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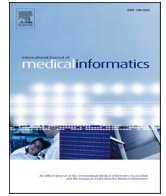
A digital approach in the rapid response to COVID-19 – Experience of a paediatric institution

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ABSTRACT

Introduction: COVID-19 has radically changed the delivery of healthcare in Australia. Central to a tertiary paediatric institution's (The Royal Children's Hospital Melbourne (RCH) response was a digital health approach comprising a broad suite of informatics and technology solutions including optimising a fully integrated electronic medical record (EMR).
Methods: This comprehensive approach spanned all patient care areas and encompassed a broad range of hospital operations. They included patient triage, registration, COVID-19 screening clinic operations, electronic ordering, prescribing and documentation, telehealth, reporting and analytics and research.
Discussion: This paper outlines key aspects of our COVID-19 digital health strategy, highlighting the rapid transition to telehealth and the development of a remote "virtual telehealth" strategy for clinicians which proved popular and allowed true "working from home".
Conclusion: COVID-19 has inadvertently focussed the spotlight on the utility of digital health for clinical care. The speed and uptake of digital health within this pandemic has been remarkable and unprecedented in both an Australian and global setting. Whilst many of these changes have been beneficial, some may have been rushed or forced with minimal consideration of ongoing governance. Key stakeholders and enablers should be identified for post-pandemic consideration in future digital health implementation and adoption strategies.

1. Introduction

The novel coronavirus COVID-19 has brought the world to a virtual standstill. Since being identified in Wuhan, China in December 2019, there have been over 3 million cases worldwide to date. At the time of writing in Australia, there have been approximately 28,000 cases, 900 deaths and a 15 % hospitalisation rate [1].

As part of a $AUD2.4 billion plan to address COVID-19, the Australian federal government included specific healthcare industry support measures such as transitioning to telehealth and provision of online training in infection control and prevention [2,3]. However, each healthcare facility was responsible for the development of its own response and approach to the pandemic. Whilst existing COVID-19 research focuses on care, treatment and immediate response, further

research focussing on ongoing digital approaches is also required [4].

Here we outline the rapid development and implementation of a "digital-health" approach comprising a broad suite of informatics and technology solutions including a fully integrated electronic medical record (EMR), in response to the COVID-19 pandemic at a single tertiary paediatric academic hospital.

2. Methods

The Royal Children's Hospital (RCH) is a 350-bed tertiary paediatric academic hospital located in Melbourne, Australia. It sits alongside campus partners the Murdoch Children's Research Institute (MCRI) and University of Melbourne (UoM) as part of the Melbourne Children's Campus hub.

Table 1
Technology Initiatives Introduced by Type.

Solution Type	Solution Details
Patient Triage / Registration	• Electronic Registration and Triage Tool (for all symptomatic patients) via REDCap™ electronic survey • Modified registration tool for asymptomatic voluntary HCW screening • Bulk SMS notification of all negative results to patients who had presented to outpatient clinic
COVID-19 Information Synthesis	• COVID-19 Summary Box • Displaying key information regarding COVID-19 • Decision support for testing • External links to DHHS testing criteria, hospital COVID-19 protocol, PPE requirements
Inpatient, Emergency Department and Ambulatory Order Panels	• Order panels in inpatient, outpatient and emergency department settings for COVID-19 ordering • Express Lane for screening clinic visits
Infection Control	• Auto-infection status rules when COVID-19 swabs are ordered and resulted (eg. COVID-19 suspected) • Paired isolation status (droplet + airborne) in order panel
Contact Tracing	• Patient/staff contact tracing of suspected/ confirmed COVID-19 patients in EMR embedded database
System Level EMR Note Templates	• Screening clinic note template • Patient discharge and isolation instructions
Telehealth	• Significant shift to telehealth (including staff offsite) and remote ordering & prescribing workflows
Reporting and Analytics	• COVID-19 Operational Dashboard with real-time reports • Test result database for notification and appropriate isolation / reporting

Since April 2016, RCH has been using a fully integrated EMR, Epic Systems (Verona, WI, USA). The EMR has been implemented across the hospital and is used for patient care in all clinical areas including inpatient, outpatient, theatre areas and the emergency department. The hospital has approximately 338,140 outpatient clinic visits, 86,140 emergency department presentations per year and 6000 staff.

