Survey of Mobile Device and Medical App use in Emergency Care.

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Abbreviations

AAEMÖNK	Austrian Association of Emergency Medicine - Österreichische Vereinigung für Notfallmedizin
ALS	Advanced Life Support
APLS	Advanced Paediatric Life Support
BNF	British National Formulary
BNFc	British National Formulary for Children
DIGNA	Deutsche Gesellschaft Interdisziplinäre Notfall- und Akutmedizin
ED	Emergency Department
EM	Emergency Medicine
MHRA	Medicines and Healthcare products Regulatory Agency
n/a	not applicable
ÖNK	Österreichische Vereinigung für Notfallmedizin und Katastrophenmedizin
PEM	Paediatric Emergency Medicine
PERUKI	Paediatric Emergency Research United Kingdom and Ireland
RCEM	Royal College of Emergency Medicine
RCPCH	Royal College of Paediatrics and Child Health
Resus	Shock room
SGNOR	Schweizer Gesellschaft für Notfall- und Rettungsmedizin
UK	United Kingdom
USA	United States of America
WETFLAG	APLS aged based calculation for the estimation of Weight, Energy, Endotracheal Tube, Fluids, Lorazepam, Glucose of a child

1 Zusammenfassung

1.1 Einleitung

Die Verwendung von Mobilgeräten und Apps ist in der Bevölkerung weitverbreitet. Die Benutzung dieser Technologie erlaubt den jederzeitigen Zugriff auf Informationen (Beispiele: Internet, Emails, Apps) wie das zuvor nie möglich war. In Großbritannien ist die Benützung dieser Technologie bei Assistenzärzten als Teil ihrer Arbeit und der Patientenbetreuung weitverbreitet. Im medizinischen Bereich hat sich die Verwendung dieser Technologie als eine positive Entwicklung in der Patientenbetreuung gezeigt. Diese Revolution fing mit der Einführung des Apple iPhone 2007 an. Der nächste entscheidende Schritt war die Eröffnung des Apple Appstore 2008. Dieser erlaubte das Herunterladen von spezifische Softwareprogrammen sogenannten “Apps” von einem Online-Geschäft und andere Unternehmen folgen bald darauf mit ihren eigenen Apps und Geschäften.

1.2 Ziele der Arbeit

Momentan ist nicht bekannt wie weit diese Technologie in der Notfallmedizin verbreitet ist und genutzt wird. Ziel dieser Arbeit ist die momentane Rolle von Mobilgeräten und medizinischen Apps in der Notfallmedizin im englisch- und deutschsprachigen Raum in Europa zu beschreiben und eine Übersicht zu bekommen wie medizinische Fachkräfte diese Technologie in ihrer täglichen Arbeit in der Notfallmedizin einsetzen.

1.3 Methodik

Eine web-basierte Umfrage (www.surveymonkey.com) wurden durchgeführt. Der erste Teil der Umfrage beschäftigte sich mit Richtlinien zur Benutzung und der Bereitstellung dieser Technologie an den einzelnen Institutionen im PERUKI Netzwerk. Der zweite Teil der Umfrage befaßte sich mit der Benutzung dieser Technologie durch einzelne medizinische Fachkräfte. Die Umfrage wurde durch den RCEM Newsletter, RCEM Website, soziale Netzwerke, das PERUKI Netzwerk und die deutsche Version durch die AAEMÖNK, DIGNA, ÖNK und SGNOR verteilt.

1.4 Ergebnisse

In der Umfrage wurde keine Schäden durch die Benutzung von medizinscher Apps gemeldet. Apple Geräte stellen den Großteil (70%) der institutionellen Mobilgeräte im PERUKI Netzwerk da und waren auch für individuelle Fachkräfte der meist benutzte Mobilgerätetyp. Die meisten Institutionen stellen zwischen eins bis fünf medizinische Apps

per Mobilgerät bereit. Die medizinischen Fachkräfte hatten die gleiche Anzahl von medizinischen Apps auf ihrem persönlichen Mobilgerät. Die BNF/BNFc Kompendium App war, die am meist installierte und empfohlene App in beiden Umfragen. Die Benützung von medizinischen Apps war hauptsächlich eine Frage der persönlichen Entscheidung.

1.5 Diskussion

In der Umfrage wurde kein Schaden durch Benutzung dieser Technologie gemeldet. Das Potential dafür läßt sich jedoch nicht ausschließen. Die Registrierung von medizinischen Apps als medizinische Geräte, zum Beispiel mit der MHRA ist eine Möglichkeit dies zu überwachen. Apple war der leitende Hardware Hersteller in der Umfrage. Dies hängt wahrscheinlich mit der langjährigen Vorreiter Stellung von Apple zusammen. Wie auch in vorherigen Studien waren im Durchschnitt eins bis fünf medizinische Apps pro Mobilgerät installiert. Das zeigt das die folgenden fünf am meisten installierten App Typen: Referenz, Reanimation, Kompendium, Antibiotikareferenz und medizinischer Rechner App, die am nützlichsten in der Notaufnahme sind. Die BNF/BNFc Kompendium App, war die am meisten installierte und empfohlene App. Fast die Hälfte der Fachkräfte benützen ihr persönliches Mobilgerät täglich um Medikamentendosen zu kontrollieren. Ungefähr ein Drittel der medizinischen Fachkräfte und ein Drittel der Einrichtungen benützen medizinische Apps in der Kinderreanimation. Im Vergleich zu 2008, als diese Technologie noch nicht existierte, deutet all dies auf eine größere Rolle von medizinischen Apps in der Notfallmedizin hin.

1.6 Schlußfolgerung

Eine Kompendium App war die am meisten verbreitete App. Die Benutzung des persönlichen Mobilgerätes um Medikamentendosis zu kontrollieren ist weitverbreitet und eine akzeptierte Methode in englisch und deutschsprachigen Ländern in Europa. Ein Drittel der Befragten benützen medizinische Apps während der Kinderreanimation. Diese Entwicklungen müssen sich in den lokalen und nationalen Richtlinien zur Benutzung dieser Technologie wiederspiegeln. Entwickler von Apps müssen wissen welche Mobilgerätetypen am meisten genutzt werden. Zulassungsstellen von medizinischen Apps müssen sicherstellen, das diese unabhängig von Geräte- und Herstellertyp benützt werden können. Seit der Entwicklung dieser Technologie 2008, haben Mobilgeräte und medizinische Apps neue Herausforderung und Möglichkeiten geschaffen, um die Patientenversorgung zu verbessern.

2 Abstract

2.1 Introduction

The use of mobile devices (smartphones and tablets) and apps is widespread in the general population. The use of these devices allows on-the-go access to information ranging from internet, apps and email like never before. The use of this technology as part of patient care is common among junior medical staff in the UK. In healthcare the use of mobile devices and medical apps has been shown to be a positive development in improving patient care. This revolution started with the release of Apple's iPhone in 2007 signalling the birth of the smartphone. The next pivotal step was the launch of the Apple Appstore in 2008. This allowed users to download specific software applications "apps" from an online shop and other companies soon followed with their own offerings.

2.2 Aims

Currently little is known how this advance in technology is applied to emergency care. The aim of this work was to investigate the current role of mobile device and medical apps in emergency care in English and German speaking countries in Europe and to provide an overview of how departments and individual clinicians engage with this technology as part of their daily work.

2.3 Method

A web-based self-report survey (www.surveymonkey.com) was performed. The first part of the survey investigated departmental practise and was distributed via the PERUKI network. The second part of the survey looked at individual clinicians' practise and was distribute via various channels including the RCEM newsletter, the RCEM website, the PERUKI network and social media. A German language version of the individual clinician survey was distributed via AAEMÖNK, DIGNA, ÖNK and SGNOR.

2.4 Results

Neither parts of the survey reported any harm from medical app use. Apple devices accounted for the majority (70%) of institutional mobile devices in the PERUKI network site survey. Apple devices were the leading device choice for individual clinicians too. In the site survey most sites provided between one to five medical apps on the institutional mobile device, similarly most individual clinicians had between one to five medical apps on their

personal mobile device. The leading five medical app categories were: medical reference app, compendium, microbial guidance, resuscitation and medical calculator app. The BNF/BNFc formulary app was the leading provided and recommended medical app in the site survey. In the individual clinician survey this was also the leading medical app on individuals' personal mobile devices and the most recommended medical app. The use of medical apps was up to personal clinician choice in both surveys.

2.5 Discussion

Whilst no harm has been reported from this technology in our survey, this does not exclude the potential for harm. Registration of medical apps as medical devices with for example the MHRA is one way to monitor for harm.

Apple was the leading hardware producer in all survey. The most likely reason for this is that Apple has been historically between the market leader. As in previous surveys there are generally no more than five medical apps installed per mobile device. This probably reflects that the following five medical apps types: medical reference, formulary, antibiotic reference, resuscitation and medical calculator app are the most useful in emergency care. The BNF/BNFc formulary app was the most common installed and recommended app in both surveys. This is also reflected in that nearly half of the individual clinicians said that they use their mobile device daily to check a drug dose. Around a third of individual clinicians and a third of sites use medical apps during paediatric resuscitation. All of this points to a greater role of medical apps in emergency care when compared to 2008, when none of this technology existed.

2.6 Conclusion

In the surveyed population in English and German speaking countries in Europe, the use of a personal mobile device to check drug doses is widespread. This is also reflected in that the BNF/BNFc formulary app was the leading app installed on mobile devices. A third of respondents use medical apps during paediatric resuscitation. This change in practise needs to be reflected in national and institutional policy.

Developers need to be aware of the most commonly used devices. Equally when being licensed, bodies must ensure apps can be accessed equitably by all clinicians independent of device.

In summary since the launch of this technology in 2008, mobile device and medical apps use in healthcare has resulted in new challenges and opportunities to improve patient care.

3 Introduction

An app, derived from application is a software program that can be run on any hardware platform (1). It is a term used for programs, which run on mobile devices for example smartphones or tablets. Medical apps are specific software programs used in healthcare ranging from formulary and reference apps to medical calculators.

The use of mobile device technology is currently an expanding field in emergency care, it is therefore important to know how institutions and clinicians use mobile devices, mobile device functions and apps as part of patient care. A previous study of junior medical staff and medical students showed, that they commonly use smartphones and apps as part of patient care in the United Kingdome (2). In healthcare the use of this technology has been shown to be a positive development, improving patient care by allowing immediate access to medical and health care information, improving decision making, potentially reducing the number of medical errors, and enhancing telemedicine capabilities (3-6).

The ever-evolving mobile device technology has resulted in an unrivalled ability to access and disseminate up-to-date information at exceptional speed across a chosen population. New apps are relatively easy to produce and release and allow rapid development and adaptation. A myriad of apps relevant to healthcare professionals are available from online stores, ranging from specialist communication apps, formularies, clinical decision tools and aids, guidelines and textbooks.

As an example previous work from the USA showed, that the App Store's "Medical" Category contains about 20000 apps, of these only about 6.9% were clinically relevant. This is just under 0.1% of the overall App Store offerings (7). This shows that with multiple offerings it can be tricky for clinicians to find the right app on the App store. However even if one has found an app, they may not be able to install it on their device, as not all apps are available both as the Apple IOS and Android apps. Mobile device choice will influence what app they can install on their device. It is therefore important to know which apps clinicians have currently installed on their mobile device, which are their favourite ones and, which they would recommend to others

Apps like any other reference aid developed in one setting may not work in another, because of differences in disease patterns and international, national and regional policy,

similar to any guideline or guidance applied blindly. It is therefore important to know which apps clinicians actually use.

