95 masks at a price of \$3.30/mask, but delivery was delayed until June 2020 and later.<sup>3</sup> Although California achieved a better price than the federal contracts, the tradeoff was a long delivery timeline which ensured continued PPE shortages in California over the first three months of the pandemic.

Below, we present estimates of the cost of procuring a robust, high quality 90-day PPE stockpile at non-pandemic prices, and contrast it with the cost of rapid procurement at pandemic prices. We focus on six types of PPE used by healthcare workers, as well as the subset of PPE (exam gloves and surgical masks) needed for other essential workers beyond healthcare. The exact size of the stockpile and the types of PPE to store will depend on the numbers of workers of different types, thus we show in Table 1 the estimated stockpile needs per 1 million healthcare workers. These estimates can then be scaled depending on who is to be covered by the stockpile.

The quantity of PPE stockpiled per worker depends on assumptions regarding the “burn rate” of PPE use during a pandemic. Because the stockpile is a form of insurance protection during low probability but potentially catastrophic emergencies, we assume a robust stockpile that ensures generous availability of PPE at burn rates similar to the early period of COVID-19. The typical hospital in a non-pandemic year reportedly procures 5,000-6,600 N95 masks,<sup>4</sup> but per a hospital survey of PPE surge demand during the COVID-19 pandemic, N95 mask demand was 17 times normal rates as of late March.<sup>5</sup> Using the high end of these numbers, it would be prudent to maintain a stockpile of at least 12.5 million N95 masks just for California hospital worker use in the first 90 days of a pandemic.<sup>6</sup> Healthcare workers outside of hospital settings also require significant PPE, but the quantity and type of PPE required varies significantly between non-hospital settings. For example, nursing homes may have high PPE burn rates given the high risk of COVID-19 infections in that setting, while other non-hospital settings may have lower average burn rates due to some (such as home health workers) seeing fewer individual patients per day. Some healthcare settings may be able to

temporarily reduce exposure for workers without any PPE required through adjustments such as increased telemedicine. Because many non-hospital settings reduced operations due to lack of PPE in the initial months of the COVID-19 pandemic, we do not have clear estimates of what they would have used if PPE had been available, thus we make the transparent assumption that the average non-hospital healthcare worker requires half the pandemic PPE of a hospital worker. California has roughly double the number of non-hospital healthcare workers as hospital-based ones, resulting in our estimated total healthcare PPE needs being double the hospital-based PPE estimate.

To estimate the healthcare stockpile needed for other PPE beyond N95 masks, we rely on the federal HHS TRACIE *Hospital Personal Protective Equipment Planning Tool* which provides estimated influenza pandemic-level consumption ratios of other PPE relative to N95 needs.<sup>7</sup> Based on use among a variety of healthcare practitioner, technical, and support occupations such as hospital nurses, physicians, technicians, etc., we estimate that for each N95 the stockpile should include 2 surgical masks, 1 face shield, 2 isolation gowns, 2 shoe covers, and 9 glove pairs. For non-healthcare essential workers, we assume one mask and four glove pairs per work day, i.e. 64 masks and 257 glove pairs per worker over 90 days.

To determine pandemic and non-pandemic price levels we reviewed multiple published and unpublished price sources. For N95 pandemic pricing we use the aforementioned federal contract bulk cost of \$5.90/mask that was negotiated for rapid delivery (California’s contract for \$3.30/mask was for later delivery in June and July, causing widespread PPE shortages during the first 90 days of the pandemic, thus is not an appropriate benchmark).<sup>8</sup> For N95 non-pandemic pricing we use the 3M midpoint list price of \$1.27/mask<sup>9</sup>, though this could be negotiated down further in a large bulk order during non-pandemic periods. Other PPE prices were drawn from a published analysis of pandemic prices in April 2020 compared to pre-pandemic prices for equivalent equipment<sup>10</sup>, cross-referenced with other sources such as reports of government contracts. In Table 1, we report estimated pandemic price markups as high as 1100%.

