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Brief Report

Characteristics of Nursing Homes by COVID-19 Cases Among Staff: March to August 2020

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Keywords:
Nursing homes
health care workforce
COVID-19

Abstract

Objective: To measure the association between nursing home (NH) characteristics and Coronavirus Disease 2019 (COVID-19) prevalence among NH staff.

Design: Retrospective cross-sectional study.

Setting and Participants: Centers for Disease Control and Prevention COVID-19 database for US NHs between March and August 2020, linked to NH facility characteristics (LTCFocus database) and local COVID-19 prevalence (USA Facts).

Methods: We estimated the associations between NH characteristics, local infection rates, and other regional characteristics and COVID-19 cases among NH staff (nursing staff, clinical staff, aides, and other facility personnel) measured per 100 beds, controlling for the hospital referral regions in which NHs were located to account for local infection control practices and other unobserved characteristics.

Results: Of the 11,858 NHs in our sample, 78.6% reported at least 1 staff case of COVID-19. After accounting for local COVID-19 prevalence, NHs in the highest quartile of confirmed resident cases (413.5 to 920.0 cases per 1000 residents) reported 18.9 more staff cases per 100 beds compared with NHs that had no resident cases. Large NHs (150 or more beds) reported 2.6 fewer staff cases per 100 beds compared with small NHs (< 50 beds) and for-profit NHs reported 0.8 fewer staff cases per 100 beds compared with nonprofit NHs. Higher occupancy and more direct-care hours per day were associated with more staff cases (0.4 more cases per 100 beds for a 10% increase in occupancy, and 0.7 more cases per 100 beds for an increase in direct-care staffing of 1 hour per resident day, respectively). Estimates associated with resident demographics, payer mix, or regional socioeconomic characteristics were not statistically significant.

Conclusions and Implications: These findings highlight the urgent need to support facilities with emergency resources such as back-up staff and protocols to reduce resident density within the facility, which may help stem outbreaks.

Since the start of the Coronavirus Disease 2019 (COVID-19) outbreak in early 2020, almost 21 million cases have been reported in the United States. Among the hardest hit have been residents of nursing homes (NHs), who comprise less than 1% of the US population but account for more than 40% of deaths attributed to COVID-19. NHs were particularly vulnerable to the outbreak due to a number of longstanding structural deficiencies, including inadequate supply and access to personal protective equipment (PPE) and staffing shortages. Anecdotal reports from early days of the pandemic documented the severe impact of these deficiencies on the mental health of NH staff as a result of stress and fatigue. To combat these issues and support nursing home staff, some states have implemented policies that modify licensure laws and increase compensation and paid leave for NH health care workers. However, properly understanding the
impact of COVID-19 on NH staff has been difficult because reliable reporting on NH staff cases and deaths has been lacking.\textsuperscript{4,5}

This study presents the first national description of COVID-19 cases among NH staff reported to the Centers for Disease Control (CDC) COVID-19 NH reporting database. The database uses systematic quality assurance to identify instances where facilities may have entered incorrect data.\textsuperscript{11} We also identify facility- and community-level factors associated with NH staff cases. Understanding these relationships is an integral step toward the further development of policies and strategies to improve the safety of NH staff, address NH staffing shortages, and improve the care quality for NH residents. Specifically, our objectives were to (1) measure the prevalence of COVID-19 among NH staff during the first wave of the pandemic (from March to August 2020), and (2) identify facility- and community-level factors associated with COVID-19 prevalence among NH staff.

Methods

In this cross-sectional retrospective study of US NHs, we linked the CDC NH COVID-19 database (https://data.cms.gov/stories/s/COVID-19-Nursing-Home-Data/bkwz-xpvg/) to facility characteristics from the LTCFocus database (http://ltcfocus.org/, Long-Term Care: Facts on Care in the US, Brown University, RI) and the USA Facts database (https://usafacts.org/visualizations/coronavirus-covid-19-spread-map/). The CDC NH COVID-19 database contains NH-reported resident and staff cases, mortality, and other COVID-19–related data as part of a federal mandate. We used data from March to August 2020. Because the database was updated weekly starting on May 24, 2020, cases before that week were reported in cumulative. Therefore, the CDC has advised against longitudinal analyses using this database.\textsuperscript{10} LTCFocus contains NH facility characteristics (such as size, occupancy, ownership, payer mix) aggregated from a number of primary and secondary sources, including Medicare claims and the Minimum Data Set, which includes assessments for all residents of Medicare- or Medicaid-certified NHs. The USA Facts COVID-19 dataset was used to obtain county-level COVID-19 prevalence rates for the same time period.