The rapid and organic growth of this new technology can result in new concerns and challenges. For example, patient's personal information being exposed to online attacks and lack of quality control. The use apps and mobile technology might also be in conflict with existing institutional and healthcare policies and guidelines, restricting the use of mobile devices at the bedside. Clear guidance how to use this technology is key to protect the patient's personal information, confidentiality and to protect users, i.e. clinicians from litigation. At the same time it is important to monitor for harm caused by the use of this technology similar to the introduction of any other new medical device or advance in therapy.

An area where medical apps may be highly beneficial is in prescribing, especially paediatric prescribing. Medication errors are more likely to harm children than adults (11). This also reflected in that the BNF/BNFc formulary app is the most popular medical app in the UK (8-10). Studies looking at simulated paediatric resuscitation at major paediatric teaching hospitals have found that medication errors commonly occur during all stages of paediatric resuscitation. In one study, only analysing syringe content identified these errors, suggesting that such errors, may be a major unrecognised source of morbidity and mortality during resuscitation in children (12, 13).

Trials of simulated paediatric resuscitation have shown that the use of reference books and charts, providing weight-based pre-calculated doses all decreases drug dose errors, especially 10-fold errors, which could be potentially fatal for a child (14).

The newest development are resuscitation aids are resuscitation apps which include the Mersey Burns (5), NeoMate (15) and PaediatricEmergencies (16) app. The use of the PaediatricEmergencies related PICU calculator app has been shown to be superior in paediatric inotrope prescribing compared to using the BNFc hardcopy, with even medical students outperforming paediatric consultants (3).

The rarity of cardiac arrests in children, weigh-based prescribing, unfamiliarity with the equipment and guidelines, all add to increased cognitive load during the management of critical unwell children. The more complex and non-automatic a process is, the greater the

cognitive load. Increased cognitive load leads to an increased potential for error and inaccuracy, and decreased retention of skills (17, 18). These factors can adversely affect both outcome for the patient and learning for the clinician. Mobile device and medical apps may decrease cognitive load by decreasing the need to perform complex calculations during paediatric resuscitation, prescribing, and making up infusions. This could be quantified in the time it takes to get the medication prescribed and made up, and also by analysing syringe content to ensure the actual right concentration is given (3, 12, 14) .

Currently no study has addressed the use of mobile devices and apps as part of emergency care in paediatric and adults, nor described their benefits and potential risks. Nor has any study addressed, which aids are commonly used in prescribing and resuscitation.
To guide best adaptation of this potentially beneficial technology, more knowledge about how clinicians use apps and mobile devices as part of patient care is essential.

4 Aim

The use of mobile devices and apps is widespread and has the potential to significantly improve patient care. A better understanding of usage patterns is required to ensure these technology advances are embraced in the best possible manner. To achieve this, the aims of this study are:

1) Explore risks or harm that has been observed from these technologies. As with any change or evolution in practice it is important to monitor for harm. The aim is to investigate if any harm has a resulted from the use of mobile devices and medical apps and to explore any other risks that may have arisen from the use of technology.

2) Assess current policies on apps and mobile devices and how they affect use at the bedside. A review of the literature has revealed that there are possible inconsistencies between policies and actual use by clinicians. Departmental and institutional policies are key in shaping and supporting any change in healthcare. The aim is to explore existing guidelines and guidance for app usage as well as usage patterns and to provide insight of how apps can be best used in healthcare. Equally we are investigating the main barriers and enablers in the adaption of this technology especially from a departmental view focusing on the infrastructure provision to run the devices and the provision of apps by the institution.

3) Assess how technology is used in emergency care. The aim is to gain better understanding how both departments and individual clinician use mobile devices and medical apps as part of emergency care. As the use of medical apps is currently and expanding field, we want to know how clinicians are actually using their mobile device and apps in their day to day practise in emergency care, as this may have an influence on patient management decisions and patient safety.

4) Create an overview of the which mobile devices and apps are recommended and actually used. The aim is to explore which mobile device and which medical apps clinicians actually use and are provided or recommended by the different

departments. Different mobile device platforms e.g. Apple IOS and Android only allow the installation of apps specific to their platform. Not all apps are available to run on both platforms. We therefore want to know which mobile device clinicians and institutions use as this may influence the apps choice and use of this technology. Previous work has shown that it can be difficult for individual clinicians to find relevant medical apps, we therefore want to provide a current overview of the commonly used and recommended medical apps. Certain hospitals and organizations have commissioned and developed medical apps. We want to investigate this process further.

5) Investigate the practical application of mobile device technology in prescribing and resuscitation. The literature has shown that the *BNF/BNFc* app has been the favourite medical apps used by clinicians in the UK (8, 19). We want to explore how apps are used prescribing in comparison to more traditional aids e.g. hardcopy formulary books. There always has been an abundance of use different aids in paediatric resuscitation ranging from the use of the WETFLAG calculation, Excel Crib sheets, etc. to the Broselow tape. We want to compare the advance in technology with these more traditional aids in both adult and paediatric resuscitation. This will also provide us with an indication of how widely this technology is used in our setting. At the same time, this will give us an indication in which areas of prescribing and resuscitation this advance in technology might be helpful and highlight any differences between adult and paediatric practice.

To achieve this, a two-stage survey will be performed:

(a) A stage (i) site survey of the PERUKI network sites to establish current departmental practice
(b) A stage (ii) individual clinician survey to assess how individual clinician use this technology in everyday clinical practice.

The two-stage survey approach will allow us to compare departmental with individual clinician practice.

5 Method

To investigate the use of mobile devices and medical apps in emergency care both from a departmental and individual clinician perspective a two stage survey was performed in 2017. The stage (i) survey investigated departmental practise. The stage (ii) survey investigated individual clinician practise. The surveys consisted of multiple choice questions and open textboxes allowed respondents to discuss any further issues (see appendix 3). The surveys were designed by the lead researcher and developed from previous literature examining mobile device and medical app use by clinicians and medical students (2, 6, 20). An expert panel reviewed the questions for content, validity, and reliability. A pilot survey was undertaken at one PERUKI site. Refinements were made during multiple iterations, with input from the study team and the PERUKI Research Steering Committee, before arriving at the final version. The two surveys were performed using a web-based survey platform (www.surveymonkey.com).

5.1 Stage (i) site survey

This survey investigated departmental practise at the PERUKI sites. The survey was disseminated via the PERUKI research network to all 54 PERUKI centres. At each PERUKI site, the site lead investigator (typically a consultant (attending) in Paediatric Emergency Medicine) was asked to complete a web-based self-report questionnaire. The PERUKI survey was open from the 31/07/2017 to the 02/09/2017.

Data was collected in the following areas: basic demographic data of respondents, mobile device policy and infrastructure (Harm, mobile device policy and guidance, free Wi-Fi access, barriers and enablers to medical app use, institutional mobile device provision and medical app provision, medical app provision on institutional device, institutional recommended medical apps to download, designed and commissioned apps, prescribing and resuscitation in children and adults). A copy of the survey is provided in Appendix 3.

5.2 Stage (ii) individual clinician survey

This survey explores individual clinician practise. The survey was displayed on the RCEM website, shared in the RCEM newsletter and via the co-collaborators twitter feeds. It was also disseminated to all 54 PERUKI site lead investigators, asking them to distribute the survey to their staff (medical and allied health professionals) to complete. The survey was

open from the 17/07/2017 to the 14/01/2018 (displayed on RCEM website from the 17/07/2017 until the 17/12/2017). The German language version of the survey was distributed via DGINA, AAEM, ÖNK and SGNOR for their members to complete. The German language survey was open from the 08/10/2017 to the 21/01/2018. Data was collected in the following areas: basic demographic data of respondents, mobile device policy and infrastructure (harm, wi-fi provision, mobile device type, number of medical apps on personal device, device policy, mobile device use in the clinical setting, type of medical apps, prescribing and resuscitation in children and adults). A copy of the survey is provided in Appendix 3.

5.3 Analysis

Both Excel and Surveymonkey were used to analyse the numerical data. Descriptive statics were used to describe the data. Answers from open ended questions were analysed using excel for single word answers e.g. name of an app. The author also performed semantic coding and organised the remaining responses to the open-ended questions. Quotations are used to illustrate the key themes from these responses.

5.4 Ethics

Both surveys accessed clinicians via a research collaborative to assess their departmental and personal practice. According to the Framework for Health and Social Care Research (UK) (21) both surveys did not require formal ethics review. Consent was implied by participation.

6 Results

6.1 Stage (i) site survey

The study questionnaire was sent to all 54 PERUKI site lead investigators (consultant in paediatric emergency medicine) to complete on behalf of each site. 46 sites completed the survey (completion rate 85.1%). Demographics are listed in table 1.

[redacted] Stage (i) site survey: Harm

No site reported any harm from medical apps use,

[redacted] Stage (i) site survey: Mobile device policy and Guidance

Out of the 46 responding sites, 24 reported that they have a mobile device policy covering both personal and institutional mobile device use in the clinical environment and at the bedside. The other 22 sites did not have mobile device policy.

Of the 24 sites with a device policy, 23 provided further details regarding the use of a personal mobile device at the bedside. At 13 sites it was allowed to use a personal mobile device in the clinical environment. At the other 10 sites it was not allowed. However the ban was only enforced at 4 of these sites and at the remaining 6 sites the use of mobile devices was tolerated in the clinical environment, despite being officially banned according to their mobile device policy.

At the 24 sites with a mobile device policy, the use of an institutional mobile device in the clinical environment was allowed at 22 sites. At the remaining two sites the use of institutional mobile devices in the clinical environment was banned. However these two sites provided an institutional mobile devices and their use in the clinical environment was tolerated.

Out of the 24 sites with a mobile device policy only 6 sites provide guidance on mobile device use, i.e. how the mobile device and medical apps should be used by clinicians as part of patient care. The responses which show a high variation are listed in table 2 and mainly centres around the promotion of institutional apps and device functions.

[redacted] Stage (i) site survey: Free Wi-Fi Access

Free Wi-Fi access is provided at 31 sites. Limited Wi-Fi (e.g. patient Wi-Fi, university Wi-Fi, limited bandwidth, hospital at night team only) is provided at 6 sites. 9 sites did not provide any free Wi-Fi for their staff.

12 sites (39%) that provide free Wi-Fi, have a mobile device policy that allows the use of personal mobile devices at the bedside.

[redacted] Stage (i) site survey: Barriers and enablers to medical app use

Table 3 lists barriers and enablers that have influenced the up-take of medical apps at these sites. The 17 "other" responses are listed at the bottom of table 3.

[redacted] Stage (i) site survey: Institutional Mobile Device Provision and Medical App Provision

37 sites provided information regarding the provision of institutional mobile device to run medical apps. Mobile devices are provided at 19 sites. Some sites offer more than one device or a choice of devices. Apple iOS devices accounted for 70%, Android 23%, and Blackberry for 7% of the provided institutional devices, as shown in Figure 1.

At these 19 sites 9 sites provided no medical apps, 9 sites provided 1-5 medical apps and 1 site provided more than 6 medical apps on the institutional mobile devices.