**Table 1: Cost of 90-day supply of PPE per million healthcare workers**

	90-day supply (per million workers)	Unit price			Cost \$million (per million workers)		
		Non- Pandemic	Pandemic	% Markup	Non- Pandemic	Pandemic	Savings
N95	14,050,662	\$1.27	\$5.90	465%	\$17.8	\$82.9	\$65.1
Surgical masks	28,101,324	\$0.05	\$0.55	1100%	\$1.4	\$15.5	\$14.1
Face shields	14,050,662	\$0.50	\$4.50	900%	\$7.0	\$63.2	\$56.2
Gowns	28,101,324	\$0.50	\$5.00	1000%	\$14.8	\$147.9	\$133.2
Shoe covers	28,101,324	\$0.11	\$0.12	109%	\$3.1	\$3.4	\$0.3
Exam glove pairs	126,455,958	\$0.04	\$0.12	300%	\$5.1	\$15.2	\$10.1

The total cost of procuring the stockpile will depend on timing<sup>11</sup> and the number and types of workers to be covered. In Table 2 we present total stockpile procurement cost estimates under non-pandemic versus pandemic pricing, assuming that all healthcare and non-healthcare essential workers are covered by the stockpile. Under Senate Bill 275, the total cost of building the initial stockpile would be spread across multiple years as the bill requires a 90-day stockpile by June 1, 2023. Using the Public Policy Institute of California’s recent estimate of 5.3 million<sup>12</sup> essential workers in California, of which 1.8 million<sup>13</sup> are healthcare workers, the stockpile would provide surgical masks and gloves to another 3.5 million non-healthcare essential workers. Per the above price estimates, purchasing real-time PPE for California’s essential workers and related key populations would cost over \$808 million if procured at pandemic prices. Alternatively, prospectively procuring the same PPE at non-pandemic prices would cost only \$134 million, i.e. 17% of the cost at pandemic prices.

**Table 2: Non-pandemic and pandemic PPE costs for essential workers**

Population Covered	Number of workers	Non-Pandemic Cost (\$ million)	Pandemic Cost (\$ million)	Savings (\$ million)
Healthcare workers	1.8 million	\$86.8	\$573.9	\$487.2
Non-healthcare essential workers	3.5 million	\$47.7	\$233.7	\$186.1
TOTAL	5.3 million	\$134.4	\$807.7	\$673.3

As of July 28, 2020, the state reported having distributed 89 million N95 masks, a substantially larger number than we have estimated as the need for essential workers. It is unclear what portion of these were for essential worker use during the first 90 days of the pandemic. However, if we assume that the N95 portion of the stockpile were increased to 89 million, the stockpile cost would increase to \$215.5 million at pre-pandemic prices. The cost at pandemic prices would increase to \$1.184 billion, implying an even larger 89% savings from advance purchase.

Advance purchase of a stockpile is a form of insurance, with the cost of the stockpile equivalent to an insurance premium. In the best case scenario it would never be needed, in which case some might consider the premium cost “wasted” since the pandemic-priced purchases would never be needed—but the COVID-19 pandemic has sadly illustrated how myopic it is to go “uninsured” without an adequate PPE stockpile. The overhead cost of maintaining the stockpile would be quite modest, similar to an insurance premium loading; e.g., the annual overhead cost of the state’s previous stockpile was only about \$4 million per year<sup>14</sup>, which we model to be 3% of the stockpile cost. With a 5-year shelf life of PPE, if we (implausibly) assume that *none* of the expiring stock could be used or re-sold, then the annual cost of maintaining the stockpile would in steady state be 23% of the startup cost. While the startup cost of the stockpile would be effectively amortized over the years until it was needed, the total cost over time can be calculated by adding in the equivalent of the 23% annual additional payments. For example, if the stockpile were needed 10 years after establishment, it would have cost the state \$134.4 million to establish plus \$443.6 million (10 years times 23% of that cost) to maintain for a total cost of \$443.6 million—but it would have averted an \$807.7 million cost to procure it at pandemic prices, thus producing a large savings. If the stockpile

was not needed for 20 years, the state would have spent \$752.8 million, still achieving a net savings. If needed after 30 years, the state would have spent \$1.06 billion, thus on net would have paid \$254 million dollars in insurance averaged over 30 years, i.e. the equivalent of \$8.5 million per year – an excellent investment in PPE insurance. Furthermore, if we more plausibly assume that half the value of the expiring inventory could be recouped each year by using or reselling it, the annual cost would be lowered to 13% of initial cost, implying that the state would on net save money even if the stockpile were not used until 38 years from establishment. Due to the fact that pandemic prices are so much higher than non-pandemic prices, establishing the stockpile in advance would produce a net savings under plausible scenarios, and the “insurance” cost would be quite modest even if we were lucky enough to not need the stockpile until over 40 years from now.

