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Telemedicine: improving clinical care and medical education in paediatrics

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Abstract
The COVID-19 pandemic has led to a rapid increase in the use of telemedicine. This is likely to continue when the social distancing restrictions have been eased. There have been a number of technological advances that have contributed to the roll-out and improved quality of telemedicine consultations. Telemedicine has a number of benefits including facilitating home working for clinicians, reduce travel time for families and allows multidisciplinary team working across different sites. In addition to these clinical benefits there are also the environmental benefits of reduced travel to and from the hospital setting. There are limitations to this change in practice including the need for repeat appointments if a telemedicine facilitated contact is not adequate and the perpetuation of inequality for vulnerable families, the so called “digital divide”. Due to the increase in the use of telemedicine it is important that clinicians develop effective consultation practices including appropriate selection of patients, technical setup and consultation tools. In order to ensure trainees are developing appropriate skills in telemedicine, educational opportunities should be developed including structured assessment tools to allow the demonstration of competence in this area.

Keywords COVID-19; medical education; remote consultation; telemedicine

Introduction
Telemedicine, the concept of practicing medicine remotely, has been supporting health care globally for many years in a variety of applications, facilitated by a range of technologies. Prior to the COVID-19 pandemic in the UK, the National Health Service (NHS) had already committed that every patient will have the right to be offered digital-first primary care by 2023-24, and all patients will have the right to online and video consultations by April 2021. Whilst equivalent targets in secondary care do not currently exist, in paediatrics previously uncommon remote consultations have become established in daily practice and other technology supported applications of telemedicine are at various stages of development and roll-out. Telemedicine may deliver improved quality and experience of patient care, provide safe and efficient new ways of working in the clinical environment and can facilitate and drive a new research and quality improvement agenda.

Across paediatrics, benefits to patients with remote outpatient consultations include reduced costs associated with transport, parents missing less work and children missing less school and improved efficiency with fewer missed appointments and shorter consultation times. For those in paediatric training posts, practicing telemedicine whilst remote working offers potential to improve trainee experience and improve retention. It may facilitate training at home, reduce time spent commuting, improve challenges associated with arranging childcare and facilitate re-integration to training for those on return from maternity/out of programme. Such flexibility may also release much needed capacity in out-patient consultation rooms for those who must have face to face consultations.

However, integration of telemedicine into routine care may create barriers and perpetuate inequality for more vulnerable families who may not have equitable access to reliable devices/ connectivity, meaning children who may be most in need of clinical care and safeguarding are those who are least likely to be able to access it, with potentially adverse long-term effects. Other issues include lack of training for health care professionals, concerns about safeguarding, ability to capture all information for documentation of core datasets, ability to examine the child (including minimum standards such as weight/height), to have investigations or pick up prescriptions at the same appointment. Potential benefits and limitations of remote consultations in paediatrics are shown in Figure 1.

Gaps in understanding of benefits and risks associated with telemedicine must be addressed by robust research and quality improvement work, and it is imperative that children and young people contribute to such programmes. Expressed simply, a patient with stable long term disease, known to a clinical team and with access to good equipment and internet connectivity is likely to have a positive and safe experience of telemedicine but this will not be the case for all patients.

Many professional bodies including The Royal College of Paediatrics and Child Health (RCPCH) have produced guidance for conducting remote consultations with children and young people. Children and young people themselves have worked in partnership with RCPCH to publish 6 key areas for doctors to consider when conducting remote consultation (Box 1).

Education and training of undergraduate medical students and postgraduate medical trainees has been significantly impacted by the pandemic. Telemedicine safely delivered by a range of technologies, including novel immersive technologies, can provide new educational opportunities which we highlight in this paper.

There has been a dramatic rise in publications related to telemedicine, highlighted by the devotion of a full special issue of Pediatric Clinics of North America to the topic. In this review we will consider key principles for practising medicine remotely in...
paediatrics, and consider novel technologies that may support future healthcare delivery, education and training.

