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Homeward Bound: A Comparison of Resident Case Volume on Home-Read Workstations and On-Site During the COVID-19 Pandemic

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THE PROBLEM

During the coronavirus disease 2019 pandemic, many health care organizations have moved to remote work if possible. Radiology departments have increasingly deployed teleradiology solutions to reduce personnel density in reading rooms [1]. Remote reading has not traditionally been offered to radiology residents owing to the need for in-person teaching, but physical distancing and quarantine guidelines have required departments to adapt.

The decrease in radiology volume in the early pandemic adversely affected the study volumes available for resident education, and not being able to read from home when quarantined or when physical space was limited further exacerbated this problem [2]. The number of studies read by radiology residents is an important benchmark of the adequacy of resident education and is correlated with board pass rates [3]. In response, our department initiated a home workstation program for residents, allowing residents to read from home when necessary. Although the home workstations proved technically feasible, it was unclear how resident volumes at home compared with those on site. It was hypothesized that residents reading at home would read as many studies as when they were on site.

WHAT WE DID

The study protocol was submitted to the institutional review board and determined to be exempt from review.

First-year through third-year radiology residents were allowed to use their academic funds to purchase a workstation for reading cases from home when needed. The workstations included a hexacore processor, 16 GB of random-access memory, two 24-inch monitors with 2,560 × 1,440 resolution as PACS displays, a 24-inch control monitor with 1,920 × 1,080 resolution, a dictation microphone, a keyboard, and a multifunction programmable mouse. Each workstation included integrated PACS, electronic medical record, and dictation software access.

Between November 2020 and April 2021, residents were assigned to read from home as needed by multiple radiology divisions. The number and modality of studies—CTs, MRIs, radiographs, and ultrasounds—read by each resident on their home workstation per full workday were retrospectively collected from the electronic medical record and dictation software. The number of studies by modality read on site per day by the resident on the same rotation in the most recent 2 weeks on that rotation, with a preference for the same week as the home-read day, was similarly collected. If the resident read from home on more than 2 weeks on the same rotation, the on-site days from all weeks they also read from home were used as controls. The number of fellows and other residents on the same rotation was collected from the departmental scheduling software for each day.

Three permutational analyses of variance were performed on the data for total studies, with CTs and MRIs and radiographs read per full day on service as dependent variables and with rotation, the resident reading from home, home or on-site status, number of fellows on service, and number of other residents on service as independent variables. P values were adjusted for multiple comparisons using the Holm-Bonferroni method. P values $< .05$ were considered statistically significant. All analyses were performed in R 4.1.0.

1546-1440/22/$36.00 ■ https://doi.org/10.1016/j.jacr.2021.12.002

OUTCOMES AND LIMITATIONS

Of 51 eligible residents, 25 (49.0%) purchased the home-read workstation. One resident's workstation was under repair during the study period. Of 24 residents with functional workstations, 11 were assigned to read from home at least 1 day between November 2020 and April 2021 for a total of 43 days: 38 were on a CT- or MRI-based rotation, 1 was on ultrasound rotation, and 4 were on radiograph rotations. The residents were on site for a total of 95 days in their most recent 2 weeks on each rotation in the same academic year between September 2020 and April 2021: 73 were on a CT- or MRI-based rotation, 7 were on ultrasound rotations, and 15 were on radiograph rotations. The most common rotations for reading at home were chest, neuroradiology, musculoskeletal, and abdominal CT.

In the multivariate analysis, there was no statistically significant difference between the volume of studies per day read by residents at home and the volume read by those same residents when on site (Table 1; $P = .467$). When the number of CTs and MRIs read by the residents on CT- or MRI-based rotations was examined, the residents read a significantly greater volume at home (Table 1 and Fig. 1; $P = .027$). When reading radiographs, residents read more studies at home than on site, but this difference was not significant (Table 1 and Fig. 2; $P = .420$), possibly related to the small sample size.

Examining the additional factors in the multivariate analysis, the number of fellows on service had no significant effect on resident volumes in total ($P = .669$), on CT or MRI rotations ($P = .720$), or on radiograph rotations ($P = .720$) accounting for both on-site and home days. Similarly, the number of other residents on service had no effect on the participating residents' volumes ($P = .610$, .610, and .597, respectively) when both home and on-site days were considered. Rotation significantly affected volumes in total ($P = .003$), CT and MRI ($P = .004$), and radiographs ($P = .004$). There was a significant difference overall between residents in total volume ($P = .003$), CTs and MRIs ($P = .003$), and radiographs ($P = .034$).