## **2. PPE Shortages Caused Healthcare Service Disruptions and Furloughs**

A widely reported consequence of PPE shortages has been the need to reduce healthcare services so as to preserve PPE for the highest priority healthcare services. On March 19<sup>th</sup>, 2020, California Governor Newsom issued an executive order that stated, “The healthcare delivery system shall prioritize services to serving those who are sickest and shall prioritize resources, including personal protective equipment, to providers providing direct care to them” and the federal CMS issued similar recommendations.<sup>15</sup>

This resulted in severe disruptions to care unrelated to COVID-19, with large decreases in preventive and other care utilization. Another consequence was largescale furloughs of healthcare workers. **Between March 15 and July 11, 2020, approximately 251,100 healthcare workers in California filed an initial Unemployment Insurance (UI) claim and were paid benefits.** Of these workers, 191,500 worked in ambulatory care services, 33,800 worked in hospitals, and 25,800 worked in nursing and residential care facilities.<sup>16</sup> Aside from the foregone healthcare to patients and the income loss to many of these workers, the total budgetary cost of these unemployment claims is quite large: although claims details have not been published, we estimate that it is likely that these healthcare workers have received hundreds of millions of dollars in Unemployment Insurance benefits since the pandemic began. The median weekly benefit amount was \$372 for Californians filing unemployment insurance claims in health care and social assistance industries (excluding the Federal Pandemic Unemployment Compensation benefits of \$600/per week) between March 15 and June 20, 2020.<sup>17</sup> For each week of this number of claims at the median benefit amount, the state spends \$93.4 million supporting healthcare workers who cannot perform their jobs.

Inadequate supplies of PPE were only one cause of these healthcare disruptions and furloughs, but an important one. As the initial wave of infections peaked and fears among providers and patients subsided, plans began to re-open non-emergent healthcare. On April 27<sup>th</sup>, 2020, the California Department of Public Health issued guidelines for resuming deferred healthcare, and similar dental care guidelines on May 7<sup>th</sup>.<sup>18</sup> A major focus of guidelines by both the state and counties was the necessity of adequate PPE supplies before re-opening, but unfortunately shortages have continued to be a barrier to timely reopening. Many media outlets continue to report these concerns, and the

American Medical Association noted this problem in a June 30<sup>th</sup>, 2020 letter to the Federal Emergency Management Agency, “We are hearing significant and growing concern from our member physicians that they cannot secure needed [PPE] supplies to safely reopen.”<sup>19</sup> We do not know what proportion of the furloughed California healthcare workers have delayed returns due to PPE shortages, or for how long. However, if in a similar future pandemic a portion of these delays could be reduced on average by even just one week by the presence of an adequate PPE stockpile, that would save tens of millions of dollars. Given their experience with the current pandemic, and their new knowledge regarding how to safely implement safety protocols, it is likely that in the future many more non-emergency healthcare providers such as elective surgeons, dentists, etc., would choose to maintain (reduced) operations rather than shuttering during a future pandemic. Indeed, we have seen substantial healthcare re-opening by June 2020 despite the ongoing pandemic, as both providers and patients have overcome their initial fear, and PPE concerns have been mitigated with new deliveries such as through the state’s BYD contract. Healthcare providers’ ability to reduce operations less and re-open earlier in the next pandemic though will depend critically on immediate availability of PPE, which would be enabled by a robust stockpile. This could save tens to hundreds of millions of dollars in reduced need for unemployment insurance payments in the next pandemic, in addition to improving healthcare access.

### **3. Insufficient PPE, and Impact on COVID-19 Cases Among Essential Workers**

The purpose of PPE is to reduce disease transmission. The primary purpose of the proposed stockpile is to ensure sufficient PPE to protect the health of essential workers. During the COVID-19 pandemic there have been widespread reports of PPE shortages, with many healthcare workers having been placed at risk due to inadequate PPE availability.

**The California Department of Public Health has reported 26,399 healthcare workers in the state testing positive for COVID-19 as of August 8, 2020.**<sup>20</sup> Complete data are not available for other essential workers, but based on essential worker case data from Washington State, we estimate a likely additional 24,550 COVID-19 cases among non-healthcare essential workers who would likely be covered by the proposed stockpile.<sup>21</sup> **This estimated total of over 50,950 essential workers testing positive for COVID-19 equals 9% of all cases in the state.** These are lower bound estimates of COVID-19 infections, as it is likely that many essential workers may not be identified by their occupation in the data. By comparison, one study of COVID-19 spread in six Asian countries found that in the early phase of the epidemic approximately half of non-imported cases were among essential workers, thus our estimate is likely conservative.<sup>22</sup>

Additionally, many people infected with COVID-19 have not been tested due to testing barriers or being asymptomatic. Data submitted to the federal government by California nursing homes indicates that nearly as many staff were suspected to have had COVID-19 in any given week as had tested positive in any given week.<sup>23</sup> These asymptomatic cases are also dangerous, as when healthcare and other essential workers are infected at work, COVID-19 often spreads to household members. One study which traced cases in Guangzhou, China estimated a household transmission

rate of 17%; household members over the age of 60 were most likely to be infected in these household transmissions.<sup>24</sup>