Remote out-patient consultations in paediatrics

Governance
The clinical consultation is the key tool supporting delivery of healthcare delivery for centuries. As with traditional face to face clinical interactions, the same principles of clinical governance apply when interacting with patients remotely. In this time of technological accessibility it can be very tempting to engage with patients quickly using personal accounts on platforms such as WhatsApp. Such platforms are accessible to patients but although this platform is secure with end-to-end encryption it is not private and as such makes a personal profile and telephone number accessible. Therefore the use of such tools should be avoided. In the UK only NHS or other regulator approved platforms should be used. Devices such as smartphones and computers should be set up to ensure patients cannot access personal information. If clinicians have to contact patients using a personal device it is important to withhold the number prior to contacting families. Instructions on how to do so are readily available.

If contacting patients by email only professional addresses and contact telephone numbers should be provided, ideally from a shared mailbox. If faced with a “friend” request from a patient, clinicians must not accept. Should such a request be made this should be addressed with the patient or family to explain that it falls outside professional boundaries and should be declared to relevant supervisors or line managers.

Modalities
When conducting a consultation remotely it is important to consider the most appropriate method i.e. telephone, video or e-consultation. Scheduling remote consultations in advance with pre-arranged appointment times is preferable for both patient and clinician. When conducting a remote consultation it is important to prepare in advance with a simple checklist summarized in Figure 2. A well-lit quiet room, good quality microphone and webcam can hugely improve the experience for patients and clinicians.

Readers are encouraged not to consider telemedicine as a like for like replacement of conventional face to face consultations. For instance, five brief interactions spread over time instead of one longer interaction may be beneficial in some clinical situations. In other contexts, mixing modalities – i.e. 20 texts

Box 1

Six key areas identified by children and young people for doctors to consider when conducting remote consultation.

1. Reassure us about how it will work
2. Give us choice of how to talk with you
3. Help us to keep it private when we are at home
4. Help us to prepare for our virtual appointment
5. Make it easy for people without good WiFi access
6. Make it clear and simple about how we get help when we need it

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Figure 1 Summary of the benefits and limitations of remote consultation in paediatrics.

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For instance, five brief interactions spread over time instead of one longer interaction may be beneficial in some clinical situations.
augmented by an artificial intelligence (AI) Chabot support tool and 5 minutes of telemedicine conversation may be far superior to 1 single appointment.

**Technical setup**

A good technical set up is key to getting the best from a telemedicine consultation. If you are conducting a video consultation then using 2 screens side by side is a good way to ensure you are able to access information whilst engaging with the patient. One screen with a web cam at eye level for use of secure video consultation software, (“Attend Anywhere” is a commercial platform widely used in the UK), the electronic patient record (if available) or other relevant information can be open on the second screen (Figure 3). The video consulting platform will invite patients to join a virtual waiting room from where they can be called into the consultation by the clinician. The video consultation platform will allow multiple attendees so patients can access multidisciplinary/multi-speciality consultations which can also be observed by undergraduate students or postgraduate trainees.

**Sound and video**

Sound quality is a key element of any telemedicine application. As high-quality speakers, earphones and microphone as possible will improve the experience for patient and professional. Where possible, conduct the consultation in a private room where you will not be overheard and minimize background noise. This has the additional benefit of meaning you don’t have to wear a headset whilst conducting the call which can appear strange to children and their families. We realize that in practise this can be challenging as clinic space can be very limited, it may be worth acknowledging your unusual appearance with the child if you are wearing a headset.
An external HD camera of 1080P/4K is ideal and will in most cases be a higher specification than the built-in camera of standard monitors/laptops camera. Positioning the camera at eye level and maintaining eye contact is critical. Cross light is ideal and avoid strong lighting in front/behind the screen.

**Connectivity**
A wired internet connection or 5G is usually ideal to minimize the risk of any connectivity issues. Many professional and patients however will be using Wi-Fi or 4G connections which may be less effective. Conducting the consultation from a desktop on the hospital site often ensures a wired connection. If a laptop is used, work where possible in a space where you can connect an Ethernet cable. Connectivity issues during a remote consultation must be documented in the patient notes. Connectivity issues may impact on the patient side also, so being able to switch from video to telephone consultation may be necessary.