As part of the overall Victorian state approach to COVID-19, a local facility COVID-19 working group was established in early March 2020 to coordinate the organisation's response. This was done to ensure a concerted approach involving key stakeholders and to facilitate rapid decision making.

In step with escalating government action, a COVID-19 screening clinic was introduced for symptomatic patients and staff from 12th March onwards (which continues to operate as a public screening clinic). Visitor restrictions were introduced on 13th March in line with Department of Health and Human Services (DHHS) guidelines, and tightened as recommendations changed. To adhere to the State of Emergency declared on 16th March restricting movement, RCH aimed to rapidly move the majority of its outpatient appointments to telehealth. This switch was completed by 23rd March.

It was evident early in this process that these radical changes to clinician workflow and organisational operation were only possible if there were accompanying adaptations from the digital health and technology solutions that drive care at RCH.

3. Results

In a synergistic approach, the EMR project team collaborated with key clinical and operational stakeholders around the hospital to prioritise, expedite and implement end-to-end COVID-19 related initiatives incorporating a range of technology-based solutions. These are summarised in Table 1 by solution type.

3.1. COVID-19 screening clinic

A systematic triage, evaluation and discharge protocol was paramount to effective operation of the RCH COVID-19 screening clinic.

Although our clinic was located within an exclusively paediatric facility, the screening clinic was made available for symptomatic screening of paediatric patients, their families as well as adult staff members.

Even though clinical care is driven by the EMR, initial triaging and screening requires patient-staff interaction. The decision was made to digitalise this process in order to deliver an all-electronic clinic, with an online screening and registration tool using an established REDCap™ electronic data capture system adopted and implemented [5]. This was done for three key reasons – to allow a complete and standardised minimum dataset to be collected from all patients, to reduce the face to face contact time between symptomatic patients and clerical staff unfamiliar with PPE precautions, and to maximised overall clinic throughput and clinician workflow efficiency.

Upon arrival, patients were directed to a secure survey tool on their smartphone via a QR code or short URL. They would input demographic data, epidemiological risk (detailed travel history, occupational exposure such as Aboriginal and Torres Strait Islander (ATSI) status, healthcare worker (HCW), clinical risk factors (such as being immunocompromised, chronic medical conditions) and symptoms. Patients were also asked for consent for future contact for follow-up, tracing and research reasons. Results of the screening process were relayed in real-time to both clerks to register patients on the EMR and for clinician evaluation prior to the face-to-face screening consult. This registration process was extremely popular with patients and staff alike, and there was a 100 % response rate from patients, who were also provided a mobile device if needed.

Two EMR "express lane" options were developed for clinician use – one for HCW/staff and another for patients/families. This approach was developed to facilitate both speed, efficiency and standardisation in documentation, lab ordering, management and patient instructions/ printed advice. They were updated regularly as testing guidelines changed. The documentation template included patient risk factors, clinical notes, overall assessment and disposition. Pre-filled order panels contained orders for COVID-19 swabs indicating appropriate priority (HCW vs patient). Standardised and up to date patient instructions and appropriate isolation advice was routinely printed for patients attending the clinic.

Results from the clinic were then sent directly to the patient in order to provide closed-loop feedback, as well as to maximise data security and privacy by discouraging staff members or others from self-searching results on the EMR.

3.2. Inpatient area

Informatics solutions for inpatients tested for COVID-19 centred around enabling and enhancing information review and synthesis, ordering, precaution status and contact tracing.

To reduce the cognitive load on clinicians evaluating patient information related to COVID-19, a COVID-19 summary box was created. This grouped the latest DHHS and hospital testing protocols acting as clinical decision support for further testing, hospital guidelines around appropriate PPE, any COVID-19 swab dates, times and results, isolation status and quick buttons to select a diagnosis or add to the problem list.