[redacted] Stage (i) site survey: Medical app provision on institutional device and institutional recommended medical apps to download

Table 4 lists the actual names and types of the medical apps provided on the institutional mobile devices. 20 sites recommended specific medical apps to download. One sited provides training with regards to medical apps by covering their use as part of professionalism during induction.

When interpreting table 4 it is important to keep in mind that recommended apps may be available for both apple and android platforms even if they are only listed for one.

The BNF/BNFc app is the most commonly available medical app on the institutional devices. The most common type of app available on institutional device were medical reference apps, but there is no clear preference for a certain app.

The most recommended medical app is the *BNF/BNFc* app followed by the *RxGuidelines* app, the *Induction* app, and the *Microguide* app. The *Microguide*, *RxGuidelines*, and

Induction app are all apps that can be configurated to local guidelines. For example, in the *Microguide* app the local antibiotic guidelines has to be selected prior to use. This also multiple institution to use the same interface, whilst providing local guidance and allowing local configuration of theses through the respective microbiology department.

A diverse number of medical reference apps accounted for the majority of recommended apps. This was then followed by a number of formulary and antibiotic guidance apps. The majority of these apps are regional specific as for example the Antimicrobial NHS Scotland app or the Microguide app with the local configurations

[redacted]Stage (i) site survey: Designed and commissioned Apps

17 sites had designed medical apps. In-house clinicians designed those at 4 sites, clinician together with the in-house IT department at 4 sites, and an external IT company at 3 sites. 6 sites did not know who designed their apps. Designed and commissioned apps are listed in Table 4 lists by type and name. The majority of the designed and commissioned apps are local reference app.

6.2 Stage (ii) individual clinician survey

In total 450 individuals responded to the survey. The demographics of the respondents are listed in table 5. Whilst the majority of respondents were from the UK, Ireland, Austria, Germany and Switzerland, there were also some respondents from other countries as listed in table 5.

[redacted]Stage (ii) individual clinician survey: Harm

None of the respondents reported any harm from the use of medical apps in this survey.

[redacted]Stage (ii) individual clinician survey: Wi-Fi provision

In the surveyed population 65.7% of respondents are provided with free Wi-Fi access at work, whereas 29.3% had no Wi-Fi access and 5% limited Wi-Fi access (e.g. patient and visitor Wi-Fi, EDUROAM Wi-Fi, limited bandwidth).

[redacted] Stage (ii) individual clinician survey: Device type

The type of the personal mobile device respondents use is listed in table 6.

[redacted] Stage (ii) individual clinician survey: Number of Medical Apps on Personal Device

The number of medical apps on the personal mobile device are listed in table 7.

[redacted] Stage (ii) individual clinician survey: Institutional Mobile Device Policy

380 of the 450 respondents completed questions regarding institutional mobile device policy. 41.6% were not aware of their mobile device policy at work.

Of the other 58.4% of individuals who were aware of their institutional device policy, 52.4% were allowed to use their personal mobile device in the clinical environment at the bedside, 35.7% were not allowed (however their use was tolerated in 78.4% of cases) and 11.8% did not know.

Of the 58.4% of individuals who were aware of their institutional device policy, 59.1% were allowed to use their institutional device in the clinical environment, 12.7% were not allowed (however tolerated in 46.4% of cases) and 28.2% did not know.

[redacted] Stage (ii) individual clinician survey: mobile device use in the clinical setting

Individuals personal mobile device type use in the clinical setting is listed in table 8.

[redacted] Stage (ii) individual clinician survey: Type of Medical Apps

The medical apps on personal mobile device of the individual respondents are listed in table 9. Apps providing similar functions were grouped together to provide an overview in table 9. Table 10 lists the personal favourite medical apps on personal device of the individual respondents. Table 11 lists the medical apps provided on institutional device individual clinicians have access to (e.g. iPad in resus) and Table 12 lists the medical apps that individuals recommend.

6.3 Comparison of Prescribing and Resuscitation in Children and Adults in the site (i) and departmental (ii) survey

Table 13 and table 14 list the difference in prescribing practices and in the use of resuscitation aids between children and adults in both surveys

7 Discussion

A two staged survey was performed to provide a snapshot of mobile devices and medical apps provision, and their use in emergency care both from a departmental and individual clinician point of view in stand-alone paediatric, mixed and adult only emergency departments mainly in English and German speaking countries in Europe.

7.1 General demographic info

The stage (i) site survey was completed by a consultant (attending physician) at each PERUKI network site (22). This combined with the high response gives us every confidence that the survey reflects current practise at through the UK and Ireland. The combination of pure paediatric emergency departments and mixed departments treating both adults and children in the network ensures that the survey reflects current practise across the UK and Ireland.

With regards to the stage (ii) individual clinician survey, we had no influence who would complete the survey. The majority of respondents were consultants (attending physicians). This gives us every confidence that this survey reflects current practise.

7.2 Harm

None of our surveys reports any harm as a result from medical app use. One consideration when adapting any new medical device or treatment is the potential for harm. Most medical apps are not licensed as *Medicines and Healthcare products Regulatory Agency* (MHRA) approved devices and therefore any harm may not be reported. One of the first medical apps to gain MHRA approval was the *Mersey Burns* app (5). Whilst this technology appears safe so far, vigilance is key to detect and report any harm, especially as this technology becomes more widespread. Developers should aim for MHRA registration as a seal of approval as is already the case for the *Mersey Burns* app (5) and *NeoMate* app. This would reassure both patients and clinicians.

7.3 Mobile device policy and Guidelines for medical app use

In the stage (i) site survey less than half of all the responding departments had a mobile device policy covering either the use of a personal or institutional mobile device at the

bedside. Nearly half of the individual clinicians in the stage (ii) individual clinician survey were not aware of their institutions mobile device policy. In both surveys, sites that ban the use of mobile devices generally do not enforced it. This questions the reason for the ban in the first place, especially when it is not enforced. As highlighted by one site where they had to put up signs explaining that staff are using mobile devices for patient care. Especially with the increasing digitalisation of healthcare, there is an urgent need for a consistent and evidence-based approach across health services with regards to mobile device and app use. In the stage (i) site survey only a minority of sites provide any guidance regarding medical app use. Any guidance mainly focused on the promotion of institutional specific apps and the *BNF/BNFc* App (23).

Our surveys show a distinct lack of knowledge and implementation of national policy and guidance from a UK perspective (24, 25). NHS digital guidance, last updated in November 2018, provides specific guidelines on the use of mobile devices in various settings within NHS hospitals (see Appendix 4).

This is in stark contrast with the reported widespread adaptation of this technology in the clinical environment (19, 26-28). Following the completion of this survey, the National Trauma Network in the UK approved *Whatsapp* as an official communications app on the 16th February 2018 in line with NHS Digital guidance (26) as response to the mass casualty events that took place in the UK in 2017. This demonstrates the rapid evolution and adaptation of this technology in healthcare and the need for a standardised approach with respect to its use.

7.4 Wi-Fi provision

Wi-Fi is an important aspect of mobile device technology allowing connection to the internet, sharing and accessing information on the-go. Whilst not all of the mobile device functions or medical apps need a constant connection to work, Wi-Fi provision was found to be a key enabler in the stage (i) site survey for the adoption of this technology. In both surveys, only about two-thirds of all institutions provided a free and usable Wi-Fi connection. The provision of free and stable Wi-Fi connection should be strongly considered to aid this digital revolution. The institution not providing free quality Wi-Fi should address this as a key priority. From a UK perspective the NHS Digital Strategy recommends the

provision of free Wi-Fi at all sites (24) that was last updated in November 2018. Equally a substantial proportion of sites in the site (i) survey that provide a free Wi-Fi connection have a progressive mobile device policy, i.e. allowing the use of a mobile device at the bedside. This may reflect that free Wi-Fi provision is also a marker of embracing this technological revolution and sign of digital literacy of that department.

7.5 Barriers and enablers to this technology

In the stage (i) site survey, poor Internet and Wi-Fi connection was perceived as the main barrier to the use of this technology. This might be explained by the fact that if there is no internet connection, individuals do not use their mobile device for their usual functions (e.g. email and social media access) resulting in an overall decreased app use. Also all mobile devices need to be connected to the internet to install and update the installed medical apps and in the case of certain medical reference apps to run them, therefore the lack of Wi-Fi leads to poor technological literacy in that department.

Funding is commented on as a further barrier to the adaption of this technology. For example one site uses a charity donated iPad to run a resuscitation medical app in resus. Increased funding may allow increased provision of hardware, i.e. mobile devices in the departments. It may also allow the provision of a range of medical apps that can be provided for free to the staff to run on their personal mobile device. Previous surveys have shown that clinicians are willing to use their personal mobile device and medical apps that they have purchased themselves or are provided for free as part of patient care (29).

Colleagues were identified as the leading enabler in the adaption of this technological revolution. Positive peer pressure may be one explanation for this (29). Good internet (Wi-Fi) connection, the institution and the provision of free medical apps were reported as key enablers of medical app use. These enablers are reflected in the NHS Digital strategy for universal Wi-Fi provision and in the NHS digital mobile device guidance (24, 25) that was last updated in November 2018.

Patients were seen equally as barrier or enabler to medical app use. This is consistent with the iDoc project in Wales (7, 19, 30), which provides foundation year doctors access to three medical textbooks and the BNF/BNFc app on their smartphone for free. It anticipated and identified patients as one of the potential challenges for the project. They proposed the following three scenarios that might be encountered by junior doctors at the bedside: "*you should know this by now*", "*using social media apps and playing games*" and "*especially elderly patients can see it negatively, at the bedside, we need sensitivity*" (7, 19, 30). These concerns are also reflected in the comments from one institution in stage (i) site survey, "*had to put up signs to tell patients that some staff use phones for taking observations, looking up information, etc*". Explaining, informing and including patients in this digital revolution is key to ensure patient acceptability.

The most common comment in the "other" category is that medical app use, is up to individual clinician choice. This may reflect that we are still in the organic growth phase of the current digital revolution. The creation of a positive environment will increase the use and acceptability of this advance in technology as envisaged by the NHS digital strategy (24, 25).

7.6 Use of mobile device technology by individual clinicians

The stage (ii) individual clinician survey the main use of mobile device technology was for web-access, followed by email, rota/calendar and social media access by individual clinicians. The stage (ii) individual clinician survey shows that we are at a threshold of this digital revolution with nearly half of the respondents using this technology as part of daily patient management (formularies, medical calculators and scoring systems, and disease diagnosis and management) compared to 2008 when this technology did not exit. These changes in how we access information and manage patients, needs to be reflected in national and institutional policy and guidance (24, 25).

7.7 Mobile device type

In the stage (i) site survey only a minority of sites provided mobile devices for staff to use. This included a charity donated iPad in resus to run a resuscitation medical app at one site.

The reason for this is that in the UK institutional mobile devices are generally only provided for consultants (attending physicians) explaining the low number of institutional devices. In the stage (i) site survey Apple devices were the most common provided type of institutional mobile device followed by Android devices. In the stage (ii) individual clinician survey Apple devices accounted for just over two-thirds of the devices and Android for the nearly all the remaining devices. Previous studies have shown the preference for Apple devices by medical staff (31-33). Apple has historically been the market-leader, both in the mobile device market and by being the first company to have an App store allowing developers to sell, and consumers to purchase and download apps (34, 35). Previous surveys have reported that medical doctors are happy to use their personal mobile devices as part of patient care (5, 10).

