COVID-19: The New Mexico Experience and Background

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ABSTRACT

Introduction: The novel Coronavirus Disease 19 (COVID-19) identified in December 2019 and the associated pandemic has temporarily changed the way that we conduct medicine, allocate resources, and educate resident and fellows. The present investigation is a summary of The University of New Mexico clinical experience managing the sudden surge of critical patients, personal protective equipment management (PPE), and resident education.

Methods: We evaluated and analyzed the data related to the COVID-19 pandemic patient load and management in New Mexico, the formation of teams to protect the providers from simultaneous exposure, the resident experience, the PPE management, and the change in trauma load due to social distancing.

Results: The timeline of infection was as expected, with the slowing of infection as social distancing measures increased. The hospital census and availability of intensive care unit (ICU) beds to care for COVID-19 patients was maximized, and the management of this situation was immediate and effective with conversion of hospital floors to non-COVID ICUs. The trauma census decreased during this time as compared to the same time period the year prior. The resident experience in education continued to be positive with zoom patient sign out and continued education conference with faculty members. There was a considerable emphasis shift towards provider wellness and safety.

Conclusion: The COVID-19 pandemic will leave long lasting effects in the way we educate, manage patient care, and utilize resources. The experience, albeit difficult with significant negative impacts, will likely lead to improvement in the way we conduct ourselves in the various aspects of medical care and training.

Keywords: COVID-19, Personal Protective Equipment, Orthopaedics, Resident Education

INTRODUCTION

On December 31, 2019, the Chinese government received the first reports of patients suffering from pneumonia-like symptoms out of the city of Wuhan.[1] Since that time, the causative pathogen, severe acute respiratory syndrome Coronavirus 2 (SARS-CoV-2) and its associated illness Coronavirus Disease 19 (COVID-19), has spread to over 200 countries and has infected almost 4 million people.[2] Mathematical models predicted that the infection toll will rise to 3 million in the United States alone.[3] The large, swift increase in cases necessitated the cooperation of government and healthcare leadership to introduce measures for slowing the spread of the disease and making available resources to adequately treat those afflicted and to protect caregivers.

SARS-CoV-2 is an enveloped, positive-sense, single-stranded ribonucleic acid virus. It is thought to be shed from its host through bodily fluids (eg, saliva, feces, urine, and respiratory droplets) and subsequently transmitted via fomites, droplets, and the feco-oral route.[1] Once it enters the new host, it is thought to infect pneumocytes through the angiotensin-converting enzyme 2 receptor.[1] The ensuing lung tissue destruction and cytokine storm then produces the classic symptoms of COVID-19 (ie, fever, cough, dyspnea, and in severe cases, respiratory failure).[1] Many patients also exhibit bilateral patchy infiltrates on chest x-rays, further

clarified as ground-glass opacities on chest computed tomography (CT) scans.[4] Although many early patients showed the expected symptoms, evidence of unusual presentations began to emerge as testing became more widely available. Asymptomatic patients and patients with olfactory and gustatory changes, diarrhea, and headaches began testing positive for the virus or showing suspicious findings on chest CT.[5] The incubation period for SARS-CoV-2 is estimated to range from 2 to 14 days, during which the asymptomatic carrier is still able to actively shed the virus.[1] This range is considerably longer when compared to those of recent epidemics, including Severe Acute Respiratory Syndrome Coronavirus 1 (SARS-CoV-1), Middle East Respiratory Syndrome Coronavirus (MERS-CoV), H1N1 influenza, and seasonal influenza.[1] The variety of presentation symptoms, including asymptomatic infection combined with the lengthy incubation period, results in high infective potential.[1] Interestingly, the basic reproductive number R_0, defined as the number of new cases generated by one existing case, is reported to be 2 to 2.5 for COVID-19, which is almost double the R_0 of influenza (1.3).[1]

Of the 3.9 million people that have been infected worldwide, approximately 270,000 have died.[2] Mortality rates are not distributed equally across age groups, with those older than 60 years and those with underlying comorbidities suffering disproportionately higher rates of death and disability.[1] The burden of disease has been felt around the world. Orthopaedic surgeons in hard-hit nations, such as China and Italy, have been forced to restructure their daily operations to continue giving necessary care to orthopaedic patients while rationing finite resources.