**We further estimate that at least 20,860 worker and associated household COVID-19 cases in California may have been avoidable with proper PPE.** While some healthcare and other essential workers who tested positive for COVID-19 may have been infected through travel, a household member, or community transmission, we estimate that at least 35% of healthcare and other essential workers in California who tested positive for COVID-19 were infected at work. One source for this estimate is from the Los Angeles County Department of Public Health, which has documented that 35% of positive healthcare workers and emergency responders had known COVID-19 workplace exposures.<sup>25</sup> This is likely a lower-bound estimate, since half of those workers testing positive reported that their infection was of unknown origin or did not answer the question, and some of these workers may also have been infected at work. The percentage of work-acquired infections could be as much as two times higher in certain settings: our analysis (detailed in the appendix) of California nursing home data indicates that more than 70% of nursing home staff cases occurred in the context of staff/patient COVID-19 case clusters that are statistically too large to be explained by non-workplace transmission. As further evidence, a recent study of healthcare workers in Houston found COVID-19 positive test rates of 0.6% among those not patient-facing, but 5.4% among patient-facing workers, again suggesting that workplace transmission from patients can account for a large share of COVID-19 cases among healthcare workers.<sup>26</sup>

**The available research on COVID-19 to-date suggests that adequate and appropriate use of PPE can largely mitigate the spread of COVID-19 among healthcare workers.** One notable study screened healthcare workers at three hospitals in the Netherlands, identifying 95 COVID-19 positive workers. Genetic sequencing of the SARS-CoV-2 clinical samples from the workers and related patients, however, found sufficient differences such that it was highly unlikely that any of the cases had resulted from nosocomial (hospital-based) transmission. Most important to this example is that the study reported that strict PPE protocols were in place in accordance with national guidelines—providing strong evidence that where available and properly used,<sup>27</sup> PPE prevents COVID-19 transmission even in high-risk hospital settings with active cases.<sup>28</sup> Conversely, studies examining hospital workers in China and long-term care facilities in Washington state found that insufficient supply and inadequate use of PPE was an important factor that contributed to the spread of COVID-19 in the facilities examined.<sup>29,30</sup>

Based on the above evidence, it is likely that at least 35% of the cases were avoidable among the approximately 50,950 COVID-19 cases identified to date among essential workers. Thus we estimate that a minimum of 17,830 California essential worker COVID-19 infections were workplace-acquired and could have potentially been avoided with proper PPE. If those worker cases had been avoided, an estimated 3,030 secondary cases among household members could have also been avoided, thus totaling at least 20,860 cases that could have been averted.

Based on COVID-19 case hospitalization rates estimated by the UC Berkeley Petris Center<sup>31</sup> and average COVID-19 hospitalization costs,<sup>32</sup> we estimate that 300 hospitalizations with an estimated total of \$10.4 million in direct medical costs could have also been avoided. Some of these

hospitalization costs would have been directly paid by the state for workers enrolled in Medi-Cal. This is in addition to sick leave costs; although such costs have not yet been well documented, we estimate that avoidable sick leave costs likely exceeded \$28 million.<sup>33</sup>

More important than these healthcare and sick leave costs is the avoidable illness burden, the most unfortunate of which is the tragic COVID-19 deaths of essential workers with likely workplace-acquired cases. Among the 10,293 COVID-19 fatalities reported by the state as of August 8, 2020, at least 135 were healthcare workers<sup>34</sup> (68 nursing home worker deaths have also been reported<sup>35</sup>). If 35% of these deaths were workplace-acquired and preventable by PPE, that would be 51 lives lost just among healthcare workers, not counting other essential workers or others who may have been exposed to COVID-19 through contact with healthcare workers. Using federal government agency values of a statistical life of over \$10 million<sup>36</sup>, a cost-benefit analysis would value these lives lost at over \$510 million. The exact number of lives that could have been saved if a stockpile had ensured adequate PPE availability is unknown—but each was eminently preventable with advance planning.

#### **4. Conclusions**

A California Health Care Foundation survey conducted June 5–July 12, 2020 among California skilled nursing facility staff found that more than 90 days into the current COVID-19 pandemic, more than 20% of respondents still report inadequate PPE, and more than 80% are very or extremely concerned about workplace infection.<sup>37</sup> The human cost of inadequate PPE during the current pandemic has been enormous in terms of illness and death due to COVID-19, indirect health threats from reduced healthcare access, and employment and income loss due to furloughs. The total avoidable social costs of unemployment insurance payments and the value of lost life could easily each reach the hundreds of millions of dollars in the next pandemic, making a PPE stockpile an urgent investment. The benefit of this preventive investment is even greater considering the hundreds of millions of dollars in procurement costs that could have been saved had a stockpile been established in advance at non-pandemic prices. We do not know when the next pandemic or health emergency will arise that will require PPE, but it will come. Both fiscal prudence and public health commonsense align in strongly recommending establishment of a robust PPE stockpile for the future.