Our outcome was the cumulative number of confirmed COVID-19 cases among staff during the study period, measured per 100 NH beds to account for facility size (cases reported as suspected COVID-19 were excluded). NHs with data flagged by the CDC as incomplete or suspected reporting error were excluded from the analysis (n = 955). To further avoid outliers from skewing our findings, the data were winsorized so that NHs that reported staff case counts in the top 1% of the distribution of staff case counts were assigned the value of the next highest observation (n = 380). Our final sample included 11,585 NHs.

NH characteristics included resident demographics (average age of residents in the facility, percentage of residents who were female, percentage who were white), case mix (percentage of patients insured by Medicare and Medicaid, respectively, and average functional status measured using the activities of daily living (ADL) score), and facility factors (size, ownership, occupancy, part of multifacility chain, direct-care staff hours per patient day, presence of advanced practitioners on staff, and presence of a Alzheimer specialty unit).\textsuperscript{11–13} We also collected information on PPE shortages reported by the NHs in the CDC COVID-19 database. NHs reported whether they had sufficient supplies of different classes of PPE over the past 7 days. PPE classes included N95 masks, surgical masks, eye protective equipment, gowns, disposable gloves, and hand sanitizer. Facilities that did not have sufficient supply to last 7 days were considered to be experiencing a shortage of the PPE. Community characteristics measured at the county level included rural versus urban location, median household income, percentage of population older than 75 years, prevalence of COVID-19 cases among NH residents (measured in cases per 1000 residents), and community prevalence of COVID-19 cases (measured in cases per 1000 residents). Cases among NH staff and NH residents were subtracted from the number of cases measured at the county level to avoid double counting. In addition, we included an indicator of whether a state had a NH visitation ban during the study period.

Analyses were performed at the NH level. For the descriptive analyses, facilities were stratified into 4 categories of COVID-19 cases among staff (no cases, more than 0 and fewer than 5 cases, 5 or fewer and fewer than 15 cases, and 15 or more cases per 100 beds). One-way analysis of variance for continuous variables and \( \chi^2 \) tests for