Based on our data on device availability, usage, and previous surveys in the UK, medical apps should be compatible with iOS and Apple products, as there are the most common mobile devices and operating systems. To achieve widespread uptake, apps should also be compatible with android products.

7.8 Medical App per Mobile Device

Previous surveys from junior doctors and medical students have shown that they have between one to five medical apps installed on their smartphone (19). This is also reflected in both surveys where between one to five medical apps were provided on the institutional mobile device or the individual clinician had between one to five medical apps on their personal device. One explanation could be that most clinicians have up to five medical app corresponding to each of the leading medical app categories on their mobile device. In both surveys the five leading medical app categories included medical reference, formulary, resuscitation, medical calculator apps and antibiotic guideline apps.

7.9 Medical apps

Previous studies have shown that it is difficult for clinicians to find the medical apps on the app store. Apps providing similar functions were grouped together to get an overview of the most common used apps in our survey. In both the stage (i) and stage (ii) survey the leading five medical app categories installed on either the institutional or personal mobile device

were medical reference, formulary, resuscitation, medical calculator apps, antibiotic guideline, and a number of various miscellaneous apps.

UK clinicians have consistently reported that the *BNF/BNFc formulary* app is their favourite medical app (8, 30). This was also confirmed in our surveys. The *BNF/BNFc formulary* app is aimed at prescribers, pharmacists and other healthcare professionals, who need up-to-date information about medicines. The app was developed to present the *BNF/BNFc* content in a more digital-ready focus, in line with the NHS digital strategy. The advantage of presenting this information as an app is that the content can easily be updated in timely manner compared to the annual edition of the paper copy and allows rapid transmission of any changes to clinicians. The app is currently available for free for all UK users (23). This may be especially relevant to paediatric prescribing where the RCPCH has identified prescribing as an area of difficulty. Access to the *BNF/BNFc formulary* app at the bedside can aid safe prescribing (5).

In the stage (ii) individual clinician survey the leading medical reference apps were *uptodate* and *Medscape* medical apps, which are based on North American guidelines. *Microguide* was the leading antibiotic guideline app. For a department it is important to be aware, which medical apps staff consult, as this may influence management decisions and how medications are dispensed. Similar to consulting a textbook and depending on the incidence and prevalence of a specific condition, this may lead to over or under investigations and potentially inadequate treatment. This is especially important with empirical antibiotic therapy, that should reflect local resistance and sensitivity patterns.

There is a trend to use medical apps that can be configured to local guidelines, especially with antibiotic guideline apps. The stage (i) and stage (ii) survey identified the following: *RxGuidelines, Induction, Microguide* apps that can be configurated to local guidelines.

The leading installed resuscitation medical apps in the stage (ii) individual clinician survey were *iResus, PaediatricEmergencies* and *NeoMate.* In the stage (ii) individual clinician survey the *PaediatricEmergencies* app was the leading favourite and recommended resuscitation medical app on both the institutional and personal mobile device in all settings. One explanation for this could be that *PaediatricEmergencies* app not only provides the resuscitation algorithm, but also calculates the drug dose, provides information on how to make up the drug or infusion, and how to administer it near instantaneously. An advantage of using apps in this setting has also been demonstrated in a study of paediatric inotrope

prescribing, where the *PaediatricEmergencies* app related *PICU calculator* app was shown to be superior in paediatric inotrope prescribing compared to using the *BNF/BNFc* hardcopy formulary, with medical students outperforming consultant paediatricians (3).

The multiple offering of similar apps within one medical app category, may be explained that we are still in the organic growth phase of this digital revolution. As previously highlighted, medical apps used by clinicians should be ideally registered by MHRA or similar regulator as a medical device. Local or national regulators or Royal Colleges should consider licensing or approving medical apps in each of the main app categories to provide clinicians with a choice of apps that they can rely on, and that is specific to the setting. Part of this process should also ensure that apps and the information is kept up to date, which could be achieved through MHRA registration. Local or national regulators, or royal colleges should consider the commissioning of medical apps in each of the leading categories relevant to their specific needs.

7.10 Medical app design and commissioning process in the PERUKI network

Survey (i) identified a good example of how medical app development is embraced at one site, where they organise regular hackathons to develop medical apps. The majority of sites that have developed apps, did so with the input from either internal or external IT departments. Having access to clinicians who are trained in app develop and who are able to support this process is key to future development. The absence of good IT support was raised as a concern at 9 sites. This raises the question, if basic IT and app development skills should be included as part of the training of the next generation of clinicians moving on from just providing apps for clinicians to use (30) or if this needs to be part of a wider national or international development strategy. As previously highlighted developers need to be aware of the commonly used device types, used by both institutions and individual clinicians, as identified in our survey, to be able to provide compatible software.

7.11 Practical Application of Mobile and App Technology in Emergency Care: Prescribing and Resuscitation

Previous studies have shown that formulary apps are the most popular and widely used app category by clinicians. The use of apps in prescribing and resuscitation is used to show case how this advance in technology is applied by departments and clinicians as part of direct patient care.

Previous research has shown that children are more likely to be harmed than adults by medication errors (36-38). Emergency departments can be stressful and distracting environments potentially leading to increased cognitive load and errors. The RCPCH has therefore developed specific training and recommendations for safe prescribing in paediatrics. In paediatrics it is standard practice to double check doses in the formulary and dose calculations when dispensing medication and making up infusions. The recommendations include having a specific prescribing area, where medical staff is not disturbed when calculating, prescribing, checking and making up medications and infusions to decrease medication errors (37).

The rarity of cardiac arrests in children, weigh-based prescribing, unfamiliarity with the equipment and guidelines can all add to increased cognitive load during the management of critical unwell children. (17, 18). Studies looking at simulated paediatric resuscitation at major paediatric teaching hospitals found that medication errors occur during all stages of paediatric resuscitation. In one study, only analysing syringe content identified these errors, suggesting that such errors may be a major unrecognised source of morbidity and mortality during resuscitation in children (12, 13).

This has led to the development of a variety of prescribing and resuscitation aids (*APLS WETFLAG* calculation, the *Broselow Tape*, a variety of *Crib sheets* and medical apps) (9, 14, 39, 40). Previous studies looking at simulated paediatric resuscitation, have shown that the use of reference books and charts providing weight-based pre-calculated doses all decreases drug dose errors, especially 10-fold errors, which could be potentially fatal for a child (14).

In this context apps, have the potential to decrease medication errors by providing medication doses and instructions of how to make up infusions at the fingertips of clinicians near instantaneously on the go.

[redacted]Prescribing

In the site (i) survey, the use of a formulary book (*BNF/BNFc*) was the leading way to check a medication dose as recommended by the RCPCH followed by the use of formulary apps (e.g. *BNF/BNFc* or equivalent). This was also the leading choice for individuals working in the UK and Ireland. This was not the case for the respondents in the German language survey. Using the local electronic guidelines on the desktop computer or a formulary app on the personal mobile device were the top two choices in the German language survey. This may reflects that in German speaking countries most of the prescribing is already part of electronic medical patient record, which have inbuild electronic formularies (41-43).
In the stage (ii) individual clinician survey, the use of desktop computers to access electronic formularies was the most often selected "other" choice to check a drug dose. This may be explained by the fact that most institutions provide free access to electronic formularies via the institutional desktop computer.
The *BNF/BNFc* app on the personal mobile device has been consistently chosen as the most popular medical app in a number of surveys in the UK by different groups of doctors (8, 30). Access to an electronic formulary on the personal mobile device or the desktop computer appears to be the future for checking medication and dosing regimens for clinicians (8, 30, 44). At the same time having access to alternatives such as paper-based back-up are important, especially in case of electronic devices failure.

[redacted]Resuscitation

Resuscitation and the management of critically ill or injured patients is an integral part of emergency medicine. The general management of these patients follows standardised algorithms. Adult resuscitation account for vast majority of all resuscitations with children accounting for only 2% of all cardiac arrests in some cohorts (17, 18). In our stage (ii) individual clinician survey resuscitation from memory was much more common in adults than in paediatrics. Resuscitation from memory in adults had a higher response in German speaking countries compared to the responses from the UK and Ireland. One explanation

may be that the respondents from the German speaking group treat more adults. In both surveys, the stage (i) site and the stage (ii) individual clinician survey this was also reflected in the comments regarding adult resuscitation under "other", which included: "*we do this so often we know all doses from memory*" and "*ready-made syringes*" (17, 45). The use of wall mounted resuscitation aids similar to *Advance Life Support* (ALS) algorithm was higher in German speaking countries compared to the UK and Ireland.

The *APLS WETFLAG* calculation used to estimate the weight, endotracheal tube length, fluid bolus, lorazepam, adrenaline, glucose dose of a child, was the leading choice both in the stage (i) site and the stage (ii) individual clinician survey. The advantage of the *APLS WETFLAG* calculation is that equipment and medication doses can be pre-calculated and prepared in anticipation of the arrival of the child in resus based on the age of the child.

There was no difference in the use of medical apps in paediatric resuscitation between UK and Ireland versus German speaking countries. One advantage of using medical apps is that some of them not only provide the dose, but also instructions on how to make up the medication, i.e. the dilution and how to give, i.e. as slow bolus, as an infusion, etc. nearly instantaneously (8, 14, 46). Knowing the correct dose in paediatric resuscitation is often only half the answer. One also needs to know how to dilute and give it. Previous work has shown that the use of *PICU calculator* app is more accurate and quicker than using the *BNF/BNFc* (3, 36) to make up inotrope infusions. Examples of these type of medical apps that provide this information include the *Mersey Burns*, *NeoMate* and *PaediatricEmergencies* apps (3, 5, 15, 47). Whilst this survey suggests that there is may be an increasing prevalence of medical apps to aid preparation for paediatric resuscitation when compared to 10 years ago, when none of these apps existed, further work is needed to delineate their adaptation over time.

The use of printed institutional weight and age-based resus *Crip* sheets for children was most common in PERUKI hospitals, less common in other UK & Ireland hospitals, and least common in German speaking countries surveyed. This difference might reflect that the majority of respondents from German speaking countries treat adults only.

Examples of printed and validated resuscitation reference aids include the *Paediatric Emergency Medication Book* (14, 39, 48) and *SPARC Cards* (14, 39, 48). Other sources for drug doses are printed reference sheets from web-based paediatric resuscitation medicine

calculators that can be accessed via the desktop computer. The following web-based calculators hosted by regional paediatric retrieval services were recommended by respondents in our survey: *CrashCall* (49), *SCOTstar* (50), *STRS* (4), and *KIDS* (51). The advantage of their use is that infusions are made up in accordance with the regional standard. This is especially helpful if the patient has to be transferred to centres of higher care.

The use of the *Broselow tape* was overall rare in the surveyed population. The advantage of the *Broselow tape* is, that no calculations need to be made, as everything can be read of the tape, once the child is measured, therefore potentially reducing the chance of medication error as described in the literature (36, 52-55).

8 Limitations

The site (i) survey was conducted only at PERUKI sites in the UK and Ireland. Not all sites completed the survey. The sites that did not complete may not use mobile devices or medical apps, therefore potentially skewing the results in favour of the centres that have embraced this technology. A lead researcher completed the survey on behalf of their site. We assume that the PERUKI site leads entered the current practise for their site and not just their individual practises. The site (i) survey only provided general data and does not reflect the practise of individual healthcare professional at each site. This survey did not take any patient perspective into account.