## **Technical Appendix**

The estimated number of non-healthcare essential workers who tested positive for COVID-19 was estimated using industry-specific data on COVID-19 cases in Washington through May 27, 2020, as these were the most comprehensive available data with information on COVID-19 patient industry of employment. In Washington, the total number of positive cases in other industries that most closely match the list of industries to which California has already provided masks during COVID-19<sup>38</sup> (Accommodation and Food Services, Agriculture, Forestry, Fishing and Hunting, Construction, Transportation and Warehousing, Public Administration, Administrative and Support and Waste Management and Remediation Services, Educational Services, and Utilities) is equivalent to 93% of the positive cases in the Health Care and Social Assistance Industry.<sup>39</sup> To estimate the number of California non-healthcare essential workers who tested positive for COVID-19, we applied 93% to the number of healthcare worker cases reported by the California Department of Public Health.<sup>40</sup>

We examined healthcare and essential worker cases beyond a 90-day period because if the state and healthcare providers already had a 90-day stockpile in place when COVID-19 began, the benefit of having adequate PPE would have extended beyond 90 days—as soon as the 90-day stockpile began to be used, the state and healthcare providers could have focused on acquiring PPE to use once the stockpile is depleted, rather than needing to fill the immediate needs. Additionally, even when examining healthcare and essential worker cases beyond 90 days, our estimates of the number of infected workers are likely to be low because of the COVID-19 testing limitations, which were particularly severe early in the pandemic.

We analyzed California nursing home data from the U.S. Center for Medicare and Medicaid Services to estimate the percentage of nursing home staff cases occurring in the context of a cluster of COVID-19 cases. We defined a cluster as a total of five or more confirmed or suspected staff and patient cases in a nursing home during any given week. For each nursing home experiencing a cluster of cases, we summed all confirmed staff cases reported that week and subtracted one case, to make the conservative assumption that the other staff cases originated from an index staff case that was community-acquired. This is a conservative assumption, as many cases likely originated from a patient admitted with COVID-19, a visitor, or from spread of the virus in the facility in prior weeks. Using these assumptions, we estimated that during the five weeks ending May 31 through June 28, 2020, an average of 73% of all confirmed staff cases in Californian nursing homes occurred in the context of a cluster of cases.<sup>41</sup> We estimated that the 15,800 potentially avoidable cases among healthcare and other essential workers and their household members were associated with approximately 300 hospitalizations at an estimated cost of \$7.9 million. The estimated number of hospitalizations was based on hospitalization rates by age group published by the UC Berkeley Petris Center.<sup>42</sup> The 13,500 worker cases were distributed by age group based on the age distribution of COVID-19 positive workers in Washington state who provided employment information,<sup>43</sup> and the age distribution for the 2,300 household cases was estimated using a study of secondary COVID-19 attacks within households.<sup>44</sup> The cost of these hospitalizations was estimated based on costs per COVID-19 hospitalization by payer type from Avalere,<sup>45</sup> weighted based on the coverage type distribution of all California children and California workers ages 20-64<sup>46</sup> and assuming all cases ages 65+ were covered by Medicare.

## Endnotes

<sup>1</sup> Lydia DePillis and Lisa Song, “In Desperation, New York State Pays Up to 15 Times the Normal Prices for Medical Equipment,” *ProPublica*, April 2, 2020, <https://www.propublica.org/article/in-desperation-new-york-state-pays-up-to-15-times-the-normal-price-for-medical-equipment>.

<sup>2</sup> Mark Maremont, Austen Hufford, and Tom McGinty, “U.S. Pays High Prices for Masks From Unproven Vendors in Coronavirus Fight,” *Wall Street Journal*, April 18, 2020, <https://www.wsj.com/articles/u-s-pays-high-prices-for-masks-from-unproven-vendors-in-coronavirus-fight-11587218400>.

<sup>3</sup> The contracted supplier is Chinese automaker BYD which twice failed to secure NIOSH approval of the contracted masks, delaying delivery until June 2020. Contract between California and BYD: <https://files.covid19.ca.gov/pdf/BYD-Motors-LLC-OES.pdf>.

<sup>4</sup> Bonnie Berkowitz, “How Far Would a Million N95 Masks Go? It’s Complicated, and This Is Why.,” *Washington Post*, accessed July 31, 2020, <https://www.washingtonpost.com/graphics/2020/health/virus-masks-ppe/>.

