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Original article

Hand surgery during the COVID-19 pandemic: Clinical care best practices

Chirurgie de la main pendant la pandémie COVID-19: Meilleures pratiques de soins cliniques

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A B S T R A C T

We aimed to evaluate the effectiveness of a single institution’s hand surgery clinical care guidelines at preventing the transmission of COVID-19. This is an anonymous survey study distributed to all employees within the division of hand surgery at a single quaternary-care academic medical facility. The primary outcome measure was the result of their employee surveillance and/or symptom initiated COVID-19 antibody (prior transmission) or polymerase chain reaction test (active infection) after institution of a COVID-19 exposure and transmission mitigating clinical care protocol. Employees were also asked multiple questions regarding their perceived and actual risk of exposure to COVID-19 while performing their clinical duties. Fifty-five of 69 (79.7%) hand clinic personnel employed during the COVID-19 surge from March 23, 2020 to May 18, 2020 (therapist: 15/19; consulting physicians: 11/16, nurses: 10/11; hand surgery residents: 6/6; hand surgery fellows: 4/5; physician assistant/nurse practitioners: 4/7; clinical desk operations specialists 3/4) responded to the survey. Forty-two employees were tested and all were negative for COVID-19 antibodies (42/42). Seventeen (17/55, 30.9%) employees had a known exposure to COVID-19 of which 13 of the 17 (76.5%) were from patients. Ten of these 17 (58.8%) employees were tested for COVID-19 antibodies and were negative. Twenty-four of the 55 (43.6%) respondents felt they were at high risk for transmission of COVID-19. These data support ongoing care of emergent and urgent hand surgery patients during the COVID-19 surge and safe operation of an elective hand surgery practice amidst the ongoing pandemic through a multimodal approach.

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R É S U M É

Notre but était d’évaluer l’efficacité des directives de soins cliniques de chirurgie de la main d’une seule institution pour prévenir la transmission de la COVID-19. Il s’agit d’une étude anonyme distribuée à tous les employés de la division de chirurgie de la main dans un seul établissement médical universitaire. Le critère de jugement principal était le résultat de la surveillance de leurs employés et/ou de l’antécortis COVID-19 initié par les symptômes ou du test de réaction en chaîne de la polymérase après l’établissement d’un protocole de soins cliniques diminuant l’exposition à la COVID-19 et sa transmission. On a également posé aux employés plusieurs questions concernant leur risque perçu et réel d’exposition à la COVID-19 dans l’exercice de leurs fonctions cliniques. Cinquante-cinq des 69 (79.7%) membres du personnel de la clinique de la main employés pendant la poussée du COVID-19 du 23 mars 2020 au 18 mai 2020 ont répondu à l’enquête. Quarante-deux employés ont été testés et tous étaient négatifs pour les antécortis COVID-19 (42/42). Dix-sept (17/55, 30.9%) employés avaient une exposition connue au COVID-19, dont 13 sur 17 (76.5%) provenaient de patients. Dix de ces 17 employés

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1. Introduction

Coronavirus disease 2019 (COVID-19) is a declared global pandemic of the highly contagious novel SARS-CoV-2 coronavirus first reported in December of 2019 and later implicated to be caused by the SARS-CoV-2 coronavirus in February of 2020 [1,2]. Since December 2019, the virus has spread rapidly. As of November 5, 2020, 48,252,129 cases have been confirmed worldwide with 1,227,544 deaths, the majority of which are in individuals that are 65 years or older [3].

In response to the COVID-19 global pandemic, restrictions have been placed at all levels of public and private life. National guidelines recommend the use of masks when in public spaces and maintaining physical distancing of six feet or greater when interacting with individuals from outside the household [4]. Some states and local communities have instituted mandates on wearing masks while in public places. Hospitals have been forced to develop plans to meet surge demand and resources have been reallocated to meet these demands [5]. Healthcare teams have expanded their scope of practice to meet the needs of patients, particularly in areas with high disease burden [6]. Other modifications to healthcare delivery include minimizing contact with patients by limiting physical exams, donning on personal protective equipment (PPE), utilizing telemedicine visits if possible, and decreasing frequency of in-person clinical follow-up [7,8].

In order to accommodate the needs of patients, our institution’s Division of Hand Surgery developed robust protocols for delivering emergent and urgent hand surgery care, education, rehabilitation, and operative management to mitigate the risk of COVID-19 while providing high quality clinical care during the local COVID-19 surge. Protocols for outpatient practice, surgical practice, and academic practice are presented in Tables 1 and 2.

