Clinical Informatics during the COVID-19 Pandemic: Lessons Learned and Implications for Emergency Department and Inpatient Operations

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Abstract

In response to a pandemic, hospital leaders can use clinical informatics to aid clinical decision-making, virtualizing medical care, coordinating communication, and defining workflow and compliance. Clinical informatics procedures need to be implemented nimbly, with governance measures in place to properly oversee and guide novel patient care pathways, diagnostic and treatment workflows, and provider education and communication.

The authors’ experience recommends: (1) creating flexible ordersets that adapt to evolving guidelines that meet needs across specialties (2) enhancing and supporting inherent telemedicine capability (3) electronically enabling novel workflows quickly and suspending non-critical administrative or billing functions in the EHR and (4) using communication platforms based on tiered urgency that do not compromise security and privacy.
Introduction

The global coronavirus pandemic named Coronavirus Disease 2019 (Covid-19) has thrust into the spotlight the importance of disease surveillance, diagnosis, treatment and research.(1) With the adoption of the Electronic Health Record (EHR) with the American Recovery and Reinvestment Act in 2009, many health networks would have less than a decade’s worth of opportunity and experience with the utility and limitations of this computer-based tool in improving healthcare quality, population health, and health system efficiency, while the medical community has been familiar with strengths and weaknesses from decades of practiced medical informatics.(2) Informatics, in its many forms and classifications and in association with health information management, is the ideal confluence of people, process, and technology.(3, 4) Many of the principles of informatics with regards to computers, software, internet connectivity, and telemedicine have been described in the literature within the area of disaster mitigation and preparedness.(5-8) However, resources elucidating the practical clinical application of informatics towards a pandemic response require further exploration.(9, 10) Swift clinical practice changes can be challenging within the confines of a large health organization even with an abundance of research and evidence.(11)

The authors intend to describe the role of clinical informatics in aiding clinical decision-making, virtualizing medical care, coordinating communication, and defining workflow and compliance during the rapidly evolving response to the Covid-19 pandemic at New York Presbyterian (NYP), a non-profit healthcare network comprised of two academic medical centers within eleven affiliate hospitals serving the New York City metropolitan area. Of note, the healthcare system is currently transitioning to a single unified EHR (Epic Systems Corporation) by a phased implementation approach beginning in 2018, due to be completed by the first quarter of 2022. Clinical departments across the network have been tasked to standardize practice as one of the guiding principles of the project. Practicing clinicians, with pre-defined roles within governance committees, participate in the clinical informatics process as a volunteer or as a designee by their respective clinical departments. All clinical departments participate in the informatics governance process.

Covid-19 Diagnostic/Treatment Order sets

Computerized provider order entry (CPOE) has been described as introducing several types of unintended adverse consequences, many of which revolve around creating new workflows and workflow demands on clinicians.(12) Order sets, defined as collective grouping of diagnostic or treatment orders within a CPOE system for a particular medical condition or purpose have been widely adopted for guidance, ease-of-use, and efficiency advantages despite the paucity of studied evidence.(13-16) Default settings and pre-selection of orders have been shown to reduce variability and drive clinician ordering habits.(17)

Our healthcare system decided to rapidly introduce Covid-19 Testing and Initial Workup, ED COVID Follow-up, and Post-Intubation order sets despite the inherent barriers of interoperability between different EHRs at different hospitals. A Covid-19 informatics committee was formed with weekly meetings that included key stakeholders and clinical experts from appropriate departments (Emergency Medicine, Laboratory Medicine, Infectious Disease, Hospital Medicine, Pulmonary Medicine and Critical Care). Debates concerning clinical utility were resolved by consensus to provide a consistent user-centric experience. Consensus decision-making followed a Quaker-based model.(18)
As the disease process became further elucidated, these order sets were continuously updated based on the most recent data and policy. Availability of a specific test or treatment (high-sensitivity troponin, interleukin-6) within each hospital compendium were denoted to ordering providers at each site. Orderset updates were reviewed weekly by the committee for consistency with up-to-the-minute policy updates and testing guidelines. Clinical decision support for the documentation of quarantined travel advisories and the suggested ordering of rapid-resulting (hours) versus standard-resulting SARS-CoV2 tests according to patient symptoms were introduced. While the Covid-19 Testing and Initial Workup orderset had been utilized over 24,000 times since inception in March 2020 (third most frequently used orderset), a formal user evaluation system had not been instituted.