With regards to the stage (ii) individual clinician survey, this was distributed through different channels. We had no influence over who would respond to this survey. We assume that a range of participants responded and not only individuals that embrace this technology. Consultants (attending physicians) accounted for nearly two-thirds of all the doctors that responded and therefore this should reflect current practise. Previous studies have shown that medical app use is more wide-spread among junior doctors and medical students, therefore this survey may actually underreport medical app use (2).

9 Conclusion and Recommendations

The survey suggests an increasing digitalisation and cultural shift from paper-based to electronic resources in prescribing and resuscitating over the last 10 years. The start was the launch of the App sore in 2008 and the subsequent development of medical apps since, e.g. the release of the first version of *BNF/BNFc* app in 2012. The use of mobile device technology in the study population is widespread with nearly half of the responding individuals accessing medication information on their personal mobile device daily.

The aims of the survey were to provide an overview to the current use of mobile device technology and medical app use in emergency care. The focus was on the hard- and software used by institutions and individuals. Mobile device policy was a focus as this governs the use of this technology at the bedside. To illustrate the use of this technology in the clinical setting and the use this technology in prescribing and resuscitation was used. Previous work had highlighted that formulary apps are the most widespread type of medical apps used by UK clinicians (8, 10, 19).

The organic growth of this advance in technology in our networks has led to a range of policies governing mobile device use as part of patient care ranging from prohibition at one end to encouraging the use specific apps at the others. Local teams as a response have developed their own apps to solve their specific needs e.g. local reference and triage app (*POPS*). This is also highlighted in the numerous offerings in certain app categories.

This survey highlights the following steps are needed to improve the integration of mobile device technology and medical apps in our setting. From a UK perspective the stage (i) site survey shows a distinct lack of knowledge and a lack of implementation of the NHS Digital strategy and guidance regarding infrastructure, mobile device and medical app use in the PERUKI network (25). There is an urgent need to highlight these policies to all staff and patients, and to implement this strategy. Especially inconsistencies in policy, which ban the use of mobile device as part of direct patient care but are then not enforced, need to be addressed as this leaves institutions and individuals open to complaints and potential litigation.

Colleagues and the provision of Wi-Fi were key enablers of this technology. The absence of Wi-Fi was one of the main barriers of this technology. There has to be a focus on providing

the hardware infrastructure, i.e. Wi-Fi to allow this technology to flourish and improve digital literacy.

None of the responding sites or individuals reported any harm of associated from mobile device or medical app use. The use of this technology has been linked to improved patient care (5). It is important to have systems in place to report any issues with medical apps so that these can be addressed and do not lead to patient harm. MHRA registration may be one way to achieve this, as is already the case for some of the leading resuscitation medical apps e.g. *MerseyBurns* and *NeoMate* apps (5, 15).

Previous work has shown that it can be tricky for clinicians to find the right app on the app store (16). In our survey, certain sites have taken steps to promote and encourage the use medical apps including locally designed medical apps at their site to encourage staff to use the most appropriate apps for their setting.

There is duplication in the offerings in some of the medical app categories e.g. the different antibiotic guidance apps. There is already a move to standardise some of the apps, as is the case for the *Microguide*, *RxGuideline* and *Induction* app. This process may be advantageous and should be further investigated, whilst still respecting the need for local solutions. This process may be especially useful for rotating doctors, who are then already familiar with these apps.

Prescribing and resuscitation, were used to illustrate the use of apps in clinical practice. Our survey and previous studies have shown that the *BNF/BNFc* app has the highest up-take among users in the UK (13), with nearly half of the individual respondents using a formulary app daily. This development should be encouraged. Medical staff should be provided with ready to access formularies at the bedside. The use of the *BNF/BNFc* app or equivalent on personal mobile device of the treating clinician would be an easy way to achieve this. This goes hand in hand with local policies that allow this.

Our survey showed that there is already widespread use of apps during paediatric resuscitation. Whilst paediatric resuscitating may be perceived to be more complex, this does not have to be the case. The use of aids including apps has been shown to reduce cognitive load in simulated resuscitation scenarios. Further work is needed to demonstrate that the use of apps can decrease cognitive load and improve resuscitation and outcomes in the real world.

Access to paper-based back-up alternatives e.g. paper-based *BNF/BNF*c or similar formulary books and in resus the *Paediatric Emergency Book* or similar aids is a must, especially in case of electronic devices failure.

Finally, thought should be given to IT and app development training for the current and next generation of clinicians, to help guide this digital revolution and improve digital literacy. Programs to increase the digital literacy and aid app development should be developed. Developers need to be aware of the most commonly used mobile devices. Equally when being licensed, bodies must ensure apps can be accessed equitably by all clinicians independent of device.

This study has also identified a number areas for further research. Future work should also explore both patient and health care staff acceptability of this technology as part of patient care at the bedside. Follow-up data is needed to see how this technology is actually perceived once implemented by both medical staff and patients and carers.

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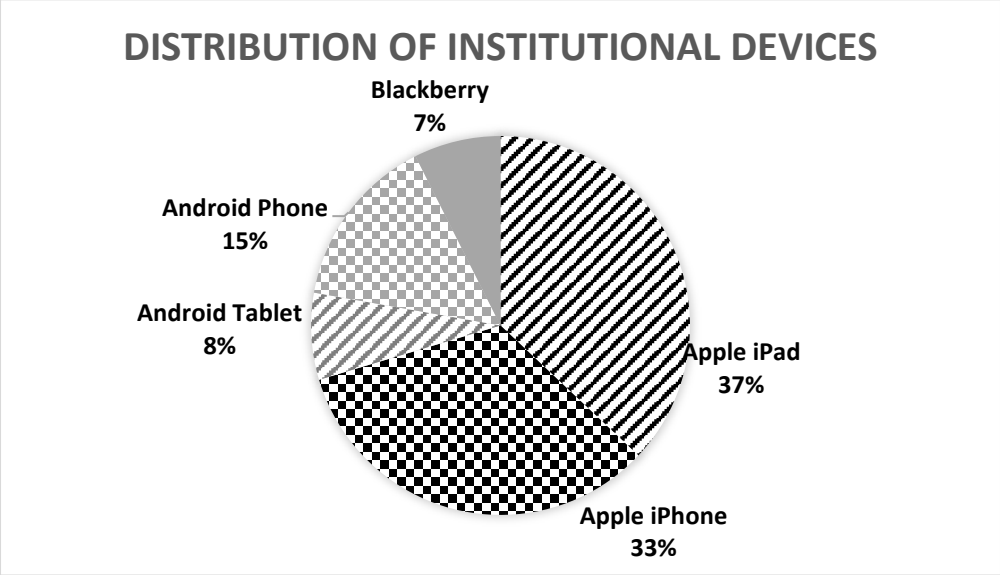
10 Appendix

10.1 Appendix 1: Figures

Figure 1: site survey: Institutional mobile device type and device manufacturer



10.2 Appendix 2: Tables

Table 1: Stage (i) site survey: Demographics

Total Sites	54
Responding Sites	46
Completion	85%
Centres that treat only children	43%
Centres that treat both adults and children	57%

Table 2: Stage (i) site survey: Guidelines for medical app use

1. Some medical apps are encouraged (Alder Hey antibiotic guideline, BNFc and Burns app). The trust has a mobile device policy. No policy for medical apps even on trust owned mobile devices. There is a trust policy on social medial access and use which includes and is not limited to 'apps'.
2. Written policy
3. Very little guidance.
4. For use for clinical reasons.
5. No specific guidance. Trust has 3 internal apps for use by staff in the clinical area
6. No multimedia messages via text message, committee has been set up to examine the use of “whatsapp”. This is currently happening regularly with anonymised pictures being sent between on-call teams

Table 3: Stage (i) site survey: Barriers and enablers to medical app use

	Barriers	Enablers
Colleagues	Preventing use: 3 7%	Encouraging use: 20 43%
Institution	Preventing use: 5 9%	Encouraging use: 11 24%
Patients	Preventing use: 4 9%	Encouraging use: 4 9%
Technical issues	Preventing use: 9 20%	Encouraging use: 6 (13%
Internet or Wi-FI connection	Absence/Poor connection: 17 37%	Provision/Good connection: 19 41%
Purchase Price of App (Cost)	High cost: 5 9%	free to download: 11 24%
Price to create App (Cost)	High cost: 8 17%	Low cost or free: 2 4%
Other	Other Barriers: 11 (24%)	Other Enablers: 6 (13%)

Free text responses "Other"	1. No barriers 2. No real barriers 3. Apps are simply used by individual clinicians on their personal phones using the national 4G network 4. There is no mandated use of apps, it will vary for each individual 5. Our department per se have not developed an app but are in collaboration with the wider trust and use 2 apps provided by the trust for clinical use. The other apps would be personally downloaded apps 6. variable reliability, slow to update 7. Slow update/ loss of connection due to poor Wi-Fi/ 3G signal 8. Trust issued android phones which act as bleeps, hospital Wi-Fi (free Wi-Fi and VIOP). The VOIP is much better than the free Wi-Fi, but patchy reception around the hospital. Installing apps via IT guy as need to pay for the app and Wi-Fi isn't good enough to download it. 9. Have had to put up signs to tell patients that some staff use phones for taking observations, looking up information etc. 10. Significant hurdles in app development, although the trust does have an app development policy. Issues include IP rights, costs, security IT issues, content control etc 11. We use PaediatricEmergencies app on a charity donated iPad, money and commissioning is difficult	1. Approved spreadsheet from regional PICU (crashcall) on desktop PCs. 2. We use medical apps but not with formal trust approval 3. We use them but in a personal capacity 4. Funding for simman app 5. Regular 'Hackathons ' are held by the Innovation department. There are also a couple of IT guys/ IT company who have been commissioned by the trust to develop apps that are needed - recent info gathering by them- info given by trainees include critique on apps they already use e.g. PCO 6. There is no mandated use of apps, it will vary for each individual

Table 4: Stage (i) site survey: Apps provided, recommended, locally designed

	Provided on Institutional Device		**Recommended by Institution**		**Locally led apps**	
	apple	**android**	**apple**	**android**	**apple**	**android**
Reference apps						

BMJ best practise	0	0	0	1	0	0
Local Reference	1	1	1	1	3	2
Induction	1	1	3	2	0	0
MedCalc	0	0	0	1	0	0
MedHand	1	1	0	0	0	0
Nervecentre	1	0	0	0	1	0
Nice Guidance App	0	1	0	0	0	0
RCH Clinical Guidance	0	1	0	0	0	0
RxGuidelines	0	0	5	2	0	0
UptoDate	1	1	1	1	0	0
Resuscitation						
APLS	0	1	0	0	0	0
Mersey Burns	0	1	0	1	0	0
NeoMate	0	0	2	0	0	0
PaediatricEmergencies	1	0	1	1	0	0
Formulary						
BNF/BNFc	5	3	9	6	0	0
Local formulary	0	1	3	3	0	0
Yellow Card	0	1	0	0	0	0
Antibiotic Guidance						
NHS Scotland antimicrobials	0	0	1	1	0	0
Microguide	1	1	4	2	0	0
Local Antibiotic Guidelines	1	1	5	5	3	2
Advice						
HANDi	0	0	1	0	0	0
NHS - Child Health	1	0	0	0	1	0
Taking the ouch of Children's Emergency	0	1	0	0	0	1
Communication						
BleebPod	0	0	1	1	0	0
NW Burns referral	0	0	1	0	0	0
Local Communication App	1	1	0	0	0	0
Miscellaneous						
Airvo 2	0	1	0	0	0	0
Arrow EZ-IO	0	0	0	1	0	0
Chameleon (game)	0	0	1	0	0	0
Citizenaid	0	0	1	1	0	0
POPS	0	0	1	1	1	1
SimMon	1	1	0	0	0	0