Due to state guidelines, our institution was required to postpone all non-emergent (elective and semi-urgent) procedures starting on March 23, 2020 (Fig. 1). On May 13, 2020, our institution resumed elective clinical visits and all (elective, semi-urgent, urgent, and emergent) surgeries were restarted on May 18, 2020 (Fig. 1). In addition, our institution developed and distributed a voluntary antibody test to evaluate for COVID-19 antibodies, indicative of prior infection, to all employees from June 1, 2020 to July 24, 2020 (Fig. 1).

This study aimed to evaluate the effectiveness of our institution’s clinical care guidelines at preventing the transmission of COVID-19 both during the initial COVID-19 surge and subsequent clinical ramp up to full elective practice by measuring the prevalence of COVID-19 antibodies in order to inform best practices for mitigating the risk of COVID-19 transmission in the future while delivering hand surgery care to patients.

2. Patients and methods

This is an anonymous survey study distributed to all employees in one hand surgery practice at a single quaternary-care academic institution requesting antibody test results following a voluntary, free, institution-sponsored COVID-19 antibody testing campaign to identify the relative prevalence of COVID-19 antibodies. Instead of reviewing medical records, data collection was performed utilizing a survey to protect the rights and identity of employees. This study was reviewed by our Institutional Review Board (IRB) and was deemed to be exempt from IRB approval.

A survey was distributed via electronic mail to all personnel within the Division of Hand Surgery (Appendix 1 in Supplementary material) employed during the local COVID-19 surge in our institution’s county from March 2020 to May 2020. Demographic information including age and employment position (nurse, therapist, consulting physician, resident physician, fellow physician, desk operations specialist, physician assistant or nurse practitioner, other, and prefer not to answer) were collected.

To gain a better sense of the relative exposure risk while at work, the survey collected the amount of time (none, <1 week, 1 week–1 month, and >1 month) during the local COVID-19 surge spent conducting in-person work with patient contact, teleworking, and on furlough. To further understand employee perspective on COVID-19 risk while at work, employees were asked if they perceived that they were at a high risk for exposure or transmission of COVID-19 within their employment position.

To evaluate for known risk factors for COVID-19 transmission, employees were asked if they had a known exposure to COVID-19, if they had traveled to a location deemed to be high-risk or were

| Table 1 | Hand surgery case priority during clinical shutdown. |
| --- | --- |
| **Hand surgery case priority** |  |
| Emergent | Open fractures |
| | Irreducible dislocations |
| | Traumatic amputations/dogloving injuries |
| | Nailbed lacerations and/or hematomas |
| | Compartment syndrome |
| | High-pressure injection injuries |
| | Perilunate dislocations |
| | Severe infection (septic flexor tenosynovitis, septic joints, necrotizing fasciitis) |
| | Neurovascular digits or extremities |
| Urgent | Tendon ruptures |
| | Irreducible fractures |
| | Ligament injuries |
| | Moderate infection (abscess, post-operative incisional cellulitis) |
| | Malignancies |
| | Retained hardware with structures at risk/injured |
| | Retained hardware at risk for or with infection |
| | Severe osteomyelitis (EMG changes/significant pain or nocturnal symptoms) |
| | Avascular necrosis of bone |
| | Nonunion (depending on chronicity) |
| | Painful masses |
| | Biopsies |

Electromyography (EMG).

\(a\) Severe infections that could not be treated with antibiotics or bedside procedures.

\(b\) Moderate infections that could be observed with expectant management for possible operative intervention.
Table 2
Practice during and after COVID-19 surge (March 23, 2020 to May 12, 2020).

| Practice protocol | Outpatient practice during and after COVID-19 surge (March 23, 2020 to May 12, 2020) | Clinic/PPE protocol | Only those patients with diagnoses in the urgent category (Table 1) and post-operative follow up were evaluated in clinic.

- Emergent diagnoses were appropriately cared for in the emergency department.
- All other clinical visits were transitioned to telemedicine.
- Only one provider “Doc of the Day” so that if exposed the team could self-quarantine at home.
- Limited post-operative follow up (e.g. patients discharged with suture removal kits or closed with absorbable sutures only; using post-operative orthoses instead of casts)
- No shaking hands. Patients asked to wash their hands to the best of their ability for 20 s with soap/water or alcohol-based hand sanitizer prior to examination.\
  
- Clinic personnel sterilized the examination room prior to each individual patient encounter.
- All patients must wear a mask covering the nose and mouth when on campus
- All providers must wear a mask on campus and socially distance ≥6 ft from one another in all feasible situations (break rooms, work rooms, bathrooms, etc.).
- All providers engaged in direct patient care must wear a mask and eye protection
- Patient contacted the day before (<24 h clinic visit to screen for COVID-19. If a patient screens positive they must get COVID-19 PCR testing.
- Patients screened again at front door and upon arrival to appointment check-in with screening questions and temperature checks.
- If positive screen on campus, patient is transported to isolation room for infection control evaluation.
- Screening questionnaire:

  1. Have you had a close contact (being within approximately 6 ft of a COVID-19 positive individual for greater than 5 min or having direct contact with infectious secretions) with a person with a laboratory confirmed case of COVID-19?
  2. In the last 14 days, have you had a fever or symptoms including cough, shortness of breath, sore throat, diarrhea, nausea, vomiting, respiratory distress, chills, muscle aches, headache, loss of smell, or change or loss of taste?