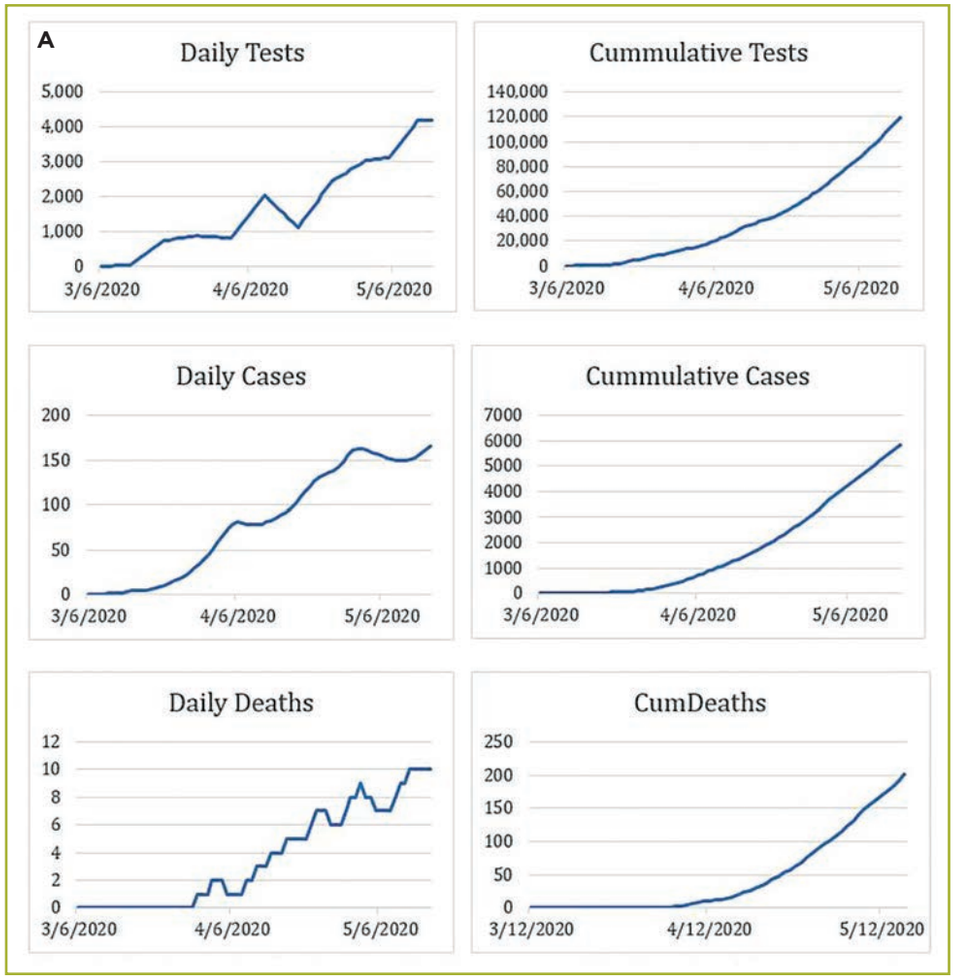
Although the healthcare infrastructures of China, Singapore, and Italy are all different from each other, all have adopted similar management strategies to deal with the COVID-19 pandemic. Each has initiated testing and subsequent segregation of suspected COVID-19 patients. The first widely available test was a reverse transcription polymerase chain reaction (RT-PCR) test of oropharyngeal specimens (reported sensitivity of 66 to 80%).[1] Due to the low sensitivity rate and initially lengthy turnaround time of the test, ground glass opacities on chest CT scan and recent (ie, within 3 weeks) febrile or respiratory symptoms were also criteria used to place patients in suspected COVID-19 isolation.[6,7] One study in Thailand reported three consecutive negative RT-PCR tests as their benchmark of downgrading isolation protocol.[7] Another commonality was the formation of a multidisciplinary overseeing board that included orthopaedic, anesthesiology, and hospital leadership.[8,9] With the input of all involved parties, decisions were made on parameters of preoperative respiratory clearance, current hospital needs and resources, and conditions of discharge from the hospital.[8] All elective procedures were cancelled or postponed, although the scope of the word "elective" is at the discretion of the overseeing multidisciplinary board.[9]

Cases that could tolerate spinal or regional anesthesia were performed under such to prevent possible virus aerosolization during intubation and further respiratory demand placed by general anesthesia.[4,8,10] This underlined the importance of personal protective equipment (PPE) for healthcare workers and was repeatedly stressed. For orthopaedic surgeons, assistants, and any operating room staff, full PPE (ie, N95 masks, eye protection, disposable gowns and gloves) was initially recommended for all case types. However, this was modified to interacting with any patient who had suspicious examination findings for COVID-19, or could not participate in screening due to unconsciousness or altered mental status.[6,7,10] Confusion occasionally persisted as Guo et al[11] recommended inpatient orthopaedists donning N95 masks at all times while in the hospital.

