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COMMENTARY

Utilisation of WhatsApp for Emergency Medical Services in Garissa, Kenya

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ABSTRACT

Garissa county, Kenya is a geographically large county with a mobile pastoralist population that has developed a method for emergency medical services (EMS) coordination using the WhatsApp communication platform. This work was based on a site visit, to better understand and describe the current operations, strengths, and weaknesses of the EMS communication system in Garissa. The use of WhatsApp in Garissa county seems to work well in the local context and has the potential to serve as a cost-effective solution for other EMS systems in Kenya, Africa, and other LMICs.

African Relevance

- WhatsApp can be used as a cost-effective EMS communication solution in LMICs.
- EMS systems are underdeveloped in Africa and many LMICs and require cost-effectivesolutions to improve coordination to enhance patient care.
- Despite affordability and ease of access, there are still challenges to using WhatsApp forEMS coordinationAfrican Relevance.

Introduction

Humans around the world are at frequent risk of needing unscheduled and acute medical attention and healthcare, and patients in low- and middle-income countries (LMICs) are particularly affected by delays in transportation to access care [1,2]. Emergency medical services (EMS) – formal systems of prehospital emergency care and transport, often delivered in ambulances – exist in a minority of African countries, and few Africans have the ability to access or utilise EMS services [3]. The Kenyan framework for the care of emergent conditions is built on a legal structure that is set forth in national law, including the constitution [4–6]. The Kenyan Ministry of Health has stated that the goal of providing universal health care requires improvement at all levels, including prehospital care [6–8]. The national goal is challenged by the absence of standards for prehospital provider knowledge or skills in Kenya [9], and there remains no single national emergency services access phone number [10]. Due in part to a county-based model of national health care devolution (decentralisation of health services to the county level), the Kenyan government is unable to estimate the number or location of EMS providers and ambulances across the country [7].

Access to wireless telecommunications, particularly mobile smartphones, has rapidly grown users' ability to share text, audio, video and photo messages [11]. Across Kenya, mobile phones are quite prevalent with some of the highest mobile phone ownership and usage rates around the world. Work in 2017 found that 80% of adults in Kenya reported owning a mobile phone, attributable, in part, to ubiquitous phone-based banking services in Kenyan society [12]. WhatsApp is a communication application that allows for direct messaging, including with groups of multiple users [11]. WhatsApp can be used on a mobile phone across all smartphone platforms[13], and also has a web-based platform for use on a PC or Mac [11]. As of 2021, WhatsApp was the most popular digital messaging platform in the world, and 97% of internet users aged 16-64 years in Kenya access WhatsApp monthly, which is the highest population percent for a single country globally [14–16]. This application is free to download and use, though users may have costs associated with the data used by their mobile phone to operate the platform. Prior research has shown that WhatsApp can be utilised for a variety of applications in telehealth/telemedicine [17],

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medical education[18], hand-off of clinical care[19], and real-time consultation with physicians [20]. Medical specialties that utilise images or short videos for clinical practice have found particular value in group messaging on WhatsApp including dermatology[21], neurosurgery[22], and orthopedic surgery [23,24]. The end-to-end encryption of WhatsApp messages provides some data security that is particularly important in healthcare communications.

Since 2015, Garissa county, Kenya has leveraged the WhatsApp platform to assist in organising EMS transport and interfacility transfers. The objective of this report is to provide a descriptive account of a locally adapted, unique system for EMS access and coordination in Garissa county, Kenya utilising WhatsApp.

Methods

Design

This is a rapid assessment of an existing EMS healthcare system using a combination of field visitation observational and in-person interviews. Authors completed a search of both peer reviewed and gray literature sources regarding the local and national context, and EMS communication tools in LMICs.

Setting and population

Garissa county, Kenya is one of 47 counties in the Republic of Kenya, located on the eastern Kenyan border with Somalia [25]. Garissa county covers 44,736 km^2 and is divided into six constituencies [25]. Per the most recent 2019 census the county has a population of 841,353 citizens, which are 54.6% male, and an average household size of 5.9 members [26]. Most of the county population is nomadic pastoralists and almost all of the land is communally owned [27]. The county network of formal roads is 2700km and the majority are dirt roads (35km is paved/bitumen, 420km is gravel surface, and 2245km of dirt roads) [27]. The county has numerous laghas (dry riverbeds) that are crossed by roadways, which can become impassable during the rainy season [27].