| Table 1 | Characteristics of Nursing Homes in the Study Sample |
|---------|---------------------------------------------------|
| Characteristic | All (n = 11,858) | No. Staff Cases (n = 2544) | 0 < Cases ≤ 5 (n = 3808) | 5 ≤ Cases ≤ 15 (n = 3147) | 15 < Cases (n = 2359) | P Value |
| NH resident confirmed COVID-19 cases per 1000 residents (SD) | 145.7 (235.5) | 7.7 (51.1) | 34.0 (87.3) | 172.8 (206.6) | 438.6 (281.5) | <.001 |
| Community COVID-19 cases per 1000 population (SD) | 13.4 (9.0) | 7.7 (6.6) | 11.9 (8.4) | 16.2 (8.7) | 18.3 (8.8) | <.001 |
| Average patient age, y, mean (SD) | 79.4 (6.7) | 79.9 (6.5) | 79.3 (6.7) | 79.3 (6.8) | 79.2 (6.9) | .001 |
| Percentage of patients who are female, mean (SD) | 66.2 (11.0) | 67.3 (11.2) | 66.2 (11.6) | 65.7 (12.3) | 65.7 (12.0) | <.001 |
| Percentage of patients who are White, mean (SD) | 67.2 (11.8) | 67.3 (11.4) | 67.2 (11.5) | 66.9 (11.7) | 66.8 (11.6) | <.001 |
| ADL score, mean (SD) | 79.1 (22.8) | 89.2 (16.4) | 81.2 (21.4) | 74.0 (24.0) | 71.5 (24.7) | <.001 |
| Presence of patients covered by Medicaid, mean (SD) | 16.7 (2.6) | 15.8 (2.7) | 16.5 (2.5) | 17.0 (2.5) | 17.4 (2.4) | <.001 |
| Percentage of patients covered by Medicare, mean (SD) | 60.4 (21.9) | 61.7 (19.6) | 61.0 (20.8) | 59.0 (23.7) | 59.9 (23.2) | <.001 |
| Percentage of patients covered by Medicaid, mean (SD) | 13.4 (11.5) | 13.3 (9.6) | 12.9 (10.6) | 14.5 (12.3) | 15.3 (13.0) | <.001 |
| Number of beds, mean (SD) | 1163 (58.2) | 806 (35.9) | 1127 (52.8) | 1228 (65.6) | 1218 (63.7) | <.001 |
| For-profit ownership status, % | 72.9 | 71.00 | 72.5 | 72.6 | 75.8 | <.001 |
| Direct-care hours per patient day, mean (SD) | 72.6 | 73.8 | 73.0 | 72.4 | 71.1 | <.001 |
| Part of a multifacility chain, % | 60.5 | 62.4 | 61.2 | 60.0 | 57.7 | <.001 |
| Rural location, % | 24.2 | 45.2 | 26.1 | 14.3 | 11.7 | <.001 |
| One-wk supply of N95 masks, % | 82.3 | 81.4 | 80.7 | 83.0 | 84.7 | <.001 |
| One-wk supply of surgical masks, % | 90.1 | 89.2 | 89.1 | 90.9 | 91.5 | .003 |
| One-wk supply of eye protection, % | 90.5 | 90.2 | 89.7 | 91.2 | 91.1 | .001 |
| One-wk supply of gowns, % | 87.6 | 87.8 | 87.0 | 87.4 | 88.7 | .277 |
| One-wk supply of gloves, % | 95.0 | 94.8 | 95.6 | 94.8 | 94.7 | .308 |
| One-wk supply of hand sanitizer, % | 95.8 | 96.2 | 96.0 | 95.7 | 95.0 | .178 |
| County median household income, $ | 54,498 | 50,663 | 54,119 | 56,606 | 56,434 | <.001 |
| Percentage of population of county older than 75, mean (SD) | 6.9 (2.0) | 7.7 (2.0) | 6.9 (1.9) | 6.5 (2.0) | 6.3 (2.0) | <.001 |
| Located in a state with a NH visitation ban, % | 64.5 | 57.3 | 62.8 | 68.4 | 69.7 | <.001 |
categorical variables were used to compare facility characteristics across the 4 categories. To measure the association between facility- and county-level characteristics, we used linear regression to estimate the number of COVID-19 cases among NH staff per 100 beds as a function of NH-, county-, and state-level factors. We included hospital referral region fixed effects to account for unobserved regional factors that may play a role in COVID-19 spread among NH staff. To address the skewness of our data, we performed negative binomial regression in a sensitivity analysis. For ease of interpretation, we report the results from our linear regression models throughout. Standard errors were adjusted for clustering at the level of the state.14,15

Statistical analyses were performed using Stata/IC Version 16.0 and Tableau Public 2020.3. The study did not meet the definition of human subjects research per [the University of Pennsylvania] institutional review board.

Results

For the average NH in the sample, the mean patient age was 79.4 [standard deviation (SD) 6.7], 66.2% of patients were women, 79.1% were white, and 60.4% were covered by Medicaid. The average ADL score was [standard deviation (SD) 6.7], 66.2% of patients were women, 79.1% were white, and 60.4% were covered by Medicaid. The average ADL score was [standard deviation (SD) 6.7], 66.2% of patients were women, 79.1% were white, and 60.4% were covered by Medicaid.

### Table 2

Adjusted Associations Between NH Staff COVID-19 Cases Per 100 NH Beds and Facility and Regional Characteristics