In China, the most common fracture sustained after the onset of the virus and government-enforced quarantine was proximal femur fracture resulting from a fall from standing.[6] Recommendations for fracture care from the Hubei province included opting for nonoperative fracture management if possible; negative pressure operating rooms for those undergoing surgical management; and close postoperative monitoring for acute decompensation, given the higher risk of COVID-19-related morbidity and mortality in elderly patients with fractures.[6] Orthopaedists in the Lombardy region of Italy recommended that elderly patients with hip fractures undergo operative treatment if they could tolerate surgery, stating that the improvement in respiratory parameters observed postoperatively is likely due to better upright positioning and decreased opioid use.[4] To relieve the burden on the main hospital and free up intensive care unit (ICU) beds, medical groups in northern Italy set up an orthopaedic hospital for patients with time critical elective procedures and those with minor orthopaedic traumas that did not require multidisciplinary care.[8] Singapore adopted methods to limit the number of people physically in the hospital. More time was encouraged between non-urgent outpatient follow-up appointments.[12] Rotating, segregated orthopaedic teams were deployed to decrease disease spread amongst the department.[12] Residency training was restructured to include online procedure videos and virtual lectures and meetings.[12] This tactic was employed world-wide and was introduced locally at the end of March. The following timelines are representative of our regional experience.

Timeline in New Mexico

March 6:	Testing began
March 10:	First positive result
March 12:	Gatherings restricted
March 13:	Educational facilities closed
March 16:	Some businesses closed
March 23:	First reported death in New Mexico from COVID-19
March 24:	All non-essential businesses closed