The county has one county referral hospital in Garissa town and seven sub-county hospitals, as well as 56 dispensaries, 21 health centers, and 123 private clinics and nursing homes [27,28]. Nomadic health clinics have been used to help improve access to primary care [27]. The county government has acknowledged that many facilities lack basic equipment and only two of the sub-county hospitals have functional operating theatres [27].

Garissa county constituents have reported that local ambulance service access is limited [29]. Ambulance services fall within the mandate of the Garissa Health and Sanitation Services department [27]. The county has acquired and operates 14 ambulances; two are based at the county referral hospital, with the other sub-county facilities with 1–2 ambulances each. The county's underdeveloped road network has created the need for frequent vehicle maintenance, which is under-funded [27]. There are no private EMS services available in Garissa county, and non-ambulance transportation options are not staffed by medically trained staff, can be prohibitively expensive, or are unable to be used over long distances [29]. Ambulances are staffed by both Emergency medical technicians (EMTs) and vehicle operators. EMTs in Garissa have basic medical skills and training (must have completed one of the following courses: EMT-basic, emergency medical dispatch, or first responder). Ambulance operators are vehicle drivers.

In one study in Garissa county, all participants (n=380) reported having and using mobile phones [30]. Garissa county has three mobile phone service providers, with a calculated geographic mobile phone network coverage of around 62% of the county [27]. Within Garissa county, mobile phones have been shown to be used for a variety of roles including coordinating shepherding work and understanding and updating on more distant grazing conditions [31].

Approach

The Emergency Medicine Kenya Foundation (EMKF), a non-governmental organisation supporting emergency healthcare providers across Kenya by strengthening the emergency healthcare system, has been working with the Garissa county government since 2018 to improve the quality of emergency healthcare services in the county. The authors, in collaboration with EMKF, crafted a set of domains and open ended topics which co-author (Kennedy) then utilised to conduct in-person interviews in April 2022. Discussions were held with stakeholders including at the county health department, the emergency referral coordinator, emergency medical technicians, ambulance staff, and healthcare workers (physicians, clinical officers, nurses) at county and sub-county hospitals. Broadly, discussions were informal and took place with either one or a few individuals at a time. Interviews were all oriented around understanding and describing the steps, workflow, reliability, and participants involved in patient referral and transport while utilising WhatsApp in Garissa county. Handwritten notes were taken but no audio or video recordings were made. All co-authors held a daily debriefing call during the field visit to review the content learned in that day's meetings and conversations and to further identify gaps that would need to be addressed in the next day's discussions.

Approvals

The county government provided written approval for the project. Institutional Review Board review was not sought, as this is a commentary highlighting existing operational procedures and no patient or individual data was obtained or evaluated. We collected verbal permission from each respondent prior to interviewing them, including an explanation that we planned to publish the anonymised findings through the lens of a description of the EMS workflow and process.

Results

Inauguration of emergency and referral WhatsApp platforms

The Garissa WhatsApp workflow/platform was created in 2015 with the aim of focusing and improving emergency coordination and transportation monitoring. Prior to implementation, EMS communication was primarily based on landline and cell phone communications and in-person patient care sign over. The updated communication workflow was done in order to improve timely coordination, monitor ambulance movement, identify logistical challenges and better gather daily data and statistics. Two separate WhatsApp groups were created: a larger group referred to as the "Movement Group", and a second "Data Group". County-based healthcare providers, ambulance teams, and administrators are all a part of the WhatsApp groups in order to enhance closer monitoring of logistics and attempt to address real-time needs.