**Location**
When conducting a video consultation, it is important to think about your surrounding environment. Your patient will be able to see not only you, but also where you are sitting. This may be particularly relevant if working from home. Dress as you would for a face to face appointment. If working from home, avoid an environment that has large amounts of personal items in the background, these can be distracting and can give patients an insight into your personal life that may not be appropriate. Platforms such as Zoom and MS Teams can enable blurring of backgrounds or enable alternative images to be used from a library. This can be enhanced by hanging a physical screen of a solid colour (often white) behind the clinician. Users may wish to experiment with this technique to establish a more professional background appearance. This is unlikely to be necessary when working in a healthcare building.

**The actual consultation**
Core principles underpinning good medical practice apply to remote consultations including:

- Ensure patient/carer consent
- Ensure patient safety is maintained throughout
- Clinicians must practice within their competency with appropriate supervision
- Accurate contemporaneous notes must be kept in the patients’ health record.

**Conducting a remote consultation**

| Consultation step | Actions |
|-------------------|---------|
| Initiating the session | Establish rapport by greeting patient and carer and introducing self (“Hello my name is ...”), role in the care team and reason for the consultation. Ensure consent is given to proceed. |
| Recommendations: | |
| 1. All clinicians require training and develop skills over time in a supervised environment |
| 2. Look at camera when talking and listening to establish eye contact. |
| 3. Consider the “patient side” lighting and environment. It may be necessary to move a patient and/or their device to optimize what the clinician sees e.g. ask the young person and/or parent move from a sofa to a table. |
| 4. Adolescents have their own specific health care needs and clinicians must be aware there may be issues they do not wish to discuss with parent/carer present. This must be managed and documented in exactly the same way as in a face to face consultation. |
| Information gathering | Active listening to the patient and carer’s explanation of the problems. |
| Recommendations: | |
| 1. Use open and closed questions, listen “actively” allowing patients time and space. |
| 2. Develop a “monitor side manner” to facilitate patient’s responses and actively look for verbal and non-verbal cues from the patient. This may be more challenging than face-to-face consultations. |
| 3. Clarify and summarize information in exactly the same way as face-to-face consultations. |
| Build the relationship | Maintain eye contact, facial expression and posture/movement to encourage communication and sense of rapport with patient. Empathy and support remain key principles. |
| Recommendation: | |
| 1. If using 2 screens ensure patient is aware how this is supporting the consultation e.g. note keeping, information gathering from other sources. |
| Explanation and Planning | Same principles for face to face consultations apply to ensure the patient and carer achieve a shared understanding of the problem and decisions made |
| Closure | Summarize and clarify plan of care moving forward. |
| Recommendations: | |
| 1. Establish safety netting guidelines and empower the patient to be aware of signs and symptoms requiring return of seeking urgent care |
| 2. THINK...has the clinician considered safeguarding principles. A low threshold for switching to face to face will be needed if there are safeguarding concerns or non-attendance and documentation must be clear |

Table 1
Traditional consultation models can be easily adapted to provide a structure to remote consultations as per face to face interactions. There will always be some limitation and challenge picking up subtle cues from patients which clinicians can overcome by considering the clinical context and mitigate to a point with training and experience. An overview is presented in Table 1.

### Examining children remotely

Whilst there are challenges, children can be examined remotely using a variety of techniques. As with face to face consultations the approach to examination will be clinical context driven whether in an acute (including primary care) or secondary chronic care setting. Examination can be helped support by the use of clinical photographs shared by patient and carer.

Always explain to the patient what you are doing, for example “I would like to assess how your joints are working by watching you walk.”