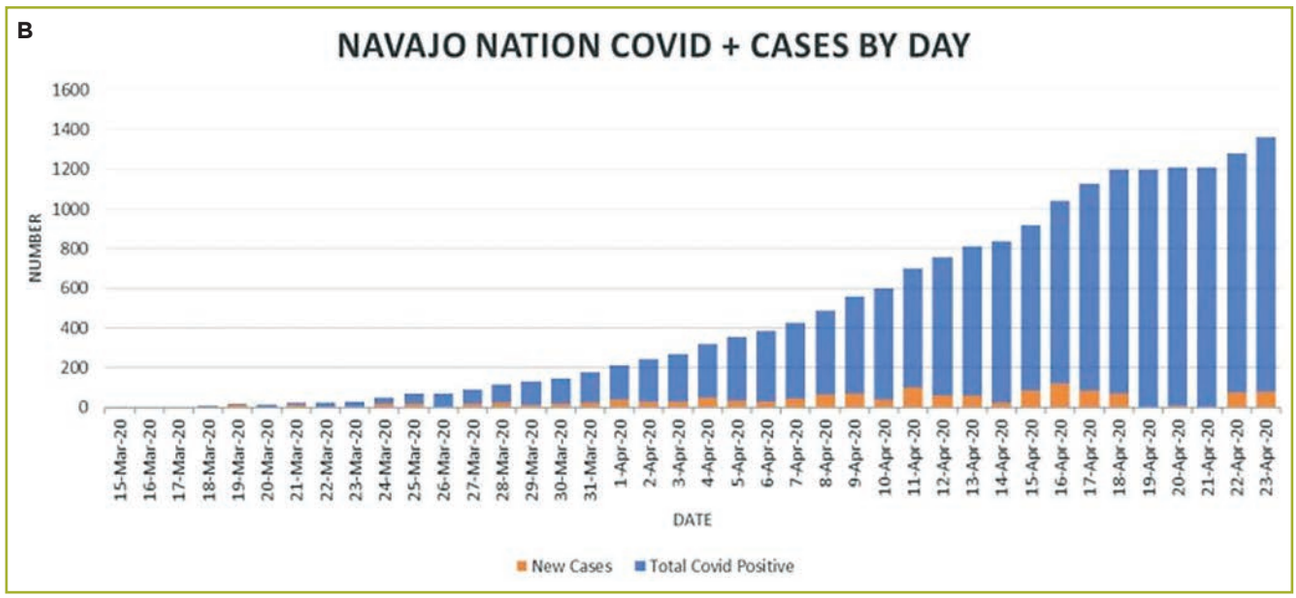


Figure 1. *A) Charts showing the timeline of testing, cases, and deaths in the state of New Mexico. B) The Navajo Nation hot spot changed the time line in New Mexico. Data was taken from: https://covid19.healthdata.org/united-states-of-america/new-mexico.*

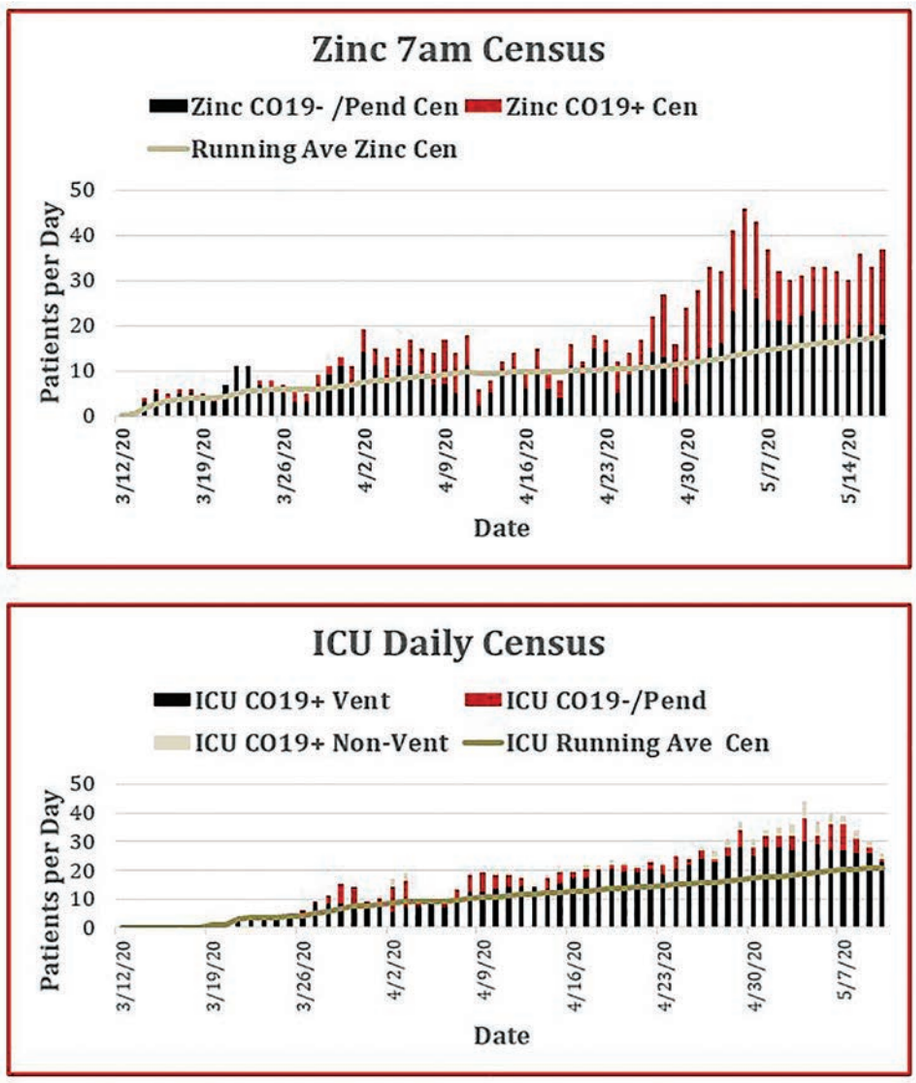


Figure 2. *Charts showing the timeline of cases at The University of New Mexico Health Science Center. Reprinted with permission.*

Charts of the number of tests, number of positive COVID-19 cases, and deaths in New Mexico from March 6, 2020 to May 6, 2020 are shown in Figure 1.