The Garissa County Referral Hospital (GCRH) and the county's Emergency and Referral Command Center (ERCC) work in coordination. The ERCC serves as the dispatch coordinator for the county and EMS teams, while the GCRH is the largest health facility and is based in Garissa town. The county emergency and referral coordinator, based at the ERCC, is the administrator of the WhatsApp groups. Supplement 1 outlines the key stakeholders in the Garissa county EMS referral and transfer process.

Operational procedure

Patient cases/referrals are brought into the Garissa county EMS transport and WhatsApp communication platform in one of three ways. First, the ERCC dispatch can receive a call from the public on the emergency phone hotline from anywhere in the county; although no specific data has been collected regarding frequency of this occurring, it is anecdotally less common. Second, a patient is referred/transferred

from one of the sub-county facilities to the GCRH. Lastly, a patient is referred/transferred out of the county to a higher-level facility. Fig. 1 highlights the flow of EMS transport systems, and Supplement 2 details the steps in the referral and communication pathways. If a sub-county facility does not have an operational ambulance or a local ambulance team is out on a call, the sub-county emergency and referral coordinator will notify the command center of the situation. The dispatcher on call will then mobilise an available ambulance from elsewhere.

WhatsApp movement group

Once a transport is initiated, the ambulance crew and other facility-based healthcare staff use the WhatsApp platform to provide de-identified clinical information about the patient and stay abreast with updates and make appropriate preparations when indicated. In some instances, a specialist can provide real-time management suggestions (Fig. 2). Supplement 3 highlights the members of the Movement Group. After handing the patient over, the ambulance team will post on the Movement Group with an update to all members (particularly the ERCC) that they have handed over the patient, who received the patient, the patient's condition and the time of hand-off.