Current ED Order Set for Initial Work-up examples:

1. Isolation Orders auto-generated with placement of Covid specific test orders:
   “PICTURE A”
2. Laboratory Orders with default selections for ease of entry:
   “PICTURE B”
3. Radiologic Orders with Covid precautions:
   “PICTURE C”

Added Clinical Decision Support examples:

1. Documentation of Symptoms and Exposure
   “PICTURE D”
2. Indication for testing
   “PICTURE E”

Facing the possibility of increased Emergency Department (ED) visits, a safety measure for discharged ED patients was introduced. The ED COVID Follow-up order had been created to be placed by the treating provider for our Nurse Practitioner (NP) pool to initiate a follow-up telephone call the next day. The telephone call served two purposes: first, to relay post-discharge results and second, to provide a safety net for the subset of patients that show more severe symptoms as the disease progresses. The follow-up calls had been conducted daily, seven days a week, with the option of transitioning from a telephone call to a telehealth video visit as per the discretion of the NP. This measure was implemented in the early stages of the pandemic as a response towards the conservation of inpatient beds with stricter admission criteria and have been used on average 3.5 times per day throughout the pandemic.

Virtualization of Services

Telemedicine and virtualization of medical services had been described as near-perfect milieus for enabling social-distancing and practicing quarantine measures.(19, 20) Telemedicine has relied
heavily on medical informatics principles with regards of providing patient specific information remotely in conjunction with rapidly accessible epidemiologic and statistical information.(21) The ED Telehealth Program at our institution consisted of (1) ED Express Care where patients presenting to the ED would be treated by a remote physician(22) and (2) a direct-to-consumer telemedicine service for at-home patients. *NYP OnDemand* allows patients to consult directly with our board-certified Emergency Physicians as an internet-based virtual healthcare service (Amwell).(23) Our direct-to-consumer telemedicine visits at our institution jumped from 30 calls/daily to over 300 calls/daily (Graph A) which correlated to the rise of COVID-19 cases in New York City (Graph B).(24)

“GRAPH A”

“GRAPH B”

Pragmatically, the increased call volume to our direct-to-consumer virtual urgent care telemedicine service required increased physician staffing, primarily filled with Emergency Medicine physicians. Our institution’s executive order to cancel elective and non-emergent surgical cases led to an enterprise wide strategic staffing model to redeploy physicians to areas of highest need. These new medical providers required provisioning and onboarding with the EHR systems to function, needed access to our Telehealth web application and information systems, and desired ongoing briefing and education about evolving Covid-19 guidelines.

Despite evidence contrary to the quality of templated or copied notes(25), the large influx of patients primarily concerned with Covid-19 symptoms and treatment favored the use of templated notes and patient instructions as an expeditious method of visit documentation and treatment plans. These templated notes and treatment plans, as Microsoft Word documents, have been easily updated and distributed through the Emergency Department’s wiki page (Atlassian Confluence 6.6.16) as guidelines evolved throughout the pandemic. The ED Covid-19 Response Committee (chaired by an ED Physician) had been charged with the maintenance and content update of uploaded documents which were made available to both ED and Telehealth patients.

“PICTURE F”

“PICTURE G”

Beginning in March 2020 and over the next two and half months, there had been over 60 redeployed physicians across 15 medical specialties that have cared for over 2,500 patients on our virtual urgent care telemedicine service. Determination of the impact of this service towards a reduction of ED visits is difficult to quantify, but the authors believe that, at minimum, a certain percentage of these patients would have sought care at an ED as primary care physicians had yet ramped up their own telehealth capabilities.(26)

Additionally, existent videoconferencing technology was co-opted for telemedicine evaluations (Avizia, Inc., Cisco Jabber), allowing physicians and other medical providers to interview patients in the ED while maintaining isolation precautions. Remote physicians conducted histories, simple physicals, and patient education while on-site ED personnel concentrated on in-person Covid-19 related testing and procedures.