| Characteristic                                      | Categories | Staff Cases Per 100 Beds | 95% Confidence Interval | P Value |
|-----------------------------------------------------|------------|--------------------------|-------------------------|---------|
| NH resident confirmed COVID cases per 1000 residents (ref. no cases) | Q1 (1.7–36.9) | 1.6 | 1.3 to 1.9 | <.001 |
|                                                      | Q2 (37.0–145.4) | 4.5 | 4.1 to 4.9 | <.001 |
|                                                      | Q3 (145.5–413.4) | 10.2 | 9.6 to 10.9 | <.001 |
|                                                      | Q4 (413.5–920.0) | 18.9 | 17.6 to 20.1 | <.001 |
| Community confirmed cases per 1000 persons (ref. no cases) | Q1 (0.1–6.8) | 3.2 | 2.1 to 4.2 | <.001 |
|                                                      | Q2 (6.9–11.2) | 4  | 2.9 to 5.0 | <.001 |
|                                                      | Q3 (11.3–18.7) | 4  | 2.8 to 5.2 | <.001 |
|                                                      | Q4 (18.8–140.2) | 5.3 | 4.0 to 6.6 | <.001 |
| Average NH resident age                              | 0.03 | 0.0 to 0.1 | .14 |
| Percentage of female patients                        | -0.01 | -0.02 to 0.01 | .44 |
| Percentage of residents who are white (ref. Q1 <67.4%) | Q2 (67.4–88.0) | -0.02 | -0.05 to 0.0 | .93 |
|                                                      | Q3 (88.1–96.8) | 0.2 | -0.05 to 0.09 | .65 |
|                                                      | Q4 (96.9–100.0) | 0.4 | -0.04 to 1.1 | .33 |
| Average ADL score                                    | 0.03 | -0.03 to 0.10 | .32 |
| NH size (ref. small; ≤50 beds)                       | Medium NH (50 ≤ beds<150) | -1.1 | -1.8 to -0.4 | .002 |
|                                                      | Large NH (≥150 beds) | -2.6 | -3.6 to -1.7 | <.001 |
| Bed occupancy (10 percentage points)                 | 0.4 | 0.2 to 0.5 | <.001 |
| For-profit (ref. nonprofit)                          | -0.8 | -1.2 to -0.4 | <.001 |
| Part of multifacility chain (ref. non-multifacility chain) | -0.2 | -0.4 to 0.1 | .21 |
| Direct-care staffing in hours per patient day        | 0.7 | 0.5 to 0.9 | <.001 |
| Presence of an NP or PA (ref. absence of an NP or PA) | -0.03 | -0.3 to 0.3 | .84 |
| Alzheimer specialty unit (ref. absence of the specialty unit) | -0.3 | -0.7 to 0.1 | .16 |
| Percentage of residents covered by Medicaid (ref. Q1 <50%) | Q2 (50.0–64.2) | -0.2 | -0.5 to 0.2 | .34 |
|                                                      | Q3 (64.3–76.0) | -0.5 | -0.8 to -0.1 | .01 |
|                                                      | Q4 (76.1–100.0) | -0.2 | -0.7 to 0.3 | .46 |
| Percentage of residents covered by Medicare (ref. Q1 <6.3%) | Q2 (63.0–10.7) | -0.1 | -0.5 to 0.3 | .55 |
|                                                      | Q3 (10.8–17.1) | -0.1 | -0.4 to 0.2 | .53 |
|                                                      | Q4 (17.2–100.0) | 0.4 | -0.1 to 0.8 | .10 |
| One-wk supply of N95 masks (ref. not enough for 1 wk) | 0.3 | 0.1 to 0.7 | .19 |
| One-wk supply of surgical masks (ref. not enough for 1 wk) | 0.8 | 0.1 to 1.5 | .02 |
| One-wk supply of eye protection (ref. not enough for 1 wk) | -0.1 | -0.6 to 0.5 | .83 |
| One-wk supply of gowns (ref. not enough for 1 wk)     | -0.3 | -0.9 to 0.4 | .44 |
| One-wk supply of gloves (ref. not enough for 1 wk)    | -0.3 | -0.8 to 0.8 | .94 |
| One-wk supply of hand sanitizer (ref. not enough for 1 wk) | -0.4 | -1.3 to 0.4 | .27 |
| Median household income (ref. Q1 ≤$44,965)            | Q2 ($44,965–$51,562) | -0.1 | -0.4 to 0.2 | .59 |
|                                                      | Q3 ($51,564–$60,179) | 0.3 | -0.1 to 0.6 | .18 |
|                                                      | Q4 ($60,219 or more) | -0.1 | -0.7 to 0.4 | .57 |
| Percentage of county population aged over 75          | 0.01 | -0.3 to 0.0 | .01 |
| Rural location (ref. urban)                           | -0.2 | -0.6 to 0.3 | .48 |
| State visitation ban (ref. not implemented)          | -0.1 | -1.1 to 0.8 | .79 |
| Constant                                             | -5.6 | -9.1 to -2.1 | .002 |

NP, nurse practitioner; PA, physician assistant.