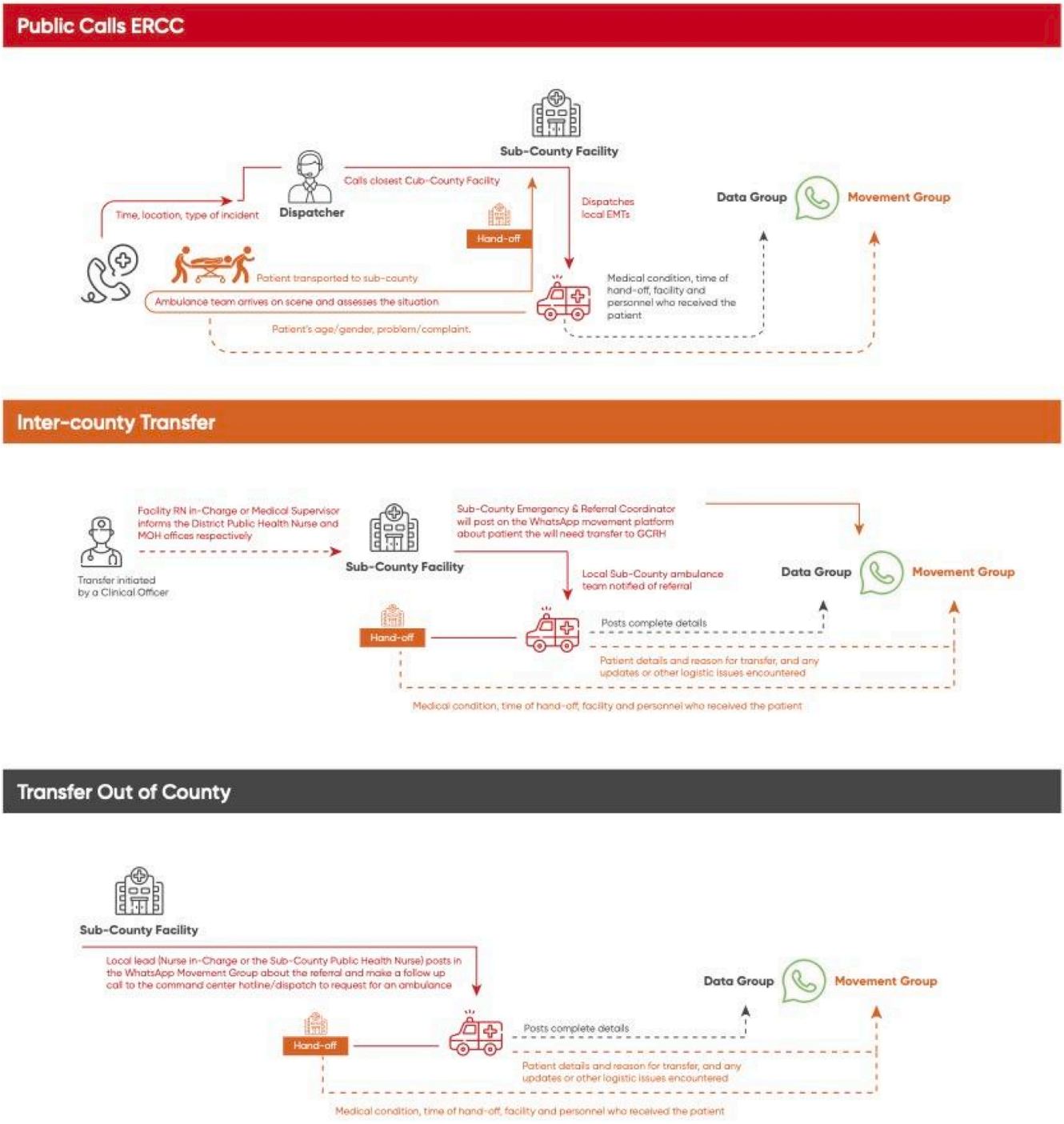

Fig. 1. Patient transport with EMS and communication flow.

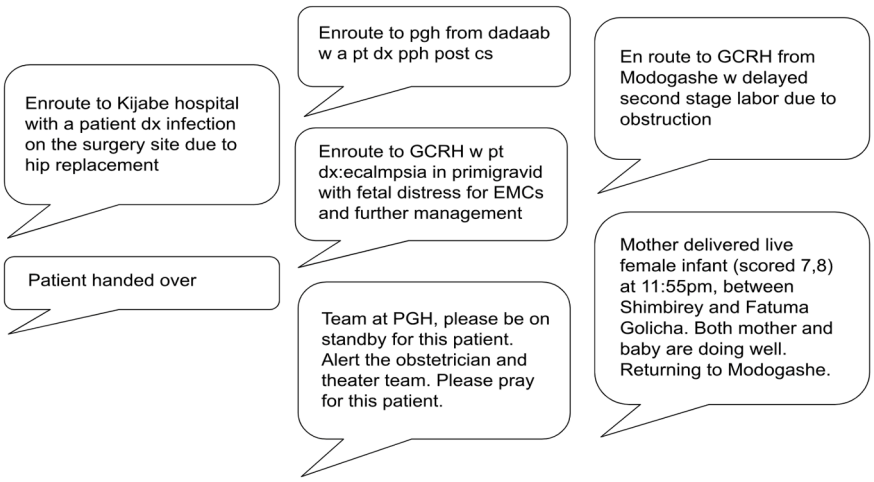

Fig. 2. Examples of movement group messages.

WhatsApp data group

Daily data entry and statistical tracking occurs throughout each ambulance team's shift (Fig. 3). The main purpose of this WhatsApp group is to collect correct and detailed patient data for all patients transported by EMS. The data is abstracted and stored electronically at the ERCC for record-keeping. There are fifteen members in this WhatsApp Data Group, including the emergency and referral unit coordinator for Garissa county and the EMTs within Garissa county.

Information security

There are over 100 different individual users with access to the Garissa county EMS WhatsApp Groups. While only de-identified data is used in the larger Movement Group, as in other local communities around the world, there is still the risk of staff being able to identify other community members based on de-identified information. The WhatsApp application is end-to-end encrypted; however, personal devices may not be encrypted. Both the Movement and Data Group conversations are not deleted or archived in any systematic manner, and they are also stored in "soft copy" on a desktop computer at the county referral coordinators office. To date, there are no known incidents of inappropriate sharing of patient's private health information, but there is no written policy on data security in place.