<sup>5</sup> Premier, “Premier Inc. Survey: As COVID-19 Spreads to New Hotspots, Hospitals...,” Premier (Premier, July 31, 2020), <https://www.premierinc.com/>, <https://www.premierinc.com/newsroom/press-releases/premier-inc-survey-as-covid-19-spreads-to-new-hotspots-hospitals-should-prepare-for-up-to-a-17x-surge-in-supply-demand>.

<sup>6</sup> An alternative estimate can be derived from a Johns Hopkins modeling tool which estimates 57 million extra N95 masks needed for hospitals nationwide during 100 days of pandemic use. (Eric Toner, “Interim Estimate of US PPE Needs for COVID-19” (Johns Hopkins Center for Health Security, April 18, 2020), <https://www.centerforhealthsecurity.org/resources/COVID-19/PPE/PPE-assumptions>.) Pro-rating this to 90 days and assuming California would account for 12% of the nationwide use, this method would estimate a 90-day need for 6.2 million N95 masks in California hospitals. This estimate is only half of ours, but they assume that PPE protocol deviations due to shortages will continue despite the safety risk. We presume that the stockpile will instead be larger, sufficient for properly complying with PPE safety protocols.

<sup>7</sup> U.S. Department of Health and Human Services, “Hospital Personal Protective Equipment Planning Tool | Technical Resources,” ASPR TRACIE, accessed July 31, 2020, <https://asprtracie.hhs.gov/technical-resources/resource/6457/hospital-personal-protective-equipment-planning-tool>. The tool does not estimate the need for surgical masks, which we assume are needed in a ratio of 2 per N95.

<sup>8</sup> Maremont, Hufford, and McGinty, “U.S. Pays High Prices for Masks From Unproven Vendors in Coronavirus Fight.”

<sup>9</sup> Specifically, we price the 1860 model which is often used in healthcare. 3M, “Get the Facts: N95 Respirator Pricing,” Revised July 8, 2020, <https://multimedia.3m.com/mws/media/18621790/get-the-facts-n95-respirator-pricing.pdf>. 3M “Surgical N95 vs. Standard N95 – Which to Consider?” June 2020,

<https://multimedia.3m.com/mws/media/17945720/surgical-n95-vs-standard-n95-which-to-consider.pdf>.

<sup>10</sup> Society for Healthcare Organization Procurement Professionals (SHOPP), “SHOPP PPD COVID Costs Analysis,” April 7, 2020, [http://cdn.cnn.com/cnn/2020/images/04/16/shopp.covid.ppd.costs.analysis\\_.pdf](http://cdn.cnn.com/cnn/2020/images/04/16/shopp.covid.ppd.costs.analysis_.pdf).

<sup>11</sup> To the extent that new stockpile investments begin before current manufacturing capacity can be adequately increased to meet pandemic demand, some portion of the initial stockpile costs could be at pandemic rather than non-pandemic prices. For example, if the first 20% of the stockpile is purchased at pandemic prices, then the savings estimated here would be reduced by 20% – but would still be quite large.

<sup>12</sup> Sarah Bohn, Marisol Cuellar Majia, and Julien Lafortune, “Essential Workers and COVID-19,” *Public Policy Institute of California* (blog), March 31, 2020, <https://www.ppic.org/blog/essential-workers-and-covid-19/>.

<sup>13</sup> U.S. Bureau of Labor Statistics, U.S. Bureau of Labor Statistics, “California - May 2019 OES State Occupational Employment and Wage Estimates.”

<sup>14</sup> California Assembly Budget Committee, “Preliminary Review of the Governor’s Proposed 2012-2013 State Budget Act,” January 31, 2012, <https://abgt.assembly.ca.gov/sites/abgt.assembly.ca.gov/files/reports/Preliminary%20Review%20of%20the%20Governor's%20Proposed%202012-2013%20State%20Budget%20Act.pdf>.

<sup>15</sup> State of California Executive Department, “Executive Order N-33-20,” March 19, 2020, <https://www.gov.ca.gov/wp-content/uploads/2020/03/3.19.20-attested-EO-N-33-20-COVID-19-HEALTH-ORDER.pdf>. U.S. Centers for Medicare and Medicaid Services, “Non-Emergent, Elective Medical Services, and

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Treatment Recommendations,” April 7, 2020, <https://www.cms.gov/files/document/cms-non-emergent-elective-medical-recommendations.pdf>.

<sup>16</sup> California Employment Development Department, “Initial Unemployment Insurance Claims data,” 2020.