*PPE supply was reported by NHs to the Centers for Medicare and Medicaid Services. The query asked “Do you have enough for 1 wk?” by PPE type and answers were collected in a binary Yes/No format.

### Multivariable Regression Results

After adjusting for facility and county-level characteristics, NHs with more resident cases were more likely to report staff cases. Compared with NHs without any resident cases, NHs in the lowest Alzheimer specialty unit. The mean direct-care hours per patient were 3.6 (SD 0.9), and 60.5% of facilities were part of a chain. Occupancy was 72.6% on average. Approximately a quarter (24.2%) of the facilities were located in rural settings. The median household income in counties with NHs in the sample was $54,498 and the average percentage of population older than 75 years was 69%. Facilities with more staff cases had a smaller proportion of white patients (89.2% of patients were white in NHs with no staff cases vs 71.5% of patients in NHs with 15 or more staff cases, P < .001) and were less likely to be in a rural location (45.2% of NHs with no staff cases vs 11.7% of NHs with 15 or more staff cases, P < .001) (Table 1).

Of the NHs in the sample, 2544 (21.5%) had no confirmed COVID-19 staff cases and 9314 (78.6%) had at least 1 case. Overall, a small but considerable number of facilities reported having less than a week’s supply of PPE. One (17.7%) in 5 facilities reported a shortage of N95 masks, 1 (9.9%) in 10 reported a shortage of surgical masks or eye protection equipment (9.5%), approximately 12% reported a shortage of gowns, and approximately 5.0% reported a shortage of disposable gloves or hand sanitizer (4.2%).

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The first quartile of COVID-19 prevalence among residents (up to 36.9 cases per 1000 residents) had 1.6 more staff cases per 100 beds [95% confidence interval (CI) 1.3–1.9, \( P < .001 \)]; NHs in the second quartile (37.0 to 145.4 resident cases) had 4.5 more staff cases per 100 beds (95% CI 4.1–4.9, \( P < .001 \)), NHs in the third quartile (145.5–413.4 cases per 1000 residents) had 10.2 more staff cases (95% CI 9.6–10.9; \( P < .001 \)); and NHs in the highest quartile of COVID-19 prevalence among residents (≥413.5 cases per 1000 residents) had 18.9 more staff cases per 100 beds (95% CI 17.6–20.1; \( P < .001 \)) (Table 2).

COVID-19 prevalence in the community was also associated with cases among NH staff. Compared with counties without any COVID-19 cases, NHs in counties in the lowest quartile of COVID-19 prevalence (0.1 to 6.8 cases per 1000 residents) had 3.2 more staff cases per 100 beds (95% CI 2.1–4.2), whereas the NHs in counties in the top quartile of COVID-19 prevalence (18.8 or more cases per 1000 residents) had 5.3 more staff cases per 100 beds (95% CI 4.0–6.6). Compared with small NHs (fewer than 50 beds), medium-size NHs had 1.1 fewer staff cases per 100 beds (95% CI −1.8 to −0.4; \( P = .002 \)) and large NHs had
Conclusions and Implications

This study presents the first national description of COVID-19 cases among NH staff in the United States. Our findings highlight the severe impact of the COVID-19 epidemic on NH staff and confirm anecdotal reports of PPE shortages. Outbreaks at the facility level among residents were strongly associated with high staff morbidity due to COVID-19, community-level transmission outside of the NH, as well as facility size, occupancy, and direct-care staffing. Efforts to make emergency resources such as extra staff available to NHs in areas with high rates of local transmission and/or to those facilities facing outbreaks could ameliorate the threat of COVID-19 to NH staff and may help reduce facility and local spread.