Participating trainees were at least as productive at home as on site. Distractions at home may be a concern for resident education. However, distractions in the reading room may be equally or more deleterious to

Table 1. Comparison of mean (±SD) resident study volumes per full workday at home versus on-site

Type of Study	Home	On Site	*P* Value
All	17.4 ± 15.0	17.4 ± 12.6	.467
CT and MRI	12.7 ± 6.1	10.7 ± 4.7	.027
Radiographs	54.5 ± 15.9	38.5 ± 8.9	.420

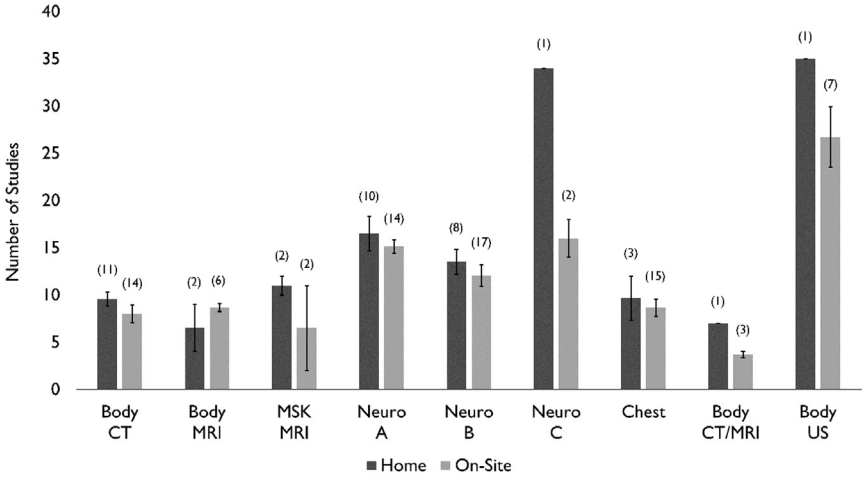

Fig. 1. Mean (± standard errors) resident volumes for each CT-, MRI-, and US-focused rotation. Sample sizes (days) are shown in parentheses. The neuroradiology rotation includes multiple sites with different study volumes, which were separated into A, B, and C sites for the purpose of comparison. MSK = musculoskeletal; Neuro = neuroradiology; US = ultrasound.

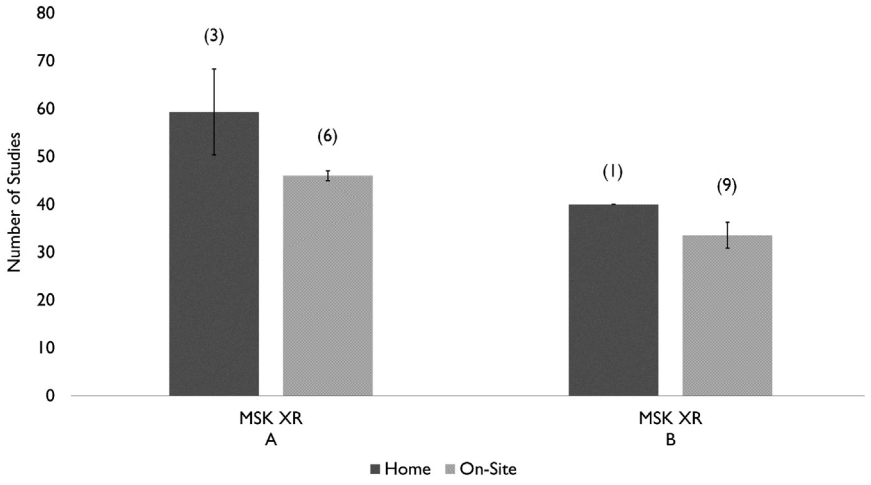

Fig. 2. Mean (± standard errors) resident volumes for each radiograph-focused rotation. Sample sizes (days) are shown in parentheses. The MSK radiograph rotation includes two sites with different study volumes, which were separated into A and B sites for the purpose of comparison. MSK = musculoskeletal; XR = x-ray.

reading efficiency, increasing the time spent per study as well as error rates [4,5]. Moreover, residents reading from home did not need to commute, potentially allowing for more time reading from their lists.

Although residents are capable of reading as many studies at home as they are on site, there are other concerns about this approach to resident education and service. Remote readouts may not provide the same education quality as in-person readouts, particularly in the presence of technical challenges [6]. Furthermore, the telephone calls answered by residents on site can provide important educational opportunities, although not all telephone calls carry educational value. Resident telephone numbers were provided to technologists for protocoling questions on some services. Finally, procedures cannot be performed remotely.

Our study had several limitations. Not all residents participated in the program, and not all participants were ultimately assigned to read from home. The residents who received home workstations were self-selected, creating the potential for selection bias. In addition, there was variability in the rotations to which each resident was assigned. We attempted to control for these variables in our statistical model. Some residents were assigned to only 1 or 2 home days on a rotation, limiting our ability to perform post hoc testing to compare volumes on specific rotations.

Balancing personnel safety and resident education during the pandemic has been challenging. Radiology is fortunate in that remote work is feasible, but technical feasibility is not always reflective of practicality. Here, we discuss a single radiology residency program's experience with resident home workstations and show that the study volumes of residents reading from home were not statistically significantly different from or were significantly greater than the volumes those residents read on site. Although remote work cannot replace on-site education for residents, home resident workstations can provide additional versatility during the pandemic. In a future, postpandemic world, resident home workstations may have other benefits, such as providing greater work flexibility in circumstances that would otherwise prevent residents from working in the reading room, allowing residents to provide backup to their on-call resident colleagues in the event of high volumes, and facilitating more secure remote access to educational and research resources from home.

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The authors state that they have no conflict of interest related to the material discussed in this article. All authors are non-partner/non-partnership track/employees.

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