<sup>17</sup> Thomas J Hedin, Geoffrey Schnorr, and Till Von Wachter, “An Analysis of Unemployment Insurance Claims in California During the COVID-19 Pandemic” (California Policy Lab, July 2, 2020), <https://www.capolicylab.org/wp-content/uploads/2020/07/July-2nd-Analysis-of-UI-Claims-in-California-During-the-COVID-19-Pandemic.pdf>.

<sup>18</sup> California Department of Public Health, “Resuming California’s Deferred and Preventive Health Care,” accessed July 31, 2020, <https://www.cdph.ca.gov/Programs/CID/DCDC/Pages/COVID-19/ResumingCalifornia%E2%80%99sDeferredandPreventiveHealthCare.aspx>. California Department of Public Health, “Guidance for Resuming Deferred and Preventive Dental Care,” May 7, 2020, <https://www.cdph.ca.gov/Programs/CID/DCDC/Pages/Guidance-for-Resuming-Deferred-and-Preventive-Dental-Care-.aspx>.

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<sup>20</sup> California Department of Public Health, “State Officials Announce Latest COVID-19 Facts,” accessed August 9, 2020, <https://www.cdph.ca.gov/Programs/OPA/Pages/NR20-190.aspx>.

<sup>21</sup> This estimate is based on occupation-specific COVID-19 case data from Washington state, which is used to generate a ratio of cases between healthcare worker cases and other essential worker cases. See Technical Appendix for further details.

<sup>22</sup> The six countries were Hong Kong, Japan, Singapore, Taiwan, Thailand, and Vietnam. Fan-Yun Lan et al., “Work-Related COVID-19 Transmission in Six Asian Countries/Areas: A Follow-up Study,” *PLOS ONE* 15, no. 5 (May 19, 2020): e0233588, <https://doi.org/10.1371/journal.pone.0233588>.

<sup>23</sup> U.S. Centers for Medicare and Medicaid Services, “COVID-19 Nursing Home Dataset | Data.CMS.Gov,” July 23, 2020, <https://data.cms.gov/Special-Programs-Initiatives-COVID-19-Nursing-Home/COVID-19-Nursing-Home-Dataset/s2uc-8wxxp>.

<sup>24</sup> Qin-Long Jing et al., “Household Secondary Attack Rate of COVID-19 and Associated Determinants in Guangzhou, China: A Retrospective Cohort Study,” *The Lancet Infectious Diseases*, accessed July 31, 2020, [https://doi.org/10.1016/S1473-3099\(20\)30471-0](https://doi.org/10.1016/S1473-3099(20)30471-0).

<sup>25</sup> Los Angeles County Department of Public Health, “COVID-19 Positive Healthcare Workers and First Responders Data, Los Angeles County,” July 20, 2020, <http://publichealth.lacounty.gov/acd/docs/COVID19HCWReport.pdf>.

<sup>26</sup> Farhaan S. Vahidy et al., “Prevalence of SARS-CoV-2 Infection Among Asymptomatic Health Care Workers in the Greater Houston, Texas, Area,” *JAMA Network Open* 3, no. 7 (July 1, 2020): e2016451–e2016451, <https://doi.org/10.1001/jamanetworkopen.2020.16451>.

<sup>27</sup> Healthcare worker training ensures that the vast majority of them would properly use PPE if available. Some non-healthcare essential workers may have insufficiently appreciated the importance of PPE, particularly early in the COVID-19 pandemic, thus we consider PPE availability as necessary but not sufficient to fully reduce transmission. Accompanying increased investments in public health outreach will also be crucial to fully realize the future potential for a PPE stockpile to avoid essential worker infections.

<sup>28</sup> Reina S Sikkema et al., “COVID-19 in Health-Care Workers in Three Hospitals in the South of the Netherlands: A Cross-Sectional Study,” *The Lancet Infectious Diseases*, July 2, 2020, [https://doi.org/10.1016/S1473-3099\(20\)30527-2](https://doi.org/10.1016/S1473-3099(20)30527-2).

<sup>29</sup> Mingkun Zhan et al., “Death from Covid-19 of 23 Health Care Workers in China,” *New England Journal of Medicine* 382, no. 23 (June 4, 2020): 2267–68, <https://doi.org/10.1056/NEJMc2005696>.

<sup>30</sup> Temet M. McMichael et al., “Epidemiology of Covid-19 in a Long-Term Care Facility in King County, Washington,” *New England Journal of Medicine* 382, no. 21 (May 21, 2020): 2005–11, <https://doi.org/10.1056/NEJMoa2005412>.

