Respiratory Disease, the Environment, and the Military: Important, Unexplored Frontiers

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In this issue of the Journal, Broderick et al. [1] report on the incidence of febrile respiratory illness (FRI) among Marine recruits during their first 4 weeks of military training, as well as the effect that closed training environments (units closed to the influx of potentially infectious convalescing persons [hereafter referred to as “closed units”]) versus open training environments (units open to the influx of potentially infectious convalescing persons [hereafter referred to as “open units”]) had on the transmission of respiratory pathogens, specifically adenoviruses. The open units accepted recruits transferring from medical convalescent or physical conditioning units. Up to 10% of these transferred recruits had adenoviruses identified in pharyngeal specimens. Closed units did not accept new people into their units. Broderick and colleagues also monitored FRI rates relative to the sizes of the military units, which varied from 50 to 90 men, and they collected environmental samples from living areas and medical clinics to test for adenoviruses [1]. Salient among their conclusions are that (1) high rates of FRI were likely related to the survivability and transmissibility of adenoviruses on environmental surfaces, because the intervention of social distancing (i.e., “cohorting”) did not decrease the FRI rates, and because viable adenoviruses were found in 5%–9% of environmental samples; and (2) recruit units with larger populations (i.e., units larger than the median size) had statistically significant higher FRI rates, suggesting that larger populations facilitated pathogen transmission [1].

Broderick et al. [1] studied the long-standing military recruit training center version of social distancing known as “cohorting.” Cohorting involves the establishment of military units very early in training and then the restriction of contact between members of the cohort and those outside the cohort. During the study, the Marine recruits were subjected to highly disciplined cohorting, with the open units being seeded by the introduction of new people, some of whom brought adenoviruses with them. The study by Broderick and colleagues provides support for emphasizing personal hygiene and the cleaning of environmental surfaces to control respiratory disease, but it provides no support for pursuing greater discipline in cohorting.

Regarding the size of the military units, the authors’ finding that units with larger populations had higher FRI rates [1] was not unexpected. In the 1940s, a study conducted among Navy recruits by Breese et al. [2] found that the occurrence of respiratory illness was associated with the number of people assigned to a room. In contrast, another Navy study [3] reported that personnel in newer barracks, where there was more space per recruit, experienced lower FRI rates, even though the number of recruits per room did not differ between the old and the new barracks; this finding suggests that space allocation per recruit was a factor in the transmission of respiratory disease. Reported studies of the effects of reducing crowding and implementing other nonpharmaceutical interventions on the incidence of respiratory illnesses were reviewed by Lee et al. [4], who concluded that reducing crowding and using related interventions may be beneficial but deserve further evaluation. Lee et al. [4] also reported that, although population-based data on hand washing and hand antisepsis (when soap and water were not available) were limited, the studies that had been done were encouraging.
The list of environmental variables that may be important in the transmission of respiratory agents and the control of FRI extends beyond population size and space per individual. Other factors, such as air exchanges per unit time, humidity, and temperature [5, 6], deserve consideration. It is possible that changes in these parameters occurring during the time that Broderick et al. [1] were conducting their study may have affected the transmissibility of respiratory pathogens. Survivability of adenoviruses in the environment (e.g., in air handling units and on fomites), along with associated contamination of breathing space, has been suggested as a potentially important factor in acquisition of respiratory illness [7]. As noted by Broderick et al. [1], this possible factor was previously researched by other investigators, who demonstrated a strong association between the presence of respiratory pathogens in the air and on surfaces and increased FRI rates [8–10]. The list of environmental variables that may contribute to the transmission of FRI agents is extensive, but it is difficult to design and implement population-based studies to define the contributions of these variables and to identify possible interventions.

Host variables also deserve consideration. An important host variable that was not considered in the study by Broderick et al. [1] is the importance of existing immunity to adenoviruses and other respiratory pathogens in new recruits. Previous studies by Russell and Broderick and their group [10], as well as other investigators, showed that immunity to adenoviruses (especially adenovirus types 4 and 7) was a key factor in protecting recruits against FRI [11]. Considering the large number of military units studied by Broderick et al. [1], any variation in preexisting immunity would probably not explain the lack of effect from cohorting. Variations in pathogenic agents, e.g., adenoviruses, influenza viruses, and Streptococcus pyogenes, also contribute to the complexity of the recruit training environment. Ongoing epidemiological studies that employed rapid molecular diagnostic procedures have enabled the detection and identification of a variety of adenoviruses, such as types 14 and 21, which have emerged in US military recruits in the past 2 years [12]. Studies of immunity to these viruses and the role that preexisting immunity may play in their control are important to the development of comprehensive FRI prevention programs. Contemporary and ongoing serologic surveys of new military recruits will provide information that should help to assess the threat of FRI outbreaks caused by emerging agents and the need for vaccines and environmental interventions.

Nonpharmaceutical interventions for FRI have been a concern for the United States military at least since 1777 [13]. The potential value of these nonpharmaceutical interventions was disregarded in the 1970s and early 1980s, when many believed that vaccines and prophylactic drugs would solve all serious infectious disease problems [13]. The loss of 2 highly effective adenovirus vaccines by the Department of Defense [14], the appearance of avian influenza A(H5N1) [15], and the emergence of severe acute respiratory syndrome [16] taught us differently. We must plan to deal with significant FRI threats without the benefit of vaccines or prophylactic drugs. Therefore, we must develop a long-term, comprehensive approach to better understand the many complex and, perhaps, interacting variables that are important in the transmission of respiratory disease agents and the occurrence of FRI. Military recruit training sites are excellent places to conduct these studies, because these military settings are well defined and well controlled. In addition, the ongoing, comprehensive, laboratory-based surveillance program at the military training sites, with close monitoring of the incidence and agents of FRI, can support studies with a high degree of sophistication [10, 17]. It is reasonable to think that much of what can be learned at these training centers might also be applied to civilian locations, such as school dormitories and similar settings.

Unfortunately, interventions cost money. This is particularly true for major construction projects, including new buildings and additions or modifications to existing buildings. It is extremely difficult to gain support for an expensive intervention. In the absence of good data on effectiveness that could justify the cost, gaining such support will likely be an impossible task. If the medical community is going to have a voice in developing construction and renovation standards for numbers of occupants per living unit, space per occupant, and heating, ventilation and air conditioning systems based on disease prevention, then we must address the difficult issues that have prevented us from performing the studies that could provide the data needed.

References