Ordering panels were created that grouped an appropriate isolation status with a COVID-19 test order. Auto-infection status rules were implemented to place a "COVID-19 suspected" status on any inpatient who had a pending test result. This would change to "COVID-19 confirmed" or be removed depending on testing results.

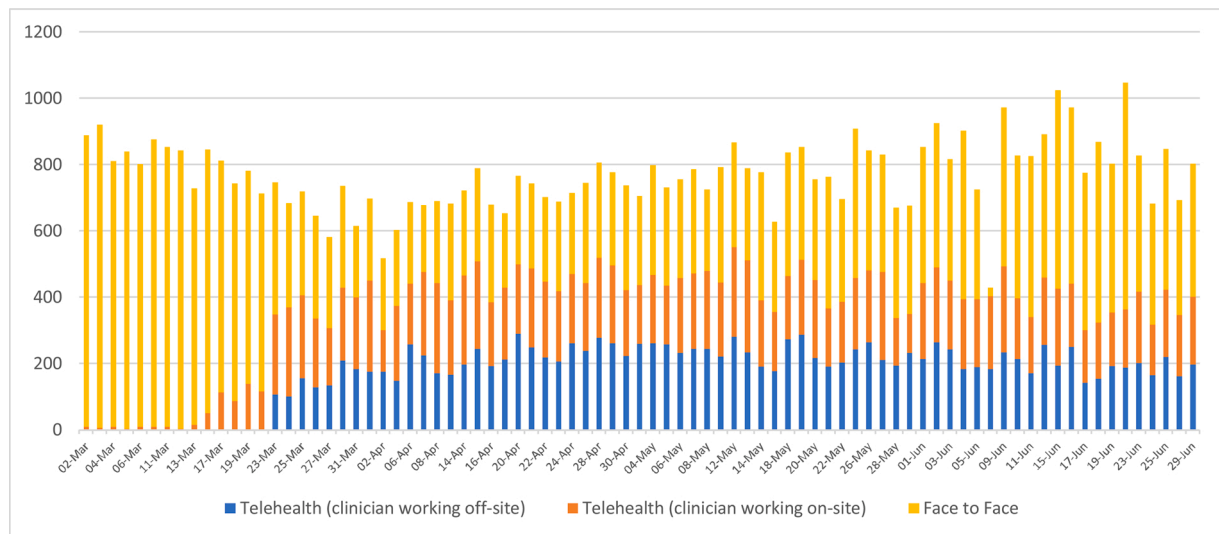By having this information available real-time and electronically,

Fig. 1. RCH Medical Outpatient Appointments - Telehealth vs Face to Face.

tracing of any patients within the EMR was made significantly easier. The infection prevention and control team were able to use specific EMR designed tools to report on pending and resulted COVID-19 patients, track isolation compliance and perform contact tracing. Using a sophisticated inbuilt tracing module, tracing of both patients or healthcare workers who had been in contact or exposed to the traced patient was available grouped by date, area of hospital or approximate time of exposure. This significantly reduced both time and resource hours needed for manual contact tracing.

3.3. Asymptomatic screening

The state government expanded the screening process on 27th April to include voluntary testing of asymptomatic healthcare workers as part of a push to increase overall COVID-19 testing to aid in gauging community prevalence of COVID-19. Based on existing solutions for symptomatic patients described above, a modified set of options was created to conduct the entire process via electronic means.

Patient registration was again completed via a shortened version of the QR code survey, with associated pre-filled order panels and visit diagnosis on the EMR. Separate reports were created for infection control staff to identify and trace any unexpected positive result.

3.4. Telehealth

Due to social distancing requirements and hospital visitor restrictions secondary to COVID-19, telehealth rapidly became a key pillar in allowing clinicians to engage with patients for non-COVID related appointments. Telehealth had already been in use within outpatient clinic settings for a period of time, but under government regulations this was limited to patients who were geographically distant from the physical hospital location.

A mass migration across to telehealth platforms occurred secondary to two key factors: a state of emergency declared in Victoria restricting patient movement, as well as the introduction of unrestricted government telehealth rebates applicable to all patients during this COVID-19 pandemic.