Timeline at The University of New Mexico Health Sciences Center (UNM HSC)

March 12:	First COVID-19 patient admitted to UNM HSC
March 16:	UNM HSC non-medical staff work from home
March 20:	Medical appointments and elective surgeries at UNM HSC cancelled

Charts of the daily census of COVID-19 patients and ICU patients at UNM HSC are shown in Figure 2.

PROVIDER SAFETY AND PATIENT CARE

In response to the COVID-19 pandemic, The University of New Mexico's Department of Orthopaedics implemented a "team-based" approach to COVID-19, with provider safety, patient care, and preservation of the resident educational experience as the primary goals. As the only level one trauma center in New Mexico, it was vitally important to protect our most important asset, our healthcare providers and support staff, in an effort to be able to continue excellent care to the citizens of our state.

Based on information provided from the Orthopaedic Trauma Association and information gleaned from experiences in New York, China, Singapore, and Italy, the department was divided into four main teams comprised of faculty from various subspecialties and an appropriately-sized resident workforce. This team-based approach was carefully planned and vetted weeks before the COVID-19 pandemic became a threat. Two teams each were assigned to either UNM hospital or Sandoval Regional Medical Center. One team covered call responsibilities at their respective hospitals while the other team stayed "home." Every 7 days, the teams would switch roles. This worked to separate the individual providers to minimize the risk of large

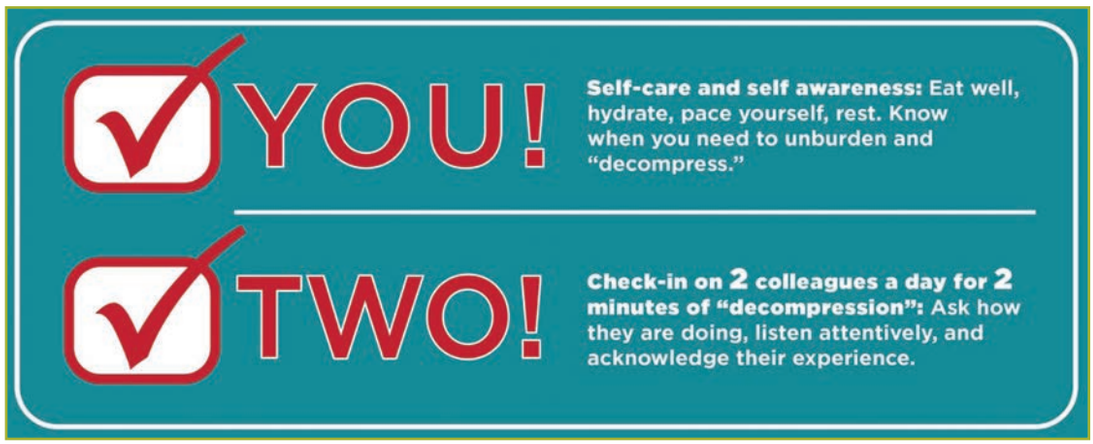


Figure 3. *Check You, Check Two. Reprinted with permission from The University of New Mexico Wellness.*

group exposure, which had the potential to quarantine or infect a large number of providers at one time. It also allowed for some down time to monitor from symptoms and to mentally recover from providing 7 straight days of acute care for fractures and infections. Additionally, hand, spine, and pediatric divisions were relegated to their own divided teams due to the specific requirements of these specialties. This worked to keep the providers adequately distanced from each other to ensure that we would be able to continue offering complex hand surgeries, microvascular cell and spinal surgeries, and pediatric fracture and infection care, should one provider become quarantined or infected.

Elective cases were canceled, and the surgeons worked diligently to reassure their patients that they would receive timely care once the viral infection threat was under control. Orthopaedic leadership worked with the hospital to ensure timely care of trauma patients to minimize hospital stay and surgical delays. The available trauma surgeon was increased from one surgeon to three surgeons via team approach, with care provided 7 days a week to ensure prompt treatment of orthopaedic trauma patients.