Table 5: Stage (ii) individual clinician survey: Demographics

Total Respondents	450	
Completion	419 (males 56%; female 44%) Average age 40 years	93%
United Kingdom & Republic of Ireland	308	68%
Rest of the World include 81 German speaking response	142	32%
German speaking Survey	81	18%
Doctors	Total: 369	88%

	Consultants (Attending) (227, (62%)) General Practitioners: (8, (2%)) Trainee Doctors: (134, (36%))	
Other Healthcare Professionals	50	12%
Number of respondents that treat children with medical presentations	334	80%
Number German speaking respondents that treat children with medical presentations	22	5%
Number of respondents that treat children with trauma presentations	234	56%
Number German speaking respondents that treat children with trauma presentations	26	6%
Number of respondents that treat adults with medical presentations	203	48%
Number German speaking respondents that treat adults with medical presentations	76	17%
Number of respondents that treat adults with trauma presentations	169	40%
Number German speaking respondents that treat adults with trauma presentations	57	13%

Table 6: Stage (ii) individual clinician survey: Personal mobile device type

Personal Mobile Device	Percentage
Apple Device (iPhone/iPad)	71%,
Android Device	29%,
Blackberry	0.3%

Table 7: Stage (ii) individual clinician survey: number of medical apps per mobile device

Number of Apps	Personal Mobile Device
0 Apps	1%
1-5 Apps	54%
6-10 Apps	28%

11-15 Apps	11%
16 or more Apps	6%

Table 8: Stage (ii) individual clinician survey: Individual mobile device

	never	Rarely	weekly	Daily
medication formulary or drug reference	123%	134%	26%	**48%**
clinical score systems or medical calculator	18%	24%	28%	**30%**
disease diagnosis or management	18%	**33%**	26%	23%
procedure documentation	**58%**	23%	10%	9%
CPD (Continuing Professional Development) or eportfolio	27%	26%	**35%**	12%
education (revision & learning)	18%	23%	**32%**	27%
calendar, rota	10%	7%	16%	**67%**
password storage (login details)	**41%**	18%	14%	27%
email access (work email)	16%	4%	7%	**73%**
staying in touch with colleagues	9%	9%	18%	**65%**
Social Media (Twitter, Facebook, etc)	17%	11%	7%	**65%**
web access	3%	5%	5%	**88%**

Table 9: Stage (ii) individual clinician survey: Medical Apps on Personal Device

Names of Medical App on Personal Mobile Device	Number of times listed
Medical Reference Apps	
UpToDate	41
Medscape	32
Toxbase	22
Growth charts	13
Aid Diagnosia (AGN Fibel)	10
Medstandards	8
BiliApp	7

EMGuidance	5
Induction	5
NHS GG&C Childrens guideline app	5
Paediatric care online	3
Rx Guidelines	3
AO Klassifikation	2
Cardio Z	2
Figure 1	2
Genetics 4M	2
NUH Guidelines app	2
ÖGARI App	2
Nchd Guide (nchd.ie)	2
BCH KIDS	1
Dynamed plus	1
Elsevier Klinikleitfaeden (diverse)	1
Harrisons Internal Medicine	1
Ignaz - own guidelines on this	1
Kittelcoach	1
NICE guidance	1
Notfallmedizin App	1
Pediatric EM Morsels	1
PICU life	1
Pubmed	1
RCEM app	1
RCH Clinical Guidelines	1
Septic arthritis	1
Vitals	1
Wells Score	1
Formulary Apps	
BNF/BNFC	140
Compendium Documed	7
Arzneimittelbuch	3
Arznei aktuell	1
Arzneimittel Pocket	1
Formulary	1

MIMS	1
Olchc formulary	1
Tarascon – formulary	1
UBQO paed formulary	1
Resuscitation Medical Apps	
iResus	31
Paediatric Emergencies	25
Neomate	24
Paeds ED	14
APLS	6
MyATLS	4
Kinderanästhesie	3
PediSTAT	3
Emuk	2
Pediatric Resuscitation	2
Pedihelp	2
burn calculator	1
iArrest	1
Jr calc from Scottish ambulance service	1
PICU Drug calculator	1
STRS retrieval service app (guidelines & drug calculator for resus drugs)	1
Medical Calculator Apps	
MDCalc	29
Medcalc	28
MedCalx.ch	18
CliniCalc	15
Mediquations	3
Qxcalculate	2
Calculate Qx	1
drug dose calculators	1
Medi calc	1
Antibiotic Guideline Apps	
Microguide	44
Antibiotica pc	1

Local antimicrobial guideline	1
Simulation Apps	
SimMon	11
Sim Monitor	2
Miscelleanous Apps	
RCPCH CPD App	7
AmiKo Desitin	3
Smack Conference App	2
1Password	1
Cerner	1
ESApp Personal	1
Jext	1
MDCoder	1
Overcast - to listen to podcasts	1
RCPCH Conference App	1
WhatsApp	1

Table 10: Stage (ii) individual clinician survey: Favourite Apps on Personal Device

Name of Favourite Medical App on Personal Mobile Device	Number of times listed
BNF/BNFc	68
Uptodate	24
PaediatricEmergencies	17
MDCalc	15
NeoMate	12
Medscape	10
MedCalX	10
Aid Diagnosia (AGN Fibel)	9
Medstandards	9
Paediatric care online	7
MedCalc	7
Microguide	7
MerseyBurns	7
Clincalc	5
Paeds ED	5

EMGuidance	4
Qxcalculate	3
Induction	3
Toxbase	3
BiliApp	3
PediSTAT	3
STRS	3
Dynamed	2
Figure 1	2
Pedihelp	2
Opioid Calculator	2
Smack	2
Compendium	2
Growth Charts	2
iResus	2
NHS GG&C Childrens guideline app	2
PICU calculator	2
PICU doctor	2
POPS	2
RCH Clinical Guidelines	2
SimMon	2
AmiKo	1
Cerener	1
Dr House	1
EMed.ie	1
Jr Calc from Scottish ambulance service	1
Mediquations	1
nchd.ie	1
Olchc app	1
Pediatric Resuscitation	1
Read by QXMD	1
safeguarding children4U	1
Stanford EPIC Haiku	1
antibiotic guidelines	1
BCH KIDS	1

Bmj best practice	1
Cardio Secur pro	1
Documed	1
Don't forget the bubbles	1
ECG	1
Em:rap	1
Emuk	1
Ganz	1
guidelines.ch	1
Heartpedia	1
ICD-10	1
NICEguidance	1
Notfall Medizin App.de	1
ÖGARI App	1
OHCM	1
Orthoflow	1
PAedEmerg	1
Paeds drug	1
Pediatric EM Morsels	1
RCEM learning	1
SIM MONITOR	1
Twitter	1
Vitals	1

Table 11: Stage (ii) individual clinician survey: Medical Apps on Institutional Device

Medical App on the Institutional Mobile Device	Number of times listed
BNF/BNFc	8
PaediatricEmergencies	4
Uptodate	4
Drug dose calculator	2
Nervecentre	2
RCH Clinical Guidelines	2
antibiotic guidelines	1
Clinical key	1
klinische richtlinien	1

microapp	1
Clincalc	1
Compendium	1
essential anatomy 5	1
GMC my CPD	1
guidelines	1
ICU notes	1
Induction	1
Lungenfunktion i-pocketcards	1
medscape	1
mt atlas	1
myotomes	1
NHS eportfolio	1
NUH Clinical Guidelines	1
Paeds ECG	1
Pubmed on tab	1
RCEM learning	1
Stanford EPIC Haiku	1

Table 12: Stage (ii) individual clinician survey: Recommended Medical Apps

Name of App	Number of time recommended
BNF/BNFc	55
Microguide	44
Uptodate	27
PaediatricEmergencies	8
Induction	5
Alder Hey Antimicrobial	4
cerner	4
EM Guidance	4
medstandards	4
NHS Scotland antimicrobials app	4
Stanford EPIC Haiku	4
Dynamed plus	3
paediatric care online	3
PICU Calculator	3
RxGuidelines	3

Burns referral	2
NeoMate	2
NUH guidelines	2
Antimicrobial guidelines app	1
Bartshealth eCPD for statman	1
BMJBestPractice	1
Edinburgh EM app	1
Ganz	1
HANDi App	1
Imperial antibiotics	1
LinkedIn	1
Olchc formulary	1
RCH Clinical Guidelines	1

Table 13: Prescribing

Prescribing	PERUKI Site survey	RCEM individual clinician survey	RCEM individual clinician survey UK & Ireland	RCEM individual clinician survey Austria, Germany and Switzerland
Total Responses	46	325	221	63
Use of a paper-based formulary book (eg British National Formulary or equivalent)	100%	47%	64%	10%
Use of a personal Smartphone to look up the dose on the electronic formulary (eg British National Formulary or equivalent)	80%	59%	61%	54%
Use of institutional mobile device to look up the dose on the electronic formulary (eg British National Formulary or equivalent)	48%	16%	10%	33%
Use of an online search engine to check the dose	37%	12%	8%	29%
Use of local guidelines (paper version)	54%	22%	24%	8%
Use of local guidelines (electronic version)	94%	48%	55%	44%
Other	0%	6%	7%	2%

Table 14: Resuscitation in Children and Adults

Resus Child	PERUKI site survey	RCEM individual clinician survey	RCEM individual clinician survey: UK & Ireland	RCEM individual clinician survey: Germany, Austria, Switzerland	Resus Adult	PERUKI site survey	RCEM individual clinician survey	RCEM individual clinician survey: UK & Ireland	RCEM individual clinician survey: Germany, Austria, Switzerland
Total	46	326	221	64	Total	46	325	220	65
Total that treat Children	46	290	217	35	-	-	-	-	-
-	-	-	-	-	Total that treat Adults	23	143	121	65
We will use a Broselow Tape when the child arrives	4%	9%	4%	14%	-	-	-	-	-
We will use the WETFLAG calculation as per APLS & follow the APLS algorithm on the Wall	87%	63%	79%	20%	We will use ALS (advanced Life Support) algorithm on the Wall	37%	27%	25%	42%
We will use the Medical App on our personal mobile device	28%	33%	34%	33%	We will use the Medical App on our personal mobile device	11%	10%	9%	11%
We will use the Medical App on our institutional mobile device	13%	4%	5%	0%	We will use the Medical App on our institutional mobile device	2%	1%	1%	3%
We will print out the institutional Excel or similar age and weight-based resus medicine crib sheet	46%	22%	30%	6%	We will print out the institutional Excel or similar resus medicine crib sheet	0%	3%	4%	3%
We will use the institutional aged base medicine folder with laminated age and weight-based crib sheets	46%	28%	33%	13%	We will use the institutional medicine folder with laminated ALS based crib sheets	11%	10%	10%	17%
We will use the Medical App on our personal mobile device get any infusions (eg	9%	13%	14%	9%	We will use the Medical App on my personal mobile device to get any infusions (eg	4%	4%	4%	6%

inotropes) ready					inotropes) ready				
We will use the Medical App on our institutional mobile device to get any infusions (eg inotrope) ready	2%	3%	4%	3%	We will use the Medical App on my institutional mobile device to get any infusions (eg inotropes) ready	2%	1%	0%	5%
We will use the institutional aged base medicine folder with laminated age and weight-based crib sheets to get any infusions (eg inotrope) ready	33%	22%	25%	11%	We will use the institutional medicine folder with laminated crib sheets to get any infusions (eg inotropes) ready	24%	10%	9%	17%
From memory	-	6%	5%	8%	From memory	-	23%	13%	55%

10.3 Appendix 3: Surveys

[redacted]1. Stage (i) site survey questionnaire

1. Could you kindly select your PERUKI site from the list below (listed alphabetically), otherwise select “other”.

2. Does your institution provide free wifi or internet access to use Apps at work (both for institutional and personal mobile devices)?
    a. Yes
    b. No
    c. Other (please specify)

2. Does your institution have a mobile device policy?
    a. Yes
    b. No

3. Does your institution's mobile device policy allow the use of personal mobile devices eg smartphones, etc in the clinical environment?
    a. Yes
    b. No
    c. No, but tolerated

    d. Other

4. Does your institution's mobile device policy allow the use of institutional mobile devices eg smartphones, tablets etc in the clinical environment?
    a. Yes
    b. No
    c. No, not allowed but tolerated

5. What guidance if any does your institution provide Medical Staff regarding the use of Medical Apps on either the institutional or personal device in the clinical environment?