“PICTURE H”

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Supporting Novel Patient Care Workflow Creation/Suspending Non-Critical Functionality

Supporting new workflows with regards to patient care and healthcare provider interaction is paramount towards a well-functioning healthcare system.(27) Specific examples from our experience include: creating an EHR based order for the (1) mildly symptomatic ED patient follow-up with a hospital dispensed pulse oximeter, seen via telemedicine, (2) normally admitted hypoxemic ED patient that had been discharged with remote patient monitoring and home oxygen, and (3) a newly discharged inpatient that had required close follow up for resolution of symptoms. Each patient cohort was followed by a different discharge service depending on presenting/discharging location and disease severity along with differing levels of EHR access and accountability.

“DIAGRAM A”

As a corollary to expediting simple and organized electronic order entry for radiologic procedures during a disaster response(28), suspension of non-critical compliance requirements for CPOE had been an important factor in order to decrease alert fatigue. Alerting logic for patient location requirements for ICU-only reserved medications (i.e. propofol by infusion) had been removed as recovery units and floor beds expanded into overflow intensive care units. Observation of the rights of clinical decision support (right information, right person, right intervention format, right channel, right time in the workflow(29)) supported the suspension of prerequisite documentation for the New York State mandate of offering HIV testing before placing a hospital admission or emergency department discharge order. Instituting CDS reminders for providers to order Covid-19 PCR testing and to check for the result had the potential to lead to expedited bed assignment and patient cohorting.

ED providers (physicians, PA’s, NP’s) suggested these changes through their Clinical Leadership Group representative and were instituted to respond to the growing amount of temporarily re-deployed medical personnel that had been unfamiliar with routine ED workflows. Intended consequences, such as a decrease in HIV testing offers were considered and deemed inconsequential. Other unintended consequences (increased walkouts, increased length of stay) were not observed with regulatory requirements and liability suspended by state government emergency mandate.(30)

Medical Provider Communication

At the core of clinical (medical) informatics has been the retrieval of information coupled with knowledge base management and transmission.(31) With almost ubiquitous searching and instant access to medical information on the internet(32, 33) the increasing acceptability of social media(34, 35), and the use of real-time crowdsourced communication tools(36, 37), the distribution of institutional and departmental policy and procedures has been paramount.

For re-deployed physicians and medical providers now providing telemedicine support, a wiki-type content management system (Atlassian Confluence 6.6.16) was constructed as described. Additionally, medical providers engaged in real-time on-shift support with medical peers through an internet-based chat mobile app (WhatsApp, Facebook, Inc.). The WhatsApp group was a private chat group enabled to provide real-time advice to other providers working clinically, to members of our core leadership team, and to our technology support team. This group chat helped respond to the needs of the new providers, giving them real-time support and “on the job” training as well as continuing education. The use of real-time group messaging had been described

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elsewhere with regards to the care of diagnosis specific patient groups with concerns over potential security and privacy settings.\(38, 39\) Future operational research detailing messaging content and HIPAA privacy compliance had been planned.

Medical provider communication adapted throughout the Covid-19 pandemic. The traditional departmental email listserv delivered daily updates from ED Leadership concerning evolving operational issues such as Personal Protective Equipment and staffing changes. Interactive video conferencing (Zoom Video Communications, Inc., Cisco Webex) was deployed and was encouraged throughout the institution as a communication tool as a substitute for in-person meetings and medical student education lectures despite inherent concerns for privacy and effectiveness.\(40, 41\)

**Conclusion**

The disruption of normal everyday workflows from the Covid-19 pandemic extends from the Emergency Department to the inpatient and outpatient clinical departments. From the evolution and universal adoption of the EHR, to the expansion of internet-based knowledge management, and to the adoption of modern media and communication tools, it is imperative that the practice of clinical informatics guides the interaction of people, technology, and information.