RESIDENT EXPERIENCE

Residents continued to participate in the care of trauma patients in both the inpatient and outpatient setting. The resident education format changed but was continued throughout the COVID-19 pandemic, and the new format continues to date. There was first a 10-person limit followed by 5-person limit in group gatherings, which led to the initiation of video conference meetings. The password protected video conference platform was used for both education and patient care. The video conferencing was well accepted by residents and carried several advantages, including national and international thought leader involvement in education. Peer publications were shared in real time to support the discussion. Additionally, the opportunity to collaborate on research publications presented itself as case cancellation and surge-team free-time occurred on many levels.[13,14]

PERSONAL PROTECTIVE EQUIPMENT

A personal protective equipment (PPE) committee was formed as a subcommittee by The University of New Mexico Emergency Operations Committee (EOC) in an effort to define appropriate PPE for use in the various clinical settings. This committee consisted of broad representation from various clinical groups within the hospital including Emergency Medicine, Hospital Medicine, Critical Care, Infectious Disease, Infection Control, Logistics, Nursing, and Anesthesia, among others. One individual from the Department of Orthopaedics was appointed to this committee and functioned as the sole representative for surgical specialties.

The PPE committee reviewed Center for Disease Control (CDC), World Health Organization (WHO), Occupational Safety and Health Administration (OSHA) guidelines, and guidelines developed from institutions that were affected much earlier throughout the course of this pandemic. The committee was ultimately responsible for delivering guidance to the EOC, recommending specific PPE for use in a variety of clinical situations. Included in the PPE committee's role was development and monitoring of N95 respirator decontamination for reuse. It was also responsible for keeping up to date on the hospital's PPE burn rate, supply chain, and PPE stockpile. Dr. Matthew Wharton, PGY-4, was the only resident representative in the UNM Hospital PPE committee as recommended by his Chair, Dr. Robert C. Schenck, Jr. Dr. Wharton proved to be an excellent leader and a powerful resident voice and advocate during these uncertain times.

Initially, the appropriate and specific use of PPE for orthopaedic surgery cases was in flux. This mostly surrounded the use of N95 masks versus standard surgical masks for orthopaedic trauma cases. Based on available literature, the PPE committee developed formal guidelines to maximize provider safety and conserve the PPE supply. Procedures were categorized by their risk based on knowledge of viral transmission, and orthopaedic procedures were deemed low risk due

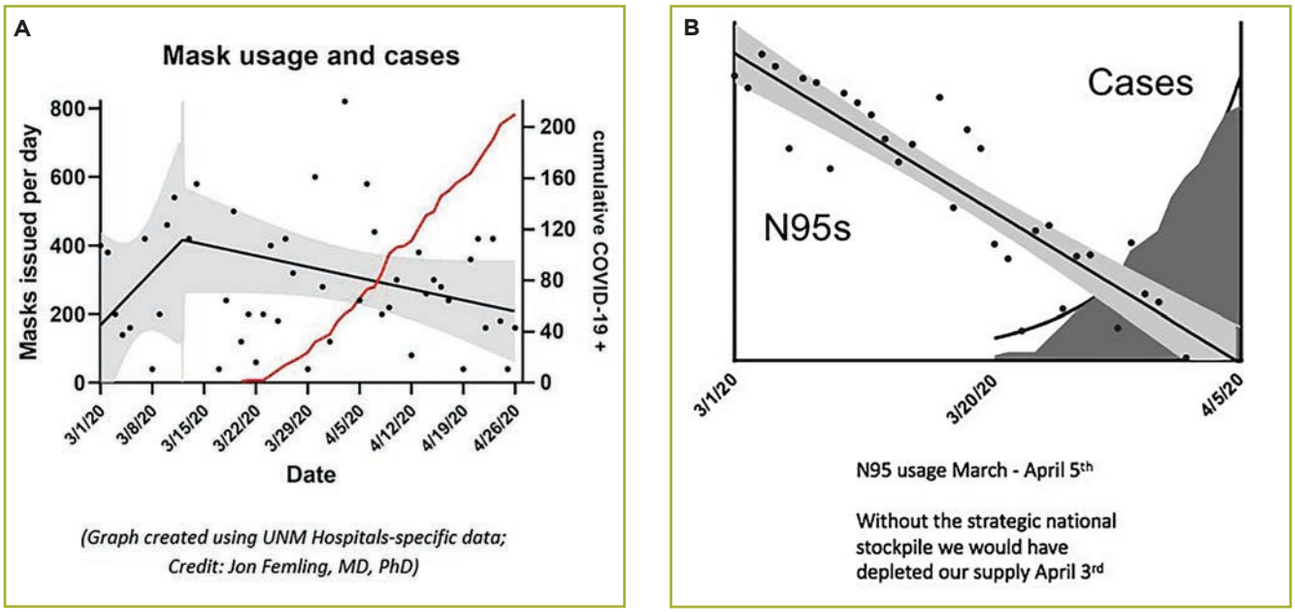


Figure 4. *A) Effect of mask utilization and re-sterilization protocols in avoiding depletion of stockpile and B) available PPE supplies. Graph created using The University of New Mexico Hospitals-specific data. Credit: Jon Femling, MD, PhD.*