Annual data

From 2015 through the end of 2021, there were 12,267 EMS transport events recorded in Garissa county Kenya. There is no delineation between scene transport and inter-facility transfers. As noted in Fig. 4, the first four years saw overall steady utilisation, though both 2020 and 2021 saw substantially decreased utilisation which is anecdotally attributed in part to the SARS-CoV-2 pandemic as well as the development of increasingly frequent oil/petroleum shortages in Kenya.

Discussion

Garissa county in Kenya has been using WhatsApp as an EMS coordination platform since 2015. Previous literature has described ways in which WhatsApp has been leveraged for coordinating out of hospital and pre-hospital care. Transfer coordination in India showed particular value in real-time information to and from interfacility healthcare teams [35]. Prior work evaluating the role of WhatsApp in EMS care in Turkey showed both improved in-hospital patient care for ST elevation myocardial infarction patients when EMS crews were able to transmit electrocardiograms for review and early hospital resource mobilisation [13]. Others have used WhatsApp to coordinate across in- and out-of-hospital team members which can increase collaboration and break down hierarchies [32,33]. Healthcare providers find applications like WhatsApp with the ability to send instantaneous messages as

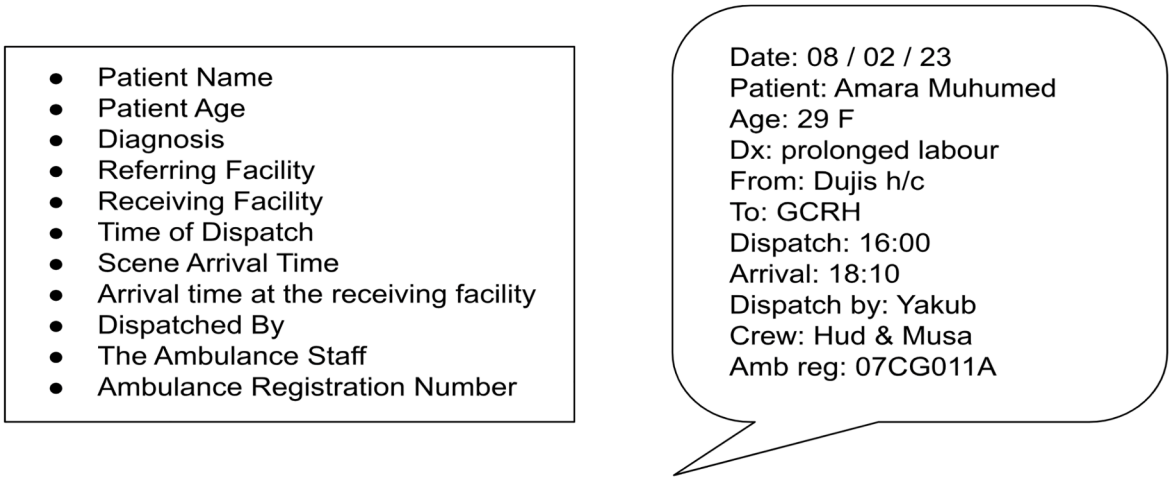

Fig. 3. Data expected for each case and an example message in the Garissa WhatsApp data group.