RCH conducts approximately 1200 ambulatory appointments per day – with a rapid drop to approximately 250 face to face consults as COVID-19 restrictions were first introduced. There was a concordant increase in telehealth from an average of 1–2 % of all appointments per day to 50–60 % - all within a week of the initial announcement. As a comparator, RCH conducted 231 consultations by telehealth for the

month of April 2019 – there were over 11,200 in April 2020.

Of particular interest was the potential to transition medical outpatient appointments to telehealth – as many of these consults do not involve interventions such as dressing changes, equipment fitting etc. Importantly, whilst telehealth allows patients to remain in isolation or at home, clinicians working in non-digital clinical environments are likely to have to still attend the healthcare facility where their patient records are based, to complete on-site or paper-based ordering or prescriptions for patients.

Thus, the challenge was to create a truly end-to-end virtual telehealth experience – where both clinician and patient were able to work or consult from home. To overcome this, our organisation developed a three-pronged approach – enabling remote access to the existing telehealth (Healthdirect Australia Video Call platform) and EMR platform, configuration of the system to enable the remote ordering of lab and imaging tests and to enhance electronic prescribing.

Clinicians indicated if the patient preference was to have lab or imaging tests done at RCH, in which case the orders would be sent electronically to the in-house pathology collection service. Alternatively, a lab or imaging request slip was mailed to the patient address using a central print & post facility. Similarly, patient preference directed electronic scripts to be sent to the main hospital pharmacy, a retail pharmacy located on campus, directly to a pharmacy of choice or to the patient address. Pharmacists could then arrange for medication pickup or delivery directly with the patient. The ability to route prescriptions electronically and offer mail delivery meant that, for many patients, there was no need to attend either their hospital clinic appointment or a pharmacy. This was not only convenient but also reduced the need for travel and physical contact in line with government recommendations.

Medical adoption of this initiative was rapid and sustained as demonstrated in Fig. 1. After only 5 weeks, medical telehealth appointments where both the patient and the clinician were remote from the hospital have increased to 57.0 % of all telehealth consults conducted. This effect has been sustained even though face to face consultations increase as cases ease.

Since launching remote prescribing and remote ordering on 25th March and 15th April respectively, we have had 4513 prescriptions and 71331 orders placed by clinicians working remotely.

3.5. Real-time reporting & analytics

Enabling the organisation to monitor and track the evolving patterns of COVID-19 and its impacts was an important priority. The team

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Summary Table

What was already known on the topic:

● COVID-19 pandemic has focussed the spotlight on the utility of digital health for clinical care

What this study added to our knowledge:

- Digital technology, including remote telehealth capabilities have been instrumental in transforming healthcare delivery in the COVID-19 era
- These overall shifts to digital health have prompted discussion around why they have yet to become mainstream practice in more areas
- Key stakeholders and enablers should be identified for post-pandemic consideration in future digital health implementation and adoption strategies.

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developed an operational dashboard consisting of a number of key reports and trends to inform decision making of the hospital COVID-19 Steering Committee. These contained real-time data on the number of patients presenting to the ED and screening clinic, as well as the number of patients tested and their test results.

Access to create ad-hoc companion reports derived from the EMR related to COVID-19 was granted to appropriate staff. This included queries about isolation status, concomitant infections, grouping of patients in negative-pressure wards to aid in patient flow and management etc.

4. Discussion

The COVID-19 pandemic required rapid development and rollout of policies, procedures and protocols as part of our organisation's approach. This paper describes a range of technology driven tools, predominantly within the EMR, that were designed, adapted for and implemented in a single institution during the pandemic.

Other Australian centres have described innovative approaches in utilising EMRs and other technology tools as a component of mainstream management of COVID-19. Two tertiary hospital EDs developed EMR data collection templates for suspected COVID patients to aid in evaluation and standardisation of clinical care [6,7].

In contrast, our institution's fully integrated EMR has allowed an opportunity to leverage technology solutions as the centrepiece rather than an adjunct in the response to COVID-19. This is a unique end-to-end health technology ecosystem with unparalleled breadth spanning an integrated EMR along with other technology solutions for outbreak management across all patient care areas.