In summary, clinical informatics principles need to be implemented nimbly, with governance measures in place to properly oversee and guide novel patient care pathways, diagnostic and treatment workflows, and provider education and communication.

The authors recognize that the “lessons learned” presented here are to be taken as one institution’s response during an unforeseen crisis and that further study and development are required. Implications for clinical operations are inter-departmental and rely on a strong and cooperative informatics governance infrastructure.
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Our authors have no competing interests to declare.

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All those designated as authors have had substantial contributions and meet criteria for authorship.

**Data Availability Statement**
The data that support the findings of this study are available from the corresponding author, upon reasonable request.
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Virtual Urgent Care Volume
| Order Items                                                                 | T  | EMER |
|----------------------------------------------------------------------------|----|------|
| Complete Blood Count with Differential                                     |    |      |
| Basic Metabolic Panel                                                     | T  | EMER |
| Reticulocyte Count                                                         | T  | EMER |
| Liver Function Panel                                                       | T  | EMER |
| Troponin I                                                                 | T  | EMER |
| Lactate                                                                    | T  | EMER |
| PT/INR                                                                    | T  | EMER |
| Activated Partial Thromboplastin Time                                     | T  | EMER |
| Fibrinogen                                                                 | T  | EMER |
| Anti-Thrombin III activity                                                 | T  | Now  |
| Test Must Be Approved by Hematology                                       |    |      |
| Lactate Dehydrogenase                                                     | T  | Now  |
| Venous Blood Gases                                                        | T  | EMER |
| Arterial Blood Gases                                                      | T  | EMER |
| Creatine Kinase                                                           | T  | EMER |
| C Reactive Protein                                                        | T  | Now  |
| Erythrocyte Sedimentation Rate                                            | T  | EMER |
| Ferritin                                                                  | T  | Now  |
| Microalbumin, Timed Urine                                                 | T  | EMER |
| Procalcitonin                                                             | T  | Now  |
| Use only in the context of suspected/established lower respiratory infection or sepsis to help discontinue antibiotics. Limit serial procalcitonin to intervals of 48 hours or more. See Pharmacy guideline at [https://info.nyp.org/pharmacy/PharmacyM/ProcalcitoninUseAdults.pdf](https://info.nyp.org/pharmacy/PharmacyM/ProcalcitoninUseAdults.pdf) #search=procalcitonin |
| Blood Culture                                                             | T  | EMER |
| Blood Culture                                                             | T  | EMER |
| Urine Culture                                                             | T  | EMER |
| Urology, Dipstick                                                         | T  | Now  |
| Type and Screen                                                           | T  | EMER |
| Order           | Pertinent Clinical Info (Exam Reason) | Diagnostic Code |
|-----------------|--------------------------------------|-----------------|
| XR Chest 1-View (Ap), Portable | COVID-19 PRECAUTION... |                |
Important (1)

Does the patient have ANY of the following:
- Fever
- Cough
- Shortness of breath
- Chills
- Headache
- Sore throat
- Myalgias
- Diarrhea
- Loss of taste or smell

If so, have the patient put on a mask and put the patient on Droplet and Contact isolation.

If the patient has traveled in the last 14 days to an area of high risk as determined by New York State or internationally, then please select the 'COVID-19 Travel Quarantine' order as well as Droplet and Contact Isolation, regardless of testing status.

If the patient has had a known high risk exposure to COVID-19, then please select the 'COVID-19 High Risk Exposure' order as well as Droplet and Contact Isolation.

Order | Do Not Order
--- | ---
Initiate Droplet Isolation
Initiate Contact Isolation
COVID-19 High Risk Exposure
COVID-19 Travel Quarantine

Acknowledge Reason
Pt does not have any of the above symptoms. Not able to assess isolation need

Accept | Dismiss
COVID-19 Testing and Initial Workup

Do the patient have symptoms consistent with COVID-19?
- [ ] Patient has symptoms consistent with COVID-19: fever, cough, shortness of breath, chills, headache, sore throat, myalgia, diarrhea, loss of taste or smell, fatigue/malaise, nasal congestion.
- [ ] Patient does NOT have symptoms consistent with COVID-19.