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### Supplementary Table 1

Negative Binomial Regression Estimates of the Associations Between NH and County Characteristics and NH Staff COVID-19 Cases Per 100 NH Beds

| Characteristic | Categories | Staff Cases per 100 Beds (IRR) | 95% Confidence Interval | P Value |
|----------------|------------|-------------------------------|-------------------------|---------|
| NH resident confirmed COVID cases per 1000 residents (ref. no cases) | Q1 (1.7–36.9) | 1.7 | 1.5–1.9 | <.001 |
| | Q2 (37.0–145.4) | 2.8 | 2.5–3.2 | <.001 |
| | Q3 (145.5–413.4) | 4.8 | 4.2–5.5 | <.001 |
| | Q4 (413.5–920.0) | 8.3 | 7.1–9.5 | <.001 |
| Community confirmed cases per 1000 persons (ref. no cases) | 1.0 | 1.0–1.0 | <.001 |
| Average NH resident age | 1.0 | 1.0–1.0 | <.001 |
| Percentage of female patients | 1.0 | 1.0–1.0 | <.001 |
| Percentage of residents who are white (ref. Q1 < 67.4%) | Q2 (67.4–88.0) | 1.0 | 0.9–1.1 | .60 |
| | Q3 (88.1–96.8) | 1.0 | 0.9–1.1 | .46 |
| | Q4 (96.9–100.0) | 0.9 | 0.8–1.1 | .32 |
| Average ADL score | 1.0 | 1.0–1.0 | <.001 |
| NH size (ref. small; < 50 beds) | Medium NH (50 ≤ beds < 150) | 0.9 | 0.8–1.0 | <.001 |
| | Large NH (≥ 150 beds) | 0.7 | 0.7–0.8 | <.001 |
| Bed occupancy | 1.0 | 1.0–1.0 | <.001 |
| For-profit (ref. nonprofit) | 0.9 | 0.8–0.9 | <.001 |
| Part of multifacility chain (ref. non-multifacility chain) | 1.0 | 0.9–1.0 | .10 |
| Direct-care staffing in hours per patient day | 1.1 | 1.1–1.2 | <.001 |
| Presence of an NP or PA (ref. absence of an NP or PA) | 1.0 | 1.0–1.0 | .91 |
| Alzheimer’s specialty unit (ref. absence of the specialty unit) | 1.0 | 0.9–1.0 | .42 |
| Percentage residents covered by Medicaid (ref. Q1 < 50%) | Q2 (50.0–64.2) | 1.0 | 0.9–1.0 | .17 |
| | Q3 (64.3–76.0) | 0.9 | 0.9–1.0 | .005 |
| | Q4 (76.1–100.0) | 0.9 | 0.9–1.1 | .57 |
| Percentage of residents covered by Medicare (ref. Q1 < 6.3%) | Q2 (6.3–10.7) | 1.0 | 0.9–1.0 | .16 |
| | Q3 (10.8–17.1) | 1.0 | 0.9–1.0 | .34 |
| | Q4 (17.2–100.0) | 1.0 | 1.0–1.1 | .52 |
| One-wk supply of N95 masks (ref. not enough for 1 wk) | 1.1 | 1.0–1.2 | .02 |
| One-wk supply of surgical masks (ref. not enough for 1 wk) | 1.1 | 0.9–1.2 | .30 |
| One-wk supply of eye protection (ref. not enough for 1 wk) | 1.0 | 0.9–1.1 | .56 |
| One-wk supply of gowns (ref. not enough for 1 wk) | 0.9 | 0.8–1.0 | .22 |
| One-wk supply of gloves (ref. not enough for 1 wk) | 1.0 | 0.9–1.1 | .89 |
| One-wk supply of hand sanitizer (ref. not enough for 1 wk) | 0.9 | 0.8–1.1 | .45 |
| Median household income (ref. Q1 < $44,965) | Q2 ($44,965–$51,562) | 1.1 | 1.0–1.2 | .11 |
| | Q3 ($51,564–$60,179) | 1.1 | 1.0–1.2 | .003 |
| | Q4 ($60,219 or more) | 1.1 | 1.0–1.2 | .03 |
| Percentage of county population aged >75 y | 1.0 | 0.9–1.0 | .003 |
| Rural location (ref: urban) | 0.9 | 0.8–0.9 | <.001 |
| State visitation ban (ref: not implemented) | 0.9 | 0.8–1.1 | .52 |
| Constant | 1.3 | 0.7–2.5 | .45 |

IRR, incidence rate ratio; NP, nurse practitioner; PA, physician assistant.