4.1. Telehealth

Besides harnessing the EMR, the pivot to telehealth has been the biggest digital health workflow change during this pandemic. Traditionally a platform that has struggled to gain significant traction with clinicians due to a range of factors, social distancing and restrictions have mandated an almost overnight shift to telehealth becoming the central care delivery platform. Its flexibility enables its use in both the COVID-19 and routine healthcare domains, particularly to support areas such as rural and remote patients where care would otherwise be lacking [11].

Early evidence has shown that many appointments can safely managed, the technology is widely available, and clinicians and patients show little resistance to this transition, especially at this time [16–18]. Mann et al. have demonstrated a remarkable 4345 % increase in non-urgent care outpatient visits across their hospital network after telemedicine was expanded [18].

Our institution also saw a similar response to telehealth. The increased uptake has been seen across most specialities not requiring in-person visits (such as a wound or burn clinic). Clinicians with varying levels of digital literacy have generally adopted to the telehealth concept well. Telehealth has been used to support the significant mental health burden in the population (secondary to the pandemic) and has been demonstrated to be an effective intervention both for RCH mental services and other institutions [19,20]. Telehealth has also been used to assist in managing COVID-19 positive patients remotely in their home setting [21], including via our Hospital in the Home (HITH) service.

Furthermore, the ability to leverage the ability for clinicians to be work remotely or away from the hospital/clinic setting without compromising care delivery to patients was both unique to our institution and also widely adopted. Remote ordering and prescribing continues to be an ongoing staple of telehealth consultations.

4.2. EMRs

Much of the existing evaluation the potential value of digital solutions in potential pandemics relate to electronic reporting and surveillance systems in tertiary and primary care settings. Surveillance systems linked directly to EMR data assisted in providing near real-time understandings of epidemiologic situations during the H1N1 outbreak in 2009 [8,9]. They demonstrated increased user accepted if shown to be embedded within existing workflows [10–13].

The limited literature on comprehensive EMR use could be related to the relatively low penetrance in past pandemics. The COVID-19 pandemic has occurred in a different setting, especially in the US where EMR adoption has reached higher maturity. As the Australian informatics landscape matures and healthcare facilities are scaling their EMR capabilities and informatics infrastructure, a silver lining in the cloud of COVID-19 could be a spur to incorporate disaster management and public health capabilities into their development.

Reeves et al. have described in detail how their tertiary institution harnessed technological support including the EMR in managing the current COVID-19 pandemic [14]. Given the embedded nature of the EMR, it is both unsurprising and important that reliance on it to support clinical care was both necessary and possible – as was the case in our institution. Whilst a pandemic is not a sole reason to implement an EMR, the ability to provide clinical decision support in management and order processing can provide both workflow efficiency, standardised care and reduce potential errors in high-volume and turnover pandemic situations has proved invaluable [15].

5. Conclusion

The COVID-19 pandemic has focussed the spotlight on the utility of digital health for clinical care. Whilst many changes during this period were forced, key stakeholders and enablers have been identified for post-pandemic consideration in future digital health implementation, adoption and application strategies. This ranges from pragmatic considerations such as digital tools to manage COVID-19 vaccine rollout and safety monitoring, to wider applications of digital health to deliver

virtual and remote care.

These overall shifts to digital health have prompted discussion around why they have yet to become mainstream practice in more areas [22]. Whilst the speed of their adoption is nothing short of remarkable, proactive and planned implementation beyond this pandemic of digital health solutions that support clinical care will enable linkage to systematic and sustainable benefits to clinical care. Governance, user and organisational aspects of digital health improvement, which are not considered here, remain paramount in any future focus the intersection of digital health and clinical care.

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Authors' Contributions

DRC and MS developed the concept for the study and were involved in the drafting, editing and proofing of the manuscript. AC was involved in the literature review, editing and proofing of the manuscript.

Declaration of Competing Interest

All authors have no conflicts of interest to declare

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