SARS-CoV-2 RT-PCR
- Frequency: Once
- Starting: 9/13/2020
- First Occurrence: Today 1326
- Scheduled Times:
  - At: 1326

Is patient PUI? [ ] Yes [ ] No

What is the indication for testing?
- Most indications
- Admission from the ED
- Emergency procedure today
- Labor and Delivery patient
- ED patient being discharged to other facility

Comments:
- Add Comments (96)
- Specimen Type: Nasopharyngeal Swab
- Specimen Src: 

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COVID-19 Symptoms and Treatment

COVID-19 is caused by a virus that most people develop flu-like symptoms. Some people may have severe symptoms:

COUGH FLU-LIKE
- Fever
- Cough
- Fatigue
- Runny nose
- Muscle pain
- Headache

CUSTODIAN FLU-LIKE
- Fever<br>Sore throat<br>Dry cough<br>Runny nose<br>Body ache<br>Loss of appetite<br>Diabetes

COVID-19 Symptoms
- Fever<br>Runny nose<br>Cough<br>Sore throat<br>Fatigue
- Chills<br>Body aches<br>Headache<br>Wear a mask

COVID-19 Treatment
- Bed rest<br>Take fluids<br>Take over-the-counter medicines<br>Symptoms improve in 2 weeks

COVID-19 Precaution
- Wear a mask<br>Wash hands often<br>Distance from others

COVID-19 Disability
- Fatigue<br>Shortness of breath<br>Loss of appetite<br>Dry cough<br>Runny nose<br>Body ache<br>Diabetes

COVID-19 Prevention
- Wear a mask<br>Wash hands often<br>Distance from others

COVID-19 Recovery
- Bed rest<br>Take fluids<br>Take over-the-counter medicines<br>Symptoms improve in 2 weeks

COVID-19 Disability
- Fatigue<br>Shortness of breath<br>Loss of appetite<br>Dry cough<br>Runny nose<br>Body ache<br>Diabetes

COVID-19 Recovery
- Bed rest<br>Take fluids<br>Take over-the-counter medicines<br>Symptoms improve in 2 weeks

COVID-19 Disability
- Fatigue<br>Shortness of breath<br>Loss of appetite<br>Dry cough<br>Runny nose<br>Body ache<br>Diabetes

COVID-19 Recovery
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Location:
Patient was seen and evaluated by me using telemedicine

CC: Concern for COVID19 Symptoms

HPI:

PMHx:

PSHx:

Med:

Allergies:

COVID19 Risk Factors:
No known positive COVID-19 contact.
No travel outside of NYC in the last 2 months.
No known travel to areas with geographical clustering.
No sick contacts at home.

VIRTUAL TELEHEALTH EXAM:

VITALS:
GENERAL: Awake, alert in no distress, speaking in full sentences
HEENT: EOM intact anicteric atraumatic FROM neck normal voice
RESP: No respiratory distress
NEURO: patient Alert oriented moving all extremities equally
MOOD/AFFECT: normal

A/P:
Clinical presentation does not warrant referral to ER as this time, as patient does not have evidence of moderate or severe respiratory infection
Patient does not meet current COVID-19 testing criteria. However, recommend them to follow up on our hotline in case our testing criteria changes.
> Patient instructed to avoid contact with others while ill. For self-isolation at home and discharge instruction for DC of self-isolation given according to latest CDC guidelines
> Please monitor your symptoms closely. If your symptoms worsen please contact your doctor or go to the emergency department. Please go to ER for chest pain, difficulty breathing, weakness, vomiting, headache, changes in vision, or other concerning symptoms.
> Medications were reviewed med reconciliation was completed
> Discharge were reviewed with patient by me and made available at MYNP.ORG
> Questions were answered and patient expressed understanding of discharge instructions
Positive Cases of COVID-19 in New York City
By Reporting Date

https://mc.manuscriptcentral.com/jamia