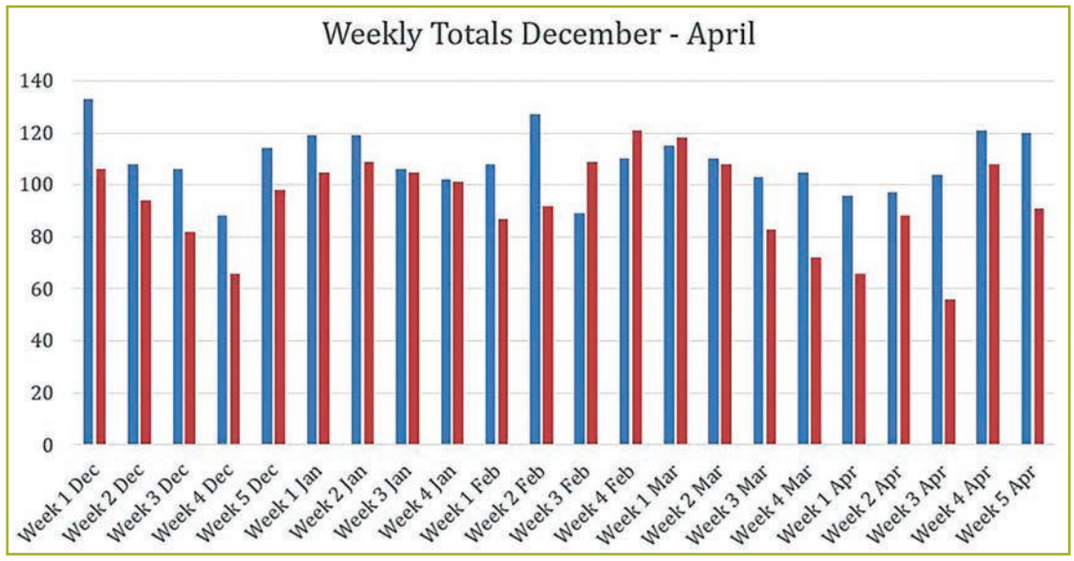


Figure 5. *Weekly Orthopaedic Consult Totals for December 2018 through April 2019 and December 2019 through April 2020. There was a drop in orthopaedic trauma during social distancing.*

to the lack of evidence showing viable virus present in blood. Using the knowledge that aerosol-generating procedures (eg, intubation) incur the highest risk of transmission, operating room practices were changed. Particularly, non-anesthesia providers were to leave the room for 15 minutes during intubation or extubation to allow for 99% air turnover, based on our facilities' air exchanges per hour. Standard approaches to avoid burn through of N95 PPE were the use of surgical masks and leaving the operating room during intubation and extubation. If splints were needed to be held during extubation, orthopaedic surgeons were required to wear N95 PPE. By doing these, we were able to curb the utilization of PPE, and with the addition of the PPE stockpile, enough PPE was available throughout the peak period of infection (Figures 4A and 4B).

CHANGES IN ORTHOPAEDIC CONSULTS FROM THE EMERGENCY DEPARTMENT

We looked at the number of orthopaedic consults per week from the emergency department for four time periods: 15 weeks pre-social distancing, 7 weeks post-social distancing, and the same two periods for the previous year as controls. The data were tested for normality using the Shapiro-Wilk Test in R. The data were found to be normal. The weekly totals for the

Table 1: Mean number of consults per week for each period and standard deviation of averages for each period

Time Period	12/2/18 – 3/16/19	3/17/19 – 5/4/19	12/1/19 – 3/14/19	3/15/19 – 5/2/19
Reason for collecting	Previous Year Control	Previous Year Control	Pre-Social Distancing	Post-Social Distancing
Weekly Average	110	107	101	81.5
Std Deviation	12.1	10.1	13.9	17.4

periods of interest are shown in Figure 5. Table 1 shows the time periods, the mean number of consults per week for each period, and the standard deviation of the mean for each period.