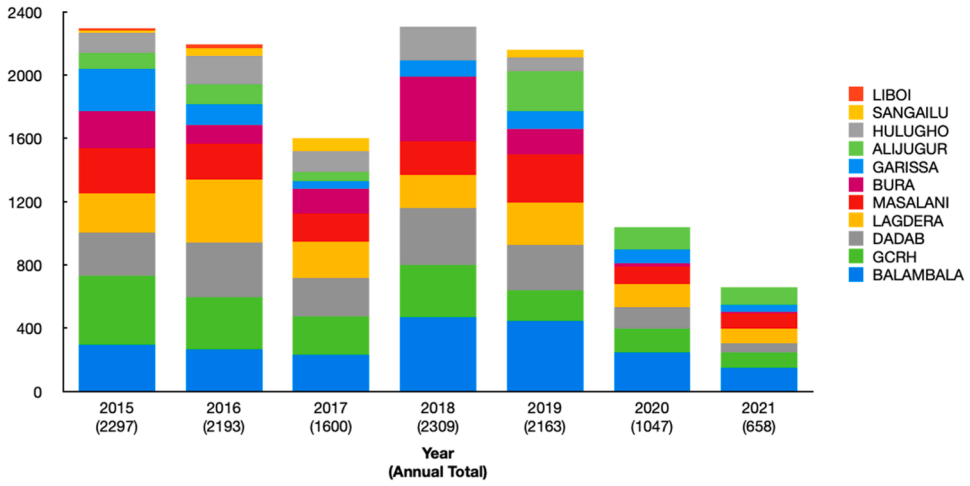

Fig. 4. Annual EMS transports in Garissa Kenya (2015–2021), by sub-county.

convenient and useful due to their "simplicity, timeliness and cost effectiveness" [34].

The use of WhatsApp in Garissa county has improved the effectiveness and efficiency of the local EMS in several ways. WhatsApp use has streamlined communication and shifted to real-time group-based conversations. Ambulances are able to be centrally dispatched based on real-time availability and demand. Using WhatsApp to notify hospitals in advance about incoming patients allows them to prepare personnel and equipment, and has also allowed facility-based staff to provide medical command to EMS teams in the field. WhatsApp does offer potential cost savings as well, eliminating pay as you go phone calls or SMS messages, or other potentially more costly communication methods. Group-based messaging has allowed for near-instant dissemination of a broadcast message to relevant stakeholders. Further, county health officials can provide real time oversight, assist in decision-making, provide quality assurance, and have a real-time source of data for collection and reporting.

Challenges

Our 2022 field visit helped to elucidate the current state of operations as well as understand the strengths and weaknesses of the Garissa EMS communication system operations. How WhatsApp sends notifications to each user in a group could lead to information overload, frequent messages, and the possibility of any given user missing an important message. There is no closed-loop format for communication – though this could be resolved by implementing a simple closed-loop feedback mechanism. Other challenges include inadequate mobile phone network coverage in some areas of Garissa county, though anecdotally individuals simply draft and hit send on such messages in WhatsApp, which are then transmitted once there is a cellular network connection. When using mobile data networks to send and receive WhatsApp messages there may be some cost to the cellular user, although several telecom providers in Kenya offer bundles that can include free data use for WhatsApp. Local officials noted that radio or other non-internet-based communication modalities could be of potential benefit but carry substantial cost implications. Ambulances and crews do not have any electronic tracking technologies to be able to know precise geographic locations, a particular challenge given the extent to which most local roads are unpaved.

Confidentiality

While a variety of mHealth applications (mobile health products and technology solutions that aim to improve patient care and healthcare delivery) are built to meet certain ethical and regulatory standards, the use of WhatsApp for the coordination of medical care does pose ethical and regulatory concerns including patient confidentiality as well as worries around data "security, record keeping, and storage" [32,34]. Patient's personal information and healthcare data are potentially at risk at several levels, including during "storage on servers, and on the sender's and receiver's phones" [38]. That said, any digital platform is potentially at risk of third parties accessing patient's data. WhatsApp messages and conversations are always protected with end-to-end encryption, and neither WhatsApp nor its parent company Meta can see private messages. There is the ongoing risk of individuals accidentally posting to the incorrect WhatsApp chat on their mobile device, for example, posting a message intended for the Data Group to a personal chat.

A patient's right to personal and healthcare confidentiality is a guiding ethical principle in medical care, with roots in the Hippocratic Oath [36]. The use of mHealth and other electronic platforms for coordination and patient care does present opportunities for a patient's personal health information to be made known to others. The Kenyan Data Protection Act of 2019 comprehensively defines patient health data as information about the past, present or future state of the physical or mental health including data collected for "registration for, or provision of health services" [37]. However, other authors have outlined steps they have taken to minimise patient data risks on WhatsApp, including "keeping record of all patients physically (either analog or digital) at the referred hospital and periodically delet[ing] all archived data", and obtaining patient consent with notice that WhatsApp is used "for the purpose of transfer" [35].