- Patients undergoing elective surgery must test negative for active COVID-19 infection with COVID-19 PCR within 48 h of surgery.
- All patients undergoing emergent surgery are presumed to be COVID-19 positive and tested with COVID-19 PCR if admitted post-operatively.
- During and up to 12 min after aerosol generating procedures, such as endotracheal intubation, employees must wear a N95 mask

| Case priority | Surgical practice during COVID-19 pandemic | Screening/PPE | Patients undergoing elective surgery must test negative for active COVID-19 infection with COVID-19 PCR within 48 h of surgery.

- Patients must self-quarantine after obtaining the pre-operative COVID-19 PCR test.
- All patients undergoing emergent surgery are presumed to be COVID-19 positive and tested with COVID-19 PCR if admitted post-operatively
- During and up to 12 min after aerosol generating procedures, such as endotracheal intubation, employees must wear a N95 mask

| Practice | Academic practice | Rotation structure \nDidactics | Hand resident on call every four days
- Hand fellow on call every five days
- Only virtual meetings
- Robust virtual curriculum

- Self-quarantine immediately
- COVID-PCR test immediately and if negative return to work.
- If positive, re-test in 14 days and return to work once test is negative and without any symptoms.

- Coronavirus disease 2019 (COVID-19); PCR: polymerase chain reaction; PPE: personal protective equipment.

a Physical contact for evaluation and treatment was permissible.

b Does not include laryngeal mask airway (LMA).

c Self-quarantine and monitor for symptoms immediately post-call until return to call duties.

d Protocol elements continued during the clinical ramp-up stage (May 13, 2020 to present).

quarantined after travel, and/or if they experienced symptoms of COVID-19. Symptoms of COVID-19 included those as listed by the Centers for Disease Control and Prevention including fever, chills, cough, shortness of breath, difficulty breathing, fatigue, muscle aches, body aches, headache, loss of taste/smell, sore throat, congestion, nausea vomiting, and/or diarrhea [9]. Additionally, we surveyed if employees were tested for possible active COVID-19 via oral or nasal polymerase chain reaction (PCR) and if they were tested for COVID-19 antibodies outside of the institutional COVID-19 antibody testing program. PCR is a method utilized to amplify viral DNA and test for the presence of active infection whereas COVID-19 antibody testing screens for antibodies produced by the immune system in response to infection indicative of prior infection.

Our institution’s antibody testing program consisted of a screening fingerstick blood test which results as “Reactive” or “Non-reactive”. Due to the high sensitivity and low specificity of the screening test, a non-reactive test effectively rules out the presence of COVID-19 antibodies. However, because a reactive test does not rule in the presence of COVID-19 antibodies, a reactive test was followed up with a more specific serology test for COVID-19 antibodies. In this study, an employee was deemed to be negative for COVID-19 antibodies if the employee had a non-reactive screening test, if the employee had a reactive screening test and subsequent negative antibody serology test, or if they were negative for COVID-19 antibodies when tested by a non-institution sponsored antibody test. All employees in our study with a reactive antibody screen followed up with the serology test. Antibody testing was performed between June 1, 2020 and July 24, 2020.

Categorical variables were summarized using counts and proportions. No advanced statistics were performed. Analyses were conducted using JMP Pro 14.1.0 (SAS Institute Inc., Cary, NC).
surge (Table 4). Five employees (9.09%) traveled to a high-risk region during the surge or were quarantined after travel of which three (60.0%) were antibody tested with a negative result. When surveyed, 24 (43.6%) employees felt they were at high risk for exposure or transmission to COVID-19 while performing their occupational duties (Fig. 2A). Two employees preferred not to answer. This is further subdivided by employment position in Fig. 2B, D.