<sup>31</sup> Richard M. Scheffler, Daniel R. Arnold, Brent D. Fulton, et al., “What are the Health Care Costs of COVID-19 in California?: State and County Estimates,” UC Berkeley Petris Center, June 25, 2020, [https://petris.org/wp-content/uploads/2020/06/CA\\_COVID\\_Cost\\_Estimates.pdf](https://petris.org/wp-content/uploads/2020/06/CA_COVID_Cost_Estimates.pdf).

<sup>32</sup> Chris Sloan, Nathan Markward, and Joanna Young, “COVID-19 Hospitalizations Projected to Cost up to \$17B in US in 2020,” *Avalere Health* (blog), June 19, 2020, <https://avalere.com/insights/covid-19-hospitalizations-projected-to-cost-up-to-17b-in-us-in-2020>.

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- <sup>33</sup> Ignoring potential sick leave among the secondary cases, if we assume the 17,830 essential worker cases each resulted in 80 hours of sick leave at a conservatively estimated \$20 per hour, this would total \$28.5 million.
- <sup>34</sup> California Department of Public Health, "State Officials Announce Latest COVID-19 Facts."
- <sup>35</sup> U.S. Centers for Medicare and Medicaid Services, "COVID-19 Nursing Home Dataset | Data.CMS.Gov."
- <sup>36</sup> Lisa A. Robinson, Ryan Sullivan, and Jason F. Shogren, "Do the Benefits of COVID-19 Policies Exceed the Costs? Exploring Uncertainties in the Age-VSL Relationship," *Risk Analysis*, July 16, 2020, <https://doi.org/10.1111/risa.13561>.
- <sup>37</sup> Kristof Stremikis, "COVID-19 Tracking Poll: Most Frontline Staff at California Nursing Homes See Infections at Work," *California Health Care Foundation* (blog), July 17, 2020, <https://www.chcf.org/blog/covid-19-tracking-poll-most-frontline-staff-nursing-homes-see-infections-work/>.
- <sup>38</sup> Governor Newsom, "Governor Newsom Announces Enhanced State Stockpile, Purchase of 420 Million New Protective Masks," California Governor, July 22, 2020, <https://www.gov.ca.gov/2020/07/22/governor-newsom-announces-enhanced-state-stockpile-purchase-of-420-million-new-protective-masks/>.
- <sup>39</sup> Washington State Department of Health and the Department of Labor & Industries Safety & Health Assessment & Research for Prevention (SHARP) program, "COVID-19 Confirmed Cases by Occupation and Industry," June 12, 2020, [https://www.doh.wa.gov/Portals/1/Documents/1600/coronavirus/covid\\_occupation\\_industry\\_summary\\_2020-06-12.pdf](https://www.doh.wa.gov/Portals/1/Documents/1600/coronavirus/covid_occupation_industry_summary_2020-06-12.pdf).
- <sup>40</sup> California Department of Public Health, "State Officials Announce Latest COVID-19 Facts."
- <sup>41</sup> U.S. Centers for Medicare and Medicaid Services, "COVID-19 Nursing Home Dataset | Data.CMS.Gov," July 23, 2020, <https://data.cms.gov/Special-Programs-Initiatives-COVID-19-Nursing-Home/COVID-19-Nursing-Home-Dataset/s2uc-8wxxp>.
- <sup>42</sup> Richard M. Scheffler, Daniel R. Arnold, Brent D. Fulton, et al., "What are the Health Care Costs of COVID-19 in California?: State and County Estimates," UC Berkeley Petris Center, June 25, 2020, [https://petris.org/wp-content/uploads/2020/06/CA\\_COVID\\_Cost\\_Estimates.pdf](https://petris.org/wp-content/uploads/2020/06/CA_COVID_Cost_Estimates.pdf).
- <sup>43</sup> Washington State Department of Health and the Department of Labor & Industries Safety & Health Assessment & Research for Prevention (SHARP) program, "COVID-19 Confirmed Cases by Occupation and Industry," June 12, 2020, [https://www.doh.wa.gov/Portals/1/Documents/1600/coronavirus/covid\\_occupation\\_industry\\_summary\\_2020-06-12.pdf](https://www.doh.wa.gov/Portals/1/Documents/1600/coronavirus/covid_occupation_industry_summary_2020-06-12.pdf).
- <sup>44</sup> Qin-Long Jing et al., "Household Secondary Attack Rate of COVID-19 and Associated Determinants in Guangzhou, China: A Retrospective Cohort Study," *The Lancet Infectious Diseases*, accessed July 31, 2020, [https://doi.org/10.1016/S1473-3099\(20\)30471-0](https://doi.org/10.1016/S1473-3099(20)30471-0).
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- <sup>46</sup> UCLA Center for Health Policy Research, "AskCHIS - California Health Interview Survey," 2018.