Begin by making an overall general inspection of the patient, noting for example:

- Where are they i.e. within the home or elsewhere?
- Ask the patient to move within their location to a site with better lighting if necessary
- Do they appear very unwell?
- Assess their overall behaviour, is it age and developmentally appropriate?
- Do they appear distressed or in pain
- Does the patient have any self — monitoring devices e.g. pulse oximeter, blood glucose device, thermometer, peak flow device, weighing scales, BP machine, and urine dip-sticks? Guide patient where necessary in taking observations.

- Use pain assessment scales

It is inevitable that in a number of situations it will not be safe to rely on remote clinical examination and a patient will need require face to face review with urgency dependant on clinical context. An overview of remote examination by system is shown in Table 2.

### Clinical photography

Patient images can be a valuable aid to remote consulting. Photographs taken under natural light without camera flash are generally of better quality. Informed consent must be obtained from patient/carer including an understanding of what the image will be used for, for example “storage within your electronic health record.”

Secure transfer and storage of patient images is mandatory and should be via an appropriate image transfer portal rather than email or tools such as WhatsApp.

### Telemedicine and multidisciplinary working

New digital solutions providing a telemedicine interface allowing coordinated and effective MDT working has transformed clinical practices since the advent of the COVID-19 pandemic. A schematic representation of multidisciplinary working is shown in Figure 4 which could be applied to many clinical scenarios.

### Using telemedicine to conduct clinical examination

| System being examined       | How telemedicine can be used                                                                 |
|-----------------------------|---------------------------------------------------------------------------------------------|
| Musculoskeletal system (MSK)| The MSK system can be assessed by inspection of function observed using active movements, supported by some passive techniques such as asking the patient/carer to describe how particular areas or feel to touch e.g. a site of swelling. Patient guidance can be provided by demonstration by the clinician. The Virtual-pGALS (V-pGALS) is an adaptation of pGALS (paediatric Gait Arms Legs Spine), an approach to basic musculoskeletal assessment widely taught to medical students, primary care and paediatric physicians. |
| Cardiovascular system       | Remote examination is primarily limited to inspection and observation of the patient (for example looking for cyanosis and assessment of work of breathing) and can be supported by equipment such as pulse oximetry and blood pressure measurement if available to the patient. The patient may be able to tap out their pulse and count the rate. Technology to provide tele-auscultation with digital stethoscope is commercially available but not yet sufficiently evaluated to recommend in routine telemedicine practice. |
| Respiratory System          | Examination allows observation of rate and work of breathing, supported by pulse oximetry if available. Look for use of accessory muscles and listen for stridor, wheeze, grunting and hoarseness of voice. Ask the patient to cough. Use of home spirometry or peak flow devices can be helpful. |
| Gastrointestinal system     | An overall impression of nutritional status can be observed e.g. overweight or thin. This can be difficult on camera alone and may be supplemented by parental, home measurements. General observation can be used to assess hydration status. A caregiver could be directed to palpate the abdomen for tenderness. |
| Neurology                   | Remote examination is limited to a basic functional screen of power, active movement and coordination. Cranial nerves can be partially examined as can cerebellar signs. Patients could be asked to walk and may demonstrate certain gaits e.g. tip-toe walking Any neurocutaneous markers could be inspected via video. |
| Dermatology                 | Inspection of lesions in a video consultation can be augmented by good quality photographs. Direct patient and carer when moving a camera to view a particular area. |
| ENT                         | Tonsils can be inspected and the neck observed for any obvious swelling. |

Table 2
Environmental benefit of telemedicine

There are also non-clinical benefits to using telemedicine to conduct remote consultations and multidisciplinary team meetings. Reducing the travelling that patients and clinicians have to do reduces their carbon emissions and therefore is vital in terms of trying to support the Greener NHS campaign launched by the NHS in January 2020 and contribute to the goal of delivering a “net-zero” National Health Service. The commitment to better use technology may make up to 30 million outpatient appointments redundant, sparing patients thousands of unnecessary trips to and from hospital. It is estimated that 6.7 billion road miles each year are from patients and their visitors travelling to the NHS.