3.3. Test results

All employees (39 of 39, 100%) who participated in the voluntary institutional employee testing program and responded to the survey (39 of 69, 56.5%) tested negative for COVID-19 antibodies (Fig. 2C) indicating no prior transmission of COVID-19. Five employees (9.09%) tested negative for COVID-19 antibodies outside of the employee testing program (Fig. 2C). Three of these employees did not participate in the employee testing program bringing the total number of individuals with negative COVID-19 antibody tests to 42 (Fig. 2C). Sixteen (16 of 69, 23.2%) employees were tested due to symptoms consistent with COVID-19 of which all tests, PCR and antibody, were negative (16 of 16, 100%).

3.4. Known exposure

Seventeen (17 of 55, 30.9%) employees (5/13 hand surgery residents [38.5%]; 4/13 consultant physicians [30.8%]; 2/13 hand surgery fellows [15.4%]; 1/13 nurses [7.69%]; 1/13 therapists [7.69%]) had a known exposure to COVID-19 with the overwhelming majority coming from PCR confirmed COVID-19 patients (13/17 from patients [76.5%]; 2/17 from co-workers [11.8%]; 1/17 from family [5.88%]; and 1/17 from a friend [5.88%]). Of the employees who had a known exposure, 10 (9 institution sponsored, 1 non-institution sponsored, 58.8%) had a negative antibody test result.

Table 3
Demographics.

| Age          | Overall |
|--------------|---------|
| 18–30 years | 7 (12.7%) |
| 31–40 years | 12 (21.8%) |
| 41–50 years | 13 (23.6%) |
| 51–60 years | 16 (29.1%) |
| 61–70 years | 6 (10.9%) |
| Prefer not to answer | 1 (1.82%) |

| Employment position | Overall |
|---------------------|---------|
| Therapist (occupational and physical) | 15 (78.9%) |
| Consulting physician | 11 (68.8%) |
| Nurse               | 10 (90.5%) |
| Resident physician  | 6 (100%) |
| Fellow physician    | 4 (80.0%) |
| Physician assistant or nurse practitioner | 4 (57.1%) |
| Desk operations specialist | 3 (75.0%) |
| Other               | 1 (100%) |
| Prefer not to answer | 1 (1.82%) |

3. Results

3.1. Demographics (Table 3)

Fifty-five of 69 (79.7%) employees responded to the survey. Thirty-nine (39 of 69, 56.5%) participated in the institutional antibody testing program. Study participant demographic information is listed in Table 3.

3.2. Exposure risk

The majority of employees worked with direct in-person contact for greater than one month during the initial COVID-19
indicating no probable transmission from their encounters. Of the remaining seven employees, 3 (3 of 7, 42.9%) were PCR tested and were negative for active infection. Of the employees who had a known exposure, five had symptoms (5 of 17, 29.4%) of which four (4 of 5, 80.0%) were PCR tested and were all negative. Two of the five employees who experienced symptoms, one of which was not PCR tested, had negative antibody results. Three of these five employees did not participate in our institution’s antibody testing program.

3.5. Symptoms

Ten employees (10 of 55, 18.2%) reported experiencing symptoms of COVID-19. Nine of these employees (9 of 10, 90.0%) were PCR tested for possible active infection and all 9 tested negative. Of these 9 employees, 5 (5 of 9, 55.6%) tested negative for COVID-19 antibodies and 4 (4 of 9, 44.4%) did not participate in the institutional sponsored antibody testing program. The single employee who experienced symptoms and was not tested for possible active infection tested negative for COVID-19 antibodies.

4. Discussion

This study supports the safe operation of a modified academic surgical hand practice while minimizing the risk of vital transmission during the COVID-19 pandemic and local surge. Projections suggest that the COVID-19 pandemic will come in waves and hospital systems must be prepared to rapidly adapt to the changing guidelines and mandates instituted by federal, state-level, community, and institutional governing bodies in response to the evolving nature of the COVID-19 pandemic [10]. The operational practices highlighted in this manuscript can be implemented to mitigate the risk of COVID-19 during times of surge and the subsequent ramp up to a fully elective hand surgery practice [8].

