When hospitals Harm: Multi-modal entry of SARS-CoV-2 into inpatient healthcare

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Keywords: SARS-CoV-2, COVID-19, nosocomial transmission, infection prevention

The primary infection prevention goal for acute care hospitals is to ensure the safety of the patients, families, care team members, and support staff within its walls. Detection of nosocomial transmission of illness signals a failure somewhere along the way with measures in use to prevent such occurrences. There is a paucity of descriptions of nosocomial transmission of SARS-CoV-2 in the acute care setting, and thus, we recognize the importance of the paper, *Nosocomial transmission of COVID-19: a retrospective study of 66 hospital-acquired cases in a London teaching hospital*, by Rickman *et al*, published in this issue of Clinical Infectious Diseases [1].

The authors describe a nosocomial outbreak of COVID-19 in an open bay unit and ward, which accounted for 15% of inpatient cases over a relatively short period of time (five weeks) [1]. Other epidemiologic descriptions of COVID-19 hospitalizations have reported similar rates of nosocomially acquired cases, generally at the beginning of the local epidemic [2, 3]. The elderly seem particularly susceptible to nosocomial acquisition [4, 5]. Another worrisome statistic is the mortality rate associated with nosocomial illness, reported as high as 36% [1, 4, 5]. This is substantially increased compared to other inpatient cohorts over the course of this pandemic [6]. In the largest description of hospitalized patients with COVID-19 in the U.S., Richardson *et al* reported an overall mortality rate of 9.7% (and 21% among patients no longer hospitalized at the time of publication). Presumably, the higher mortality among those with nosocomial COVID-19 is due to the fact that patients who are already vulnerable from underlying illness, which necessitated their hospitalization, are less capable of surviving the added morbidity of a COVID-19 infection.

Introduction of SARS-CoV-2 into the facility occurs from patients, care team members, visitors or support staff. These introductions occur when these individuals enter with symptoms consistent with COVID-19, with symptoms not easily recognized as COVID-19, with presumed asymptomatic disease, or those in the pre-symptomatic phase of illness. Thus, it is important to understand the transmission dynamics of SARS-CoV-2 for each of these scenarios as they relate to nosocomial transmission. There have been published examples of mildly ill individuals with high viral loads detected by PCR with no downstream transmission to close contacts [7]. This suggests that intensive cross-sectional or admission diagnostic testing may not be as high-yield an exercise for control of COVID-19 within hospitals compared to recognizing symptoms in patients presenting for care or developing during admission. Initially unrecognized sources accounted for four cases in this series [1], but super-shedder events are known to result in transmission to many downstream patients. At our own 750-bed academic health center, we have seen numerous diagnostic delays of COVID-19 which were misdiagnosed as acute coronary syndromes, sickle-cell crises, viral gastroenteritis, and other conditions that led to exposures of both staff and patients. Accurate recognition of inpatient symptoms and rapid initiation of appropriate isolation precautions is essential to control of COVID-19 within hospitals.

The authors say that a comprehensive infection prevention approach was associated with control of nosocomial spread in their hospital and conclude by recommending that others adopt a combination of measures to include screening of all patients on admission (presumably, the term "screening" means testing for SARS-CoV-2), meticulous universal PPE and precautions, and routine surveillance testing of staff and patients. The most striking finding for the authors' series of 66 cases, however, was that 21 (32%) had no identified source of infection, including eight

cases in single-occupancy rooms. In contrast to many other hospital-acquired infections, this highlights the potential for COVID-19 to enter inpatient facilities via visitors or care team members themselves, neither of whom were subject to symptom screening or diagnostic testing during the study period. The authors mention that staff illness levels were "high" during the study and that 27% of staff were asymptomatic, but without direct source attribution, it is difficult to estimate the relative contribution of asymptomatic versus symptomatic hospital care team members in this series. We have found in our own workforce that working while sick with symptoms other than fever, cough, or shortness of breath is common, with 75% of our workforce describing none of those symptoms on their initial day of illness despite 98% of all outpatient care team members reporting symptoms.

Regarding "screening" of all patients on admission, we would propose that this term be expanded to mean that a robust "symptom screen" be performed on all patients as well as universal SARS-CoV-2 PCR testing. We found through structured interview of positive outpatients and inpatients that the symptoms associated with COVID-19 are highly variable and often extremely mild. Subjective fever and gastrointestinal symptoms were common among all patients, fever and dyspnea more common among inpatients, and symptoms typically associated with seasonal allergies or a mild upper respiratory infection more common among ambulatory patients. This adds complexity to developing a comprehensive, yet "usable" screening tool for all admissions, some of whom will have typical, well-described complaints, and others, particularly those presenting for surgery or those without suspected COVID-19, may have atypical or mild symptoms. We have decided to develop a comprehensive symptom screening tool for all patients and have a team of nurses to conduct this exercise on admission and then perform the SARS-

CoV-2 testing. Like others, the initial symptom screening is utilized to assign risk for placement (into isolation, a cohort, or a regular room) while waiting on the test results [8]. This facilitates the meticulous use of PPE and precautions as mentioned by the authors, without overuse and waste. Additionally, we advocate for daily reassessment of symptoms among patients who tested negative for SARS-CoV-2 and immediate retesting if any develop; however, we find the value of routine surveillance re-testing of asymptomatic patients, as suggested by the authors, may be limited only to patient populations unable to reliably report symptoms given what is understood regarding asymptomatic transmission, and the paucity of data regarding testing characteristics in this population.

Illness rates in staff, how they acquired illness, and who they have transmitted illness to can often be difficult to ascertain, particularly when there is widespread community transmission of COVID-19. In the two weeks leading up to this editorial, our local community experienced an almost 200% increase in confirmed cases [9]. This was accompanied by a more than 300% increase in workforce illness and 52 admissions identified as COVID-19 positive. Five (9.6%) of those patients had probable nosocomial acquisition, similar to the epidemiology described by others [1-3]. Rickman *et al* did not track exposure to ill staff or visitors as a potential source to inpatients. We consider this an important aspect of prevention and have formed a multidisciplinary contact tracing team. We determined that three of the five patients with nosocomial COVID-19 likely acquired their illness from a staff member who was working while symptomatic and the other two from unknown sources, possibly ill visitors. Additionally, contact tracing revealed that the vast majority of staff acquired their illness in the community, from co-workers, or from known positive household contacts.

We would suggest that the only way to bring the incidence of nosocomial COVID-19 to zero is based on co-equal emphasis on control of three entry populations: patients, the healthcare workforce, and visitors. Control measures must include continuous education about and assessment for subtle, protean COVID-19 symptoms among all three populations. For the workforce, continuous self-monitoring and immediate furlough for testing if symptoms develop is required. For patients, frequent symptom monitoring may be just as essential as diagnostic screening testing given that the latter cannot practically take place repeatedly during the known incubation period for COVID-19. Of all three populations entering the hospital, visitors remain the most difficult to screen effectively and may require blanket restrictions during periods of widespread local transmission. Control of nosocomial COVID-19 requires continuous adjustment of infection prevention and control measures aimed at these entry populations, without over-reliance on admission and surveillance SARS-CoV-2 testing.

Potential Conflicts of Interest

SC reports honorarium for FMT expert at symposium from Ferring Pharmaceuticals, outside the submitted work. CS reports royalties for textbook editing from Wolters Kluwer Health, outside the submitted work.

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