Mobile robotic telemedicine

Telemedicine allows face-to-face contact between a clinician, often a specialist, and a patient in a hospital setting that may not have been previously feasible. Robotic telepresence (RTP) is being utilized in our institution in the neonatal surgical unit (Figure 5). This meets the increasing demand for rapid clinical interactions between patients and specialists around the clock without need for time consuming and costly travel between hospital sites. RTP machines are linked to the remote specialist via the internet and have synchronous bidirectional audio and visual communication capabilities with zoom and a digital camera for image capture. In addition, the video screen is able to move as per the requirement of the specialist while caring for patients.

Remote patient monitoring

Remote patient monitoring (RPM), including the capture of biometric data from indwelling or wearable devices, can be utilized in many clinical settings. Beyond height and weight remote patient monitoring systems that collect biometric data are now widely available and include Electrocardiogram (ECG), Electroencephalogram (EEG), oxygen saturation using pulse oximetry, blood pressure, body temperature and blood glucose levels. Continuous glucose monitoring and monitoring of cardiovascular implantable devices are examples of many potential applications of RPM shown to be beneficial to clinicians and patients alike. In our own institution, patients with Type I diabetes mellitus use a digital solution to record clinical data including blood glucose levels.

Figure 4 Schematic for Regional Network MDT working using telemedicine.

Figure 5 Remote consultation on the paediatric neonatal surgical unit.
readings which is accessible by the clinical team as outlined in Figure 6.

**Immersive technology**

Immersive technology, also referred to as extended reality (XR), enables users to combine digital experiences within the physical world providing new ways of care delivery and also provides education and training opportunities. The technology exists in the form of Virtual Reality (VR), Augmented Reality (AR) and Mixed Reality (MR).

There are many providers of XR technologies. Our institution has deployed XR with Microsoft HoloLens2 into daily clinical...
practice as a point-of-service communication platform in the clinical setting for patient review (e.g. ward rounds), multidisciplinary team meetings, surgical skills training in theatre and medical education.

The Microsoft Hololens glasses provides AR as a wearable holographic computer that permits heads up interactive 3-dimensional (3D) visualisations of medical images and electronic health record data which can support medical and surgical procedures (Figure 7). Bidirectional communication using HoloLens with Dynamics 365 Remote Assist uses Microsoft Teams to send a secure live video-feed to a remote computer, allowing students to follow the visual field of a tutor while remaining at a safe distance (Figure 7).

Mass deployment of AR is limited by cost, with VR headsets offering a more cost-effective option for technical skills training. Cross sectional imaging from patient’s computerised tomography (CT) and magnetic resonance imaging (MR) scans can be presented alongside anatomical images in 3D to aid surgical training.

## Telemedicine and medical education

Undergraduate and postgraduate medical education has been significantly impacted by the COVID-19 pandemic. In the UK medical student placements in hospital were suspended for long periods limiting contact between students and patients and health care professionals. As medical student placements return new regulations including social distancing continue to impact on learning opportunities from face to face interactions. Lectures and small group learning switched to online and various digital platforms have been able to support this very effectively.

Postgraduate medical training has equally been affected. In order to improve the number of educational opportunities available to trainees and to allow them to meet competencies without

| Remote working activities | Relevant platform(s) required | Example curriculum domain | Supervision/Metrics |
|---------------------------|-------------------------------|--------------------------|---------------------|
| **CLINICAL ACTIVITY**     |                               |                          |                     |
| Remote telephone/video clinics | Access to electronic patient records remote dictation and prescribing, clinical guidelines | Professional Values and Behaviours | Clinical and educational supervision real-time within the digital platform, or post session in supervision meetings |
|                           | Access to suitable platforms such as Attend Anywhere for video consultations | Communication, Patient management, Health promotion, Leadership and team working, Patient safety, Safeguarding | Evidence of learning in e-portfolio or other training log |
|                           |                               |                          | Adaptation of existing supervised learning events eg case based discussion/mini CEX and development of bespoke tools |
| Teleconferencing to support clinical care, for example multidisciplinary meetings such as clinical-radiology meetings | Access to meeting platforms such as Microsoft Teams/Zoom | Patient management, Education and training |                     |
| **TEACHING**              |                               |                          |                     |
| 1. Attending and delivering remote teaching sessions | Access to meeting platforms such as Microsoft Teams/Zoom | Education and training | Feedback from teaching |
| 2. Online learning modules/webinars/courses | Interactions can be facilitated by use of chat functionality |                          | Evidence of attendance/completion |
| **GOVERNANCE**            |                               |                          |                     |
| Developing new or updating existing clinical guidelines/SOPs | Access to existing guidelines/SOPs | Quality improvement, Patient safety, Leadership and team working, Communication, Grid subspecialty curriculum | Regular communication with appropriate supervisor |
| Developing new or updating existing patient information resources | Access to existing resources |                          | Ability to attend relevant meetings to share and discuss outcomes |
| Clinical audit            | Access to relevant patient notes/data |                          | Completed projects recorded on ePortfolio |