6. Does your institution provide mobile devices eg mobile phones, smartphones, tablets, etc for communication and to run Apps?
    a. Yes
    b. No

7. Does your institution provide their staff with a smartphone or other mobile device to run Medical Apps? Select all relevant
    a. Blackberry
    b. Android Phone
    c. Android Tablet
    d. iPhone
    e. iPad
    f. Other (please specify)

8. How many Medical Apps are provided on your Institutional Device, if any?
    a. 0
    b. 1-5
    c. 6-10
    d. 11-15
    e. 16-20
    f. more than 20

9. Which APPLE Medical Apps are provided on your trust or institution device (e.g. electronic formulary, drug dose calculators, clinical guidelines, etc)?
    a. Name of App
    b. Name of App
    c. Name of App
    d. Name of App
    e. Name of App

10. Which ANDROID Medical Apps are provided on your trust or institution device (e.g. electronic formulary, drug dose calculators, clinical guidelines, etc)?
    a. Name of App
    b. Name of App
    c. Name of App

d. Name of App
e. Name of App

11. Which BLACKBERRY Medical Apps are provided on your trust or institution device (e.g. electronic formulary, drug dose calculators, clinical guidelines, etc)?
    a. Name of App
    b. Name of App
    c. Name of App
    d. Name of App
    e. Name of App

12. Do the Medical Apps on your institutional device require an internet or wifi connection at the point of use, eg electronic formulary, electronic guidelines, etc?
    a. No, none require an Internet connection
    b. Yes, some require an Internet connection
    c. Yes, all require an Internet connection
    d. Not Applicable
    e. Other

13. Does your institution recommend specific local, regional network, national or international Medical Apps (Hospital App, Micro guide, Burns, Retrieval, PICU App etc) for clinicians to run on their personal smartphone or mobile device?
    a. Yes
    b. No

14. What is the process for your institution to recommend a Medical App?

15. Are these recommended Medical Apps available for free to download?
    a. No, have to be bought by individual
    b. Yes, free for all to download
    c. Yes, only for free for clinician working at the trust to download
    d. Some are for free to download, other have to be bought by the individual
    e. Not applicable
    f. Other

16. Does your institution provide any training regarding the use of recommended Medical Apps in the Clinical Environment, especially regarding perception by patients and relatives?
    a. Yes
    b. No
    c. Not applicable

17. If yes, could you explain

18. Which ANDROID Medical Apps are recommended by your institution?
    a. Name of App
    b. Name of App

c. Name of App
d. Name of App
e. Name of App

19. Which APPLE Medical Apps are recommended by your institution?
    a. Name of App
    b. Name of App
    c. Name of App
    d. Name of App
    e. Name of App

20. Which BLACKBERRY Medical Apps are recommended by your institution?
    a. Name of App
    b. Name of App
    c. Name of App
    d. Name of App
    e. Name of App

21. Has your department designed or commissioned specific local or regional network Medical Apps (Hospital App, Micro guide, Burns, Retrieval, PICU App etc) for clinicians to run on their personal smartphone or mobile device?
    a. Yes
    b. No

22. What was the design or commissioning process for the Medical App?
    a. Medical App designed in house by clinician
    b. Medical App designed in house by clinician with IT department
    c. Medical App designed in house by clinician and university
    d. Medical App designed outsourced to App design company
    e. Other (please specify)

23. Which APPLE Medical Apps (if any) has your Emergency Department designed or commissioned?
    a. Name/Topic of App
    b. Name/Topic of App
    c. Name/Topic of App
    d. Name/Topic of App
    e. Name/Topic of App

24. Which ANDROID Medical Apps (if any) has your Emergency Department designed or commissioned?
    a. Name/Topic of App
    b. Name/Topic of App
    c. Name/Topic of App
    d. Name/Topic of App
    e. Name/Topic of App

25. Has your department encountered any barriers regarding the use of Medical Apps in the Clinical Environment in your department? Select all relevant
    a. Unable to comment as we do not use Medical Apps in our Department
    b. Colleagues
    c. Institution
    d. Patients
    e. Technical
    f. Internet or Wifi Connection to run Medical App
    g. Price (cost to create Medical Apps)
    h. Price (cost to download Medical Apps)
    i. Other

26. What has enabled the use of Medical Apps in the Clinical Environment in your setting? Select all relevant
    a. Unable to comment as we do not use Medical Apps in our Department
    b. Colleagues
    c. Institution
    d. Patients
    e. Technical
    f. Internet or Wifi Connection to run Medical App
    g. Price (free to download)
    h. Price (funding to create Medical Apps)
    i. Other

27. Are you aware of any patients that has suffered harm, due to the use of Medical Apps as part of their care in your department (e.g. wrong drug dose, etc)? Select all relevant
    a. No, harm
    b. Yes, Serious Adverse Event (any untoward medical occurrence(s) that result in death, hospitalisation or prolongation of existing hospitalisation, persistent or significant disability/incapacity or a congenital anomaly or birth defect associated with treatment).
    c. Yes, Adverse Event (any unfavourable and unintended signs, including abnormal laboratory results, symptoms or a disease associated with treatment).
    d. Other

28. If you answered Serious Adverse Event, could you tell us what the problem was? Otherwise move on to next question.

29. If you answered Adverse Event, could you tell us what the problem was? Otherwise move on to next question.

30. When prescribing the following are acceptable options at your institution to check the dosing regime. Select all relevant
    a. Use of a paper based formulary book (eg British National Formulary or equivalent)

b. Use of a personal Smartphone to look up the dose on the electronic formulary (eg British National Formulary or equivalent)
c. Use of institutional mobile device to look up the dose on the electronic formulary (eg British National Formulary or equivalent)
d. Use of an online search engine to check the dose
e. Use of local guidelines (paper version)
f. Use of local guidelines (electronic version)
g. Other

31. In resus (sick patient in a time critical situation). There has been a pre-alert of a 2 year old arriving in 5 minutes seriously injured/unwell. To get yourself ready. Select all relevant
    a. We do not treat Children
    b. We will use a Broselow Tape when the child arrives
    c. We will use the WETFLAG calculation as per APLS & follow the APLS algorithm on the Wall
    d. We will use the Medical App on our personal mobile device
    e. We will use the Medical App on our insitutional mobile device
    f. We will print out the institutional Excel or similar age and weight based resus medicine crib sheet
    g. We will use the institutional aged base medicine folder with laminated age and weight based crib sheets
    h. We will use the Medical App on our personal mobile device get any infusions (eg inotropes) ready
    i. We will use the Medical App on our institutional mobile device to get any infusions (eg inotropes) ready
    j. We will use the institutional aged base medicine folder with laminated age and weight based crib sheets to get any infusions
    k. (eg inotropes) ready
    l. Other

32. In resus (sick patient in a time critical situation). There has been a pre-alert of a 30 year old arriving 5 minutes seriously unwell/injured. To get yourself ready. Select all relevant
    a. We do not treat adults
    b. We will use ALS (advanced Life Support) algorithm on the Wall
    c. We will use the Medical App on our personal mobile device
    d. We will use the Medical App on our institutional mobile device
    e. We will print out the institutional Excel or similar resus medicine crib sheet
    f. We will use the institutional medicine folder with laminated ALS based crib sheets
    g. We will use the Medical App on my personal mobile device to get any infusions (eg inotropes) ready
    h. We will use the Medical App on my institutional mobile device to get any infusions (eg inotropes) ready
    i. We will use the institutional medicine folder with laminated crib sheets to get any infusions (eg inotropes) ready

j. Other

[redacted]2. Stage (ii) individual clinician survey questionnaire

1. Where do you work?
    a. I work in the United Kingdom or Ireland
    b. Any other country

2. 4. In what country do you work?

3. How old are you?
    a. Years

4. What is your gender?
    a. Female
    b. Male
    c. Other

5. Please select the type of patients you normally treat. Select all relevant
    a. Adults (Medical)
    b. Children (Medical)
    c. Adult (Trauma)
    d. Children (Trauma)

6. Are you a medical doctor or medical Student?
    a. Yes, I am a medical doctor or medical student
    b. No, other healthcare professional

7. What is your role?
    a. Consultant (or equivalent on specialist register)
    b. General Practitioner (or equivalent on specialist register)
    c. Middle Grade Doctor (Staff grade or equivalent)
    d. Middle Grade Doctor (Registrar - ST4-ST8 or equivalent)
    e. Junior Medical Doctor (Senior House Officer - ST3 or equivalent)
    f. Junior Medical Doctor (Senior House Officer - ST1- ST2 or equivalent)
    g. Junior Medical Doctor (F2 or equivalent)
    h. F1 (Preregistration House Officer or equivalent)
    i. Medical Student
    j. Other

8. What is your Specialty (or specialty training program if trainee)? Select all relevant
    a. Anaesthetics
    b. Emergency Medicine
    c. Emergency Medicine & Paediatric Emergency Medicine (subspecialty training)

d. General Internal Medicine
e. General Practice
f. Intensive Care
g. Paediatrics (General Paediatrics)
h. Paediatrics & Paediatric Emergency Medicine (subspecialty training)
i. Paediatric Intensive Care
j. Paediatric Surgery
k. Surgery
l. Trauma & Orthopaedics
m. Other

9. What is your role?
    a. Paramedic
    b. Nurse Practitioner
    c. Advanced Nurse Practitioner (ANP)
    d. Emergency Room Nurse Practitioner (ENP)
    e. Paediatric Advanced Nurse Practitioner
    f. Nurse
    g. Other

10. In relation to the following types of Apps and mobile device functions, please indicate how often you use them to help you with your clinical and educational activities:
    Select all relevant
    a. medication formulary or drug reference
    b. clinical score systems or medical calculator
    c. disease diagnosis or management
    d. procedure documentation
    e. CPD (Continuing Professional Development) or eportfolio
    f. education (revision & learning)
    g. calendar, rota
    h. password storage (login details)
    i. email access (work email)
    j. staying in touch with colleagues
    k. Social Media (Twitter, Facebook, etc)
    l. web access
    m. other (please detail in comment box)
    n. Other