The data were compared with a Welch Two Sample *t*-test in R. The difference between the samples from the previous year control periods was not significant ($P = 0.4665$). The difference between the samples from pre-social distancing and post-social distancing were significant ($P = 0.02328$). We conclude that the social distancing and lockdown requirements in New Mexico led to a 20% drop in orthopaedic emergency department consults.

CONCLUSION

The recent COVID-19 pandemic has led to a transformation in care provided worldwide. This has often been fraught with fear and anxiety. However, in the scenario of UNM HSC, there were constant reminders to remain calm, flexible and positive. Daily testing, reports of positive tests, intubations, and deaths were all a central focus of healthcare providers (Figure 1). Leadership during this time was certainly tested, redefined, and critical for our successes. UNM Orthopaedics allowed faculty and residents to be leaders, which was evidenced by a very cohesive and well-informed approach to the COVID-19 crisis. Part of the communication process was a daily message by Dr. Robert Schenck, which eventually morphed into a two member message with Dr. Mathew Wharton discussing what we know, what to expect, and what our concerns were. The messaging on a daily basis to the UNM Orthopaedic Team/Family from both an attending and resident proved to be a unique and powerful approach. Furthermore, mental health and wellbeing of all the department became a continued focus and source of inspiration for all working during the trying times. Use of recommendations from outside sources for mental health, such as Rutger's "Check You, Check Two," was suggested during daily messages. The "Check You, Check Two" initiative urged all to attend to their own needs and then touch base with two colleagues daily by phone, text, or a brief message (Figure 3). We liken this concept to "a string of compassion" in that when you think of someone, regardless how random, check in on them and see how things are going. The pressure of the crisis for providers, patients, and families was a large determinant in making mental health a priority for UNM Orthopaedics.

COVID-19 infections have occurred among UNM HSC healthcare workers during this pandemic. Out of 660 healthcare personnel tested through mid-May 2020, thirty (4.6%) workers have tested positive for COVID-19 infection. Most of the exposures that lead to infection were not from direct patient care, but instead from work meetings or spending time with colleagues. Some were acquired from travel to areas with known community spread of COVID-19 infection. Two healthcare personnel acquired COVID-19 infection from patient exposures; however, these happened early on during the pandemic when COVID-19 infection was not clincially suspected, thus appropriate PPE had not been worn. These events have been reviewed and other protections have since been put into place to lessen the risk to healthcare personnel, including universal masking of patients and healthcare personnel and the testing of all inpatients upon admission to the hospital.

Research is still needed to define specific transmission risks. To date, the science hasn't shown how much infection transmission is mediated by droplets versus aerosols, how much virus leads to infection, or what type of mask affords the best protection in different scenarios when working with COVID-19 infected individuals. What is known about SARS-CoV-2 transmission is that more prolonged exposure to COVID-19 infected patients (eg, greater than 10 to 30 minutes), and performing aerosol generating procedures on infected patients imposes the greatest risk of transmission. It's important to have N95 masks available for those in healthcare who do more prolonged, face-to-face work in COVID-19 dedicated units and those performing procedures that generate aerosols.

Unfortunately, SARS-CoV-2 surged across the globe and caught the world unprepared. Hospitals all over the globe experienced shortages of PPE as the demand did not cease. As we and many other hospitals have found, previous levels of PPE use are poor predictors of PPE use during a pandemic. If we had continued to use our N95 masks as we had in March, we may have run out of N95 masks by early April.

We were able to use our UNM HSC pandemic supply, a supply that was put into place after the 2009 H1N1 influenza pandemic, to bridge many key PPE items as we looked for other sources to procure PPE. We have also updated our PPE practices to provide N95 masks for those at greater risk. We now extend and reuse our N95 masks so that our current supply lasts longer per updated CDC guidance. We continue to seek out alternatives to N95 masks and evaluate all leads for other types of PPE. Since we have changed our practices related to PPE, we're ensuring that we're not

only protected today but also pacing ourselves to have an adequate PPE supply as this pandemic ameliorates, and more importantly, for our next pandemic.

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