SOPs, standard operating procedures; WBAs, work-based assessments.

Table 3
the need to extend their training, innovative approaches need to be utilized. In 2021 telemedicine is already complementing existing education programmes but work is needed to formally develop and evaluate new curriculum content, bespoke assessment tools and delivery of remote educational supervision.

Multi-disciplinary team meetings can be delivered over virtual platforms, facilitating patient care and widening access to educational opportunities for example to those working remotely in network hospitals or from home.

Remote working and learning activities and how they can be supported by telemedicine are shown in Table 3.

A trainee can be directly supervised conducting a video consultation and receive real-time or delayed feedback. Supervised learning events such as a Mini-cex or Case Based Discussion can be adapted for supervision in the context of remote consultation but there is a need to develop bespoke assessment tools in this context. This is a way of working that is likely to continue once the current pandemic has passed and therefore it is important that trainees are trained and assessed in this area of practise as they would be traditional learning environments. We note the Royal College of General Practitioners (RCGP) use a consultation observation tool to assess the ability of trainee to conduct a remote consultation as part of telephone triage, telephone consultation or working out of hours. Such assessment tools must be developed across different speciality curricula to reflect new ways of working and learning.

Telemedicine can allow trainees to attend multi-disciplinary team meetings (MDTs) not previously available. For example MDTs taking place off site or in a small space have previously meant these educational opportunities were not available and platforms such as MS Teams allow trainees to join remotely and observe and get involved in the meetings without adding to the number of people in a room or having to travel to a different site.

Telemedicine technologies can be of benefit for larger scale education. For example an online interactive learning wall such as PADLET (https://en-gb.padlet.com/) can be used to post webinars, videos of simulations or slides from pre-recorded teaching sessions in order to allow trainees to access the content remotely at a time of convenience. Learners can engage with this platform on an ad hoc basis and as such maximize their time and learning opportunities.

Conclusion

Reflecting on changes driven by the COVID-19 pandemic, paediatricians in the UK have identified use of remote technology, particularly for triage and out-patient work as a key change and something to hold onto now and in the future. Change in practice must be introduced, evaluated and refined with input from children and young people and must ensure patient care is not compromised. Telemedicine will never totally replace the need for face to face interaction between caregiver and patient but may offer more than a live interaction and the potential for innovation and new technology is almost without limits.

The future of telemedicine is difficult to predict, but we feel that it will become regarded as basic medicine without requiring the tele prefix. As time progresses the advances in cameras, machine vision and connectivity will allow the lens to see more than the simple human eye. Allowing for the detection of greater clinical subtleties than can be seen and providing insights to both emotional and physiological states. Simply put, rather than dehumanizing the clinical experience, there is potential to become more than human.

We should take this opportunity to improve patient outcomes and experiences by using technology to provide high quality clinical care, minimize the need for multiple appointments in numerous locations and also to improve communication. It is important that educational opportunities provided by telemedicine are not overlooked; medical training will need to adapt to reflect the expanding use of telemedicine within our consultations. Ongoing innovations in the field of immersive technology are likely to continue to expand our ability to effectively review patients remotely.

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