11. Does your institution provide free wifi or internet access to use Apps at work (both on the institutional and your personal mobile devices)?
    a. Yes
    No
    Other

12. Are you aware of your institution's mobile device policy?
    a. Yes

b. No

13. Does your institution's mobile device policy allow the use of a PERSONAL mobile devices eg smartphones, etc in the clinical environment?
    a. Yes
    b. No
    c. No, but tolerated I do not know
    d. Other

14. Does your institution's mobile device policy allow the use of an INSTITUTIONAL mobile devices eg smartphone, tablet etc in the clinical environment?
    a. Yes
    b. No
    c. No, but tolerated
    d. I do not know
    e. I do not know, as INSTITUTION does not provide mobile device
    f. Other

15. Do you use Medical Apps on your PERSONAL mobile device?
    a. Yes
    b. No

16. How many Medical Apps do you have on your personal mobile device (smartphone) per device?
    a. 0
    b. 1-5
    c. 6-10
    d. 11-15
    e. 16-20
    f. more than 20

17. Which type of mobile device do you use?
    a. Blackberry
    b. iPhone/iPad
    c. Android Phone/Tablet
    d. Other

18. Which BLACKBERRY Medical Apps do you have on your own personal device (e.g. electronic formulary, drug dose calculators, clinical guidelines, etc)?
    List them in order of frequency of use (most often used first).
    a. Name of App
    b. Name of App
    c. Name of App
    d. Name of App
    e. Name of App

19. Which is your FAVOURITE BLACKBERRY Medical App, that you love to use or you would highly recommend to a colleague?
    a. Name of App
    b. Name of App
    c. Name of App
    d. Name of App
    e. Name of App

20. Which APPLE Medical Apps do you have on your own personal device (e.g. electronic formulary, drug dose calculators, clinical guidelines, etc)?
    List them in order of frequency of use (most often used first).
    a. Name of App
    b. Name of App
    c. Name of App
    d. Name of App
    e. Name of App

21. Which is your FAVOURITE APPLE Medical App, that you love to use or you would highly recommend to a colleague?
    a. Name of App
    b. Name of App
    c. Name of App
    d. Name of App
    e. Name of App

22. Which ANDROID Medical Apps do you have on your own personal device(e.g. electronic formulary, drug dose calculators, clinical guidelines, etc)?
    List them in order of frequency of use (most often used first).
    a. Name of App
    b. Name of App
    c. Name of App
    d. Name of App
    e. Name of App

23. Which is your FAVOURITE ANDROID Medical App, that you love to use or you would highly recommend to a colleague?
    a. Name of App
    b. Name of App
    c. Name of App
    d. Name of App
    e. Name of App

24. Are you provided with an INSTITUTIONAL device to run Medical Apps?
    a. Yes
    b. No

25. How many Medical Apps are there on your institutional mobile device (smartphone, tablet, etc)?
    a. 0
    b. 1-5
    c. 6-10
    d. 11-15
    e. 16-20
    f. more than 20

26. What type INSTITUTIONAL mobile devices are you provided with to run Medical Apps?
    a. Blackberry
    b. iPhone/iPad
    c. Android Phone/Tablet
    d. Other

27. Which APPLE Medical Apps are provided on your trust or institution device (e.g. electronic formulary, drug dose calculators, clinical guidelines, etc)?
    List them in order of frequency of use (most often used first).
    a. Name of App
    b. Name of App
    c. Name of App
    d. Name of App
    e. Name of App

28. Which ANDROID Medical Apps are provided on your trust or institution device (e.g. electronic formulary, drug dose calculators, clinical guidelines, etc)?
    List them in order of frequency of use (most often used first).
    a. Name of App
    b. Name of App
    c. Name of App
    d. Name of App
    e. Name of App

29. Which BLACKBERRY Medical Apps are provided on your trust or institution device (e.g. electronic formulary, drug dose calculators, clinical guidelines, etc)?
    List them in order of frequency of use (most often used first).
    a. Name of App
    b. Name of App
    c. Name of App
    d. Name of App
    e. Name of App

30. Does your Institution recommend you Medical Apps to use on your personal mobile device?
    a. No
    b. Yes and they are for free to download for staff

c. Yes, but I have to pay for them
d. Yes some are free and some I have to pay for
e. I do not know

31. Which APPLE Medical Apps does your institution recommend?
    a. Name of App
    b. Name of App
    c. Name of App
    d. Name of App
    e. Name of App

32. Which ANDROID Medical Apps does your institution recommend?
    a. Name of App
    b. Name of App
    c. Name of App
    d. Name of App
    e. Name of App

33. Which BLACKBERRY Medical Apps does your institution recommend?
    a. Name of App
    b. Name of App
    c. Name of App
    d. Name of App
    e. Name of App

34. When asked to prescribe a drug that you need to check the dose regimen for....
    Select all relevant
    a. I will use a paper based formulary book (eg British National Formulary or equivalent)
    b. I will use my personal Smartphone to look up the dose on the electronic formulary (eg British National Formulary or equivalent)
    c. I will use an online search engine to check the dose
    d. I will use the institutional mobile device to look up the dose on the electronic formulary (eg British National Formulary or equivalent)
    e. I will use local guidelines (paper version)
    f. I will use local guidelines (electronic version)
    g. Other (please specify)

35. You are in resus (sick patient in a time critical situation). There has been a pre-alert of a 2 year old arriving in 5 minutes seriously injured/unwell. To get yourself ready
    Select all relevant
    a. I do not treat Children
    b. I will use a Broselow Tape
    c. I will use the WETFLAG calculation as per APLS & follow the APLS algorithm on the Wall
    d. I will use the Medical App on my personal mobile device
    e. I will use the Medical App on the institutional mobile device

f. I will print out the institutional Excel or similar age and weight based resus medicine crib sheet
g. I will use the institutional aged base medicine folder with laminated age and weight based crib sheets
h. I will use the Medical App on my personal mobile device get any infusions (eg inotropes) ready
i. I will use the Medical App on my institutional mobile device to get any infusions (eg inotropes) ready
j. I will use the institutional aged base medicine folder with laminated age and weight based crib sheets to get any infusions (eg inotropes) ready
k. I know all the calculations and dosages
l. From memory
m. Other (please specify)

36. You are in resus (sick patient in a time critical situation). There has been a pre-alert of a 30 year old arriving in 5 minutes seriously unwell/injured. To get yourself ready Select all relevant
    a. I do not treat Adults
    b. I will use ALS (Advanced Life Support) algorithm on the Wall
    c. I will use the Medical App on my personal mobile device
    d. I will use the Medical App on the institutional mobile device
    e. I will print out the institutional Excel or similar resus medicine crib sheet
    f. I will use the institutional medicine folder with laminated ALS based crib sheets
    g. I will use the Medical App on my personal mobile device to get any infusions (eg inotropes) ready
    h. I will use the Medical App on the institutional mobile device to get any infusions (eg inotropes) ready
    i. I will use the institutional medicine folder with laminated crib sheets to get any infusions (eg inotropes) ready I know all the calculations and dosages
    j. From memory
    k. Other (please specify)

10.4 Appendix 4: IGA The Use of Mobile Devices in Hospitals

Information Governance Alliance IGA

The Use of Mobile Devices in Hospitals (e.g. Phones, Tablets and Cameras)

Purpose

1. This short guidance note is aimed at hospitals where there are concerns about the inappropriate use of mobile devices, particularly cameras, within premises where care is provided. Each organisation is responsible for developing their own policy on the use of mobile devices and some may encourage and facilitate their use e.g. through provision of free Wi-Fi. However, there are risks that must be managed and this guidance aims to assist with the management of those risks.

Recommended Actions

- NHS Trusts should have clear rules on the use of mobile devices and on the use of mobile and camera phones, cameras, video and audio recording devices
- These rules and why they are important should be understood by all staff who need to be clear on expected behaviour and what to do when confronted by unacceptable behaviours
- Nurses in charge in clinical areas may agree exceptional use of mobile devices where circumstances warrant it e.g. to take pictures of a new-born or where a patient is too ill to move to a location where use is permitted. When agreeing the use of devices it is important that the risks identified in this guidance are recognised and managed
- All areas should be clearly marked with appropriate signage to leave patients, staff and visitors in no doubt where mobile devices can or cannot be used
- All staff should be encouraged and supported to enforce hospital rules by drawing attention to policies and restrictions
- Where there are recurring examples of unacceptable behaviours Trusts should consider whether sections 119 and 120 of the Criminal Justice and Immigration Act 2008 might provide options for removing individuals from hospital premises

Guidance

2. Communication with family and friends is often an essential element of support and comfort for a patient admitted to hospital. Patients generally prefer to use mobile devices e.g. phones and their integrated functionality such as texting and e-mailing to communicate. These mobile devices must be accepted as an important resource for patients and their visitors, but the risks associated with their use must be managed. The use of cameras within premises where care is provided is a particularly significant concern and many mobile phones are also cameras, video and audio recorders.

3. Many of these risks also apply to staff use of mobile devices for personal purposes on premises where care is provided and even where staff use is permitted, e.g. in emergencies, there are a range of significant information governance issues that need to be addressed (see IGA guidance on 'Bring Your Own Devices' for further information)[1].

4. It is important to differentiate between the use of mobile devices by patients to capture details of or record their own consultations which, if this can be done without incurring any of the risks identified below, is increasingly an accepted practice. Staff may need support to

[1] See also the GMC guidance at www.gmcuk.org/guidance/ethical_guidance/making_audiovisual.asp

10.5 Appendix 5: Acknowledgement

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10.6 Appendix 7: Ehrenwörtliche Erklärung

Ehrenwörtliche Erklärung

Hiermit erkläre ich, dass mir die Promotionsordnung der Medizinischen Fakultät der Friedrich- Schiller-Universität bekannt ist,

ich die Dissertation selbst angefertigt habe und alle von mir benutzten Hilfsmittel, persönlichen Mitteilungen und Quellen in meiner Arbeit angegeben sind,

mich folgende Personen bei der Auswahl und Auswertung des Materials sowie bei der Herstellung des Manuskripts unterstützt haben:

- Roland, D Consultant PEM, Leicester, UK, survey design, distribution Twitter
- Lyttle, M Consultant PEM, Bristol, UK, survey design, distribution PERUKI, distribution Twitter
- Jahn, IHJ Lecturer Mechanical Engineering, University of Queensland, Brisbane, Australia, statistics
- Behringer, W Prof EM, University of Jena, Germany, survey design, distribution of German language survey, review

die Hilfe eines Promotionsberaters nicht in Anspruch genommen wurde und dass Dritte weder unmittelbar noch mittelbar geldwerte Leistungen von mir für Arbeiten erhalten haben, die im Zusammenhang mit dem Inhalt der vorgelegten Dissertation stehen,

dass ich die Dissertation noch nicht als Prüfungsarbeit für eine staatliche oder andere wissenschaftliche Prüfung eingereicht habe und

dass ich die gleiche, eine in wesentlichen Teilen ähnliche oder eine andere Abhandlung nicht bei einer anderen Hochschule als Dissertation eingereicht habe.

SACHRANG ASCHAU i. CHIEMGAU 13.03.20 Heiko

Ort, Datum Unterschrift des Verfassers