The COVID-19 care protocols implemented at our institution are effective at reducing the transmission of COVID-19 between employees and patients as well as among employees. No employee within the division of hand surgery tested positive for COVID-19 antibodies or active infection. As of July 8, 2020, sixteen days prior to the discontinuation of the institutional sponsored COVID-19 antibody testing program, there were 1168 confirmed cases of COVID-19 in our institution’s county making the prevalence of confirmed cases in the county 0.74% (1168 of 158,293) [11,12]. With a low prevalence rate of 0.74%, out of 42 employees, one would expect no cases of prior COVID-19 infection. However, we believe this is relevant as the majority of employees had contact with patients for greater than one month during the clinical shutdown period and healthcare workers are known to be at the highest risk of contracting the disease [13]. Additionally, as a quaternary academic medical facility, our institution continued to provide emergent and urgent clinical care to an international and national patient population, many of whom were traveling from high-risk states or countries. Thus, the actual prevalence of COVID-19 infection in our patient population is likely greatly underestimated.
Major mitigation strategies involve the full-time use of masks, including surgical-grade masks for outpatient and inpatient evaluation as well as N95 respirator masks during aerosol generating procedures; wearing eye protection when involved in direct patient care, employee screening including twice-daily temperature checks and daily symptom checks; and screening of all patients within 24 h prior to arrival on campus via electronic and telephone communication. Specific to hand surgery care, in-line with Center for Disease Control and Prevention guidelines, our institution requires patients to wash their hand for at least 20 s with soap and water or an alcohol-based hand sanitizer prior to examination [4]. Additionally, clinical personnel sterilized the entire room with anti-viral aerosolized sprays prior to rooming patients.

The most effective way to prevent transmission of COVID-19 is to prevent person-to-person interaction [4]. In a surgical practice, this necessitates transitioning some portion of the outpatient practice to the virtual setting. During the elective hand surgery clinical shutdown period from March 23, 2020 to May 18, 2020 (Fig. 1), our practice transitioned the majority of outpatient visits to telemedicine. The only patients that were evaluated in-person were those who were triaged to likely need emergent or urgent surgery. Additionally, in any case during which an eight-week delay in treatment would increase the chance of a worse outcome, patients were evaluated and taken to emergency (Table 1: Urgent). Last, it was the consulting physician’s discretion to determine if patients in the semi-urgent category needed to be evaluated in-person (Table 1: Semi-urgent). The remaining patients were instructed to wait for face-to-face consultation or follow-up examination until the practice reopened on May 13, 2020 (56 days from the initial practice shut down on March 23, 2020).

To prevent exposure to COVID-19 between employees in the workforce, conferences, lectures, and didactic education were transitioned to a virtual format and schedules were redesigned to minimize contact between employees. To care for emergent situations during the clinical shutdown, resident physicians and fellow physicians were placed on every 4-day (Q4) and 5-day (Q5) call schedules, respectively. While not on call, fellows and residents were instructed to self-quarantine and monitor for symptoms. During the COVID-19 surge, our hand surgery division instituted a so called “Doc of the Day” consulting physician in the outpatient clinic which is in a separate physical location from the hospital and operating suites. In this way, all patients who were scheduled for a clinic appointment (including post-operative follow ups and those listed in the urgent category of Table 1) were evaluated by the Doc of the Day, regardless of treating consultant. This allowed for a rotating schedule of consulting physicians to leave adequate time for self-quarantine between shifts in clinic. During our ramp up to full clinical practice, this schedule has been phased out. Other orthopedic residency programs have instituted similar practices such as instituting a two-team system with two-week rotations to provide ample time to monitor symptoms during self-quarantine [14].

There are limitations to this study. Given that the data were collected via a survey, we do not have the antibody test results for the entire division. The survey was designed to be anonymous, though it is possible that if an employee did test positive for COVID-19 antibodies they would be less likely to complete the survey to avoid workplace or personal discrimination. Additionally, of the employees who did complete the survey, nearly 20% did not participate in the institution sponsored voluntary employee antibody testing program. Furthermore, the survey was designed to only capture if an employee experienced symptoms of COVID-19 one or more times and did not allow the employee to report multiple instances of symptoms or multiple PCR test results. Additionally, because COVID-19 antibody testing is not 100% sensitive, it is possible that some employees contracted COVID-19 and did not test positive for COVID-19 antibodies. Lastly, the timing of the antibody test, over one month following the reopening of the practice, limits our ability to isolate exposure to one specific timeframe or location.

5. Conclusion

Given the absence of COVID-19 antibodies in our division, these data support the delivery of emergent and urgent hand surgery care during the local COVID-19 surge and safe reopening of an elective hand surgery practice amidst the ongoing COVID-19 pandemic through the use of personal protective equipment, screening, thoughtful scheduling, and the transition of meeting and some clinical visits to the virtual setting. The COVID-19 pandemic has brought on numerous societal, health, and business challenges in which thoughtful and agile response will be needed to ensure the continuation of high-quality patient-centered care to all patients in the future.

Financial support and conflict of interest disclosure

The authors report no conflicts of interest. No funding was needed for completion of this study.

Ethics information

This study was conducted after review and approval from the institutional review board. All research was conducted ethically.

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Appendix A. Supplementary data

Supplementary material related to this article can be found, in the online version, at doi: https://doi.org/10.1016/j.hansur.2021.05.011.

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