Other communication platforms

While the price and ubiquity of WhatsApp are particularly appealing for use in a variety of situations, there are other platforms that have been developed for mobile communications that can be used by emergency services. Unfortunately, many of those applications come with a cost to either set up and/or maintain. Vula mobile, based in South Africa, was built for healthcare workers and health departments and is built to facilitate consultation and referral, and allows for the transfer of patient images and information [39]. RapidDeploy is a cloud-based dispatch platform[40], Twiage is a prehospital communication app[41], and Pulsara is a unified prehospital and health facility communications platform [42]. There are numerous other commercial applications with mobile phone capability, but again, most of these come with high start-up and ongoing utilisation costs, thereby increasing the appeal and practicality of WhatsApp, particularly in Kenya where personal cell

phones are ubiquitous and phone calls and text messages are often pay-as-you-go.

To address the challenges of accurately geographically locating EMS crews or patients in the field, EMS teams in Garissa, and elsewhere, may find benefit from using the what3words application. What3words is an application that has taken the world map and divided it into 3×3 meter squares, and each square has been given a unique three word name [43]. Users can navigate to or from any location using other integrated navigation applications, and locations can also be accessed through an online website if not using the application [43]. Alternatively, using local landmarks that are well-known in the community, or establishing land landmarks or collection points where necessary, may be one strategy to minimize this challenge particularly in a large and minimally paved land-area like Garissa county.

Applicability to other LMICs

We believe that the WhatsApp coordination system as implemented in Garissa county in Kenya has the potential to be adapted elsewhere; growing EMS systems that are aiming to professionalise and improve coordination may find benefit from such a system. WhatsApp is particularly appealing in locations with high levels of active mobile phone and WhatsApp usage and is a potentially cost-effective approach with benefits that can extend beyond phone call or radio-based communications, including the ability to coordinate information with multiple recipients and share media files. Systems that have integrated lay first responders may also find value in leveraging WhatsApp group messaging to coordinate a response to the scene or forward details of a scene to a central coordinator. Further, the WhatsApp platform can help collect data that can be used to form a database that can be used for advocacy around emergency system gaps and needs.

Approaches to improving confidentiality protections, both in Garissa county, as well as elsewhere, could include some of the following suggestions: education and training for all WhatsApp group members, establish clear written protocols for access and archiving, ensure strict access controls, perform regular audits and monitoring, minimise patient data sharing to the extent possible, engage patients in a consent process, routine data archiving/deletion, ensure local and national legal and regulatory compliance, delineate in writing the roles and responsibilities of WhatsApp group members, and provide routine refresher training and ensure abeyance with policies.

Limitations

The information collected in the study was based on a single field visit and a non-exhaustive set of meetings and conversations with different leaders and members of the EMS system in the county. This commentary was based on publicly available data and non-systematic descriptive conversations to obtain information. During the field visit itself, several ambulances were out of commission and national fuel shortages hampered research team member's ability to experience transportation to all sub-county sites and ensure all potential stakeholders' experiences or perspectives were captured.

Conclusion

Garissa county in Kenya has developed a functional system for coordinating and communicating EMS patient care based on the WhatsApp platform. While there are particular benefits, such as widespread availability, we identified specific challenges, including data security and incomplete cellular coverage. Notwithstanding, the novel use of WhatsApp is a potentially cost-effective solution for EMS systems throughout Kenya, Africa, and other LMICs.

Dissemination of results

This work has been shared with the Emergency Medicine Kenya Foundation and will be further disseminated with relevant stakeholders at the local and national level within Kenya.

Author's contribution

Authors contributed as follow to the conception or design of the work; the acquisition, analysis, or interpretation of data for the work; and drafting the work or revising it critically for important intellectual content: JAL 45%, BWW and NKMM 20% each, JK 10%, and NA 5%. All authors approved the version to be published and agreed to be accountable for all aspects of the work.

Declaration of competing interest

The authors declare no conflicts of interest.

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Supplementary materials

Supplementary material associated with this article can be found, in the online version, at doi:10.1016/j.afjem.2024.01.002.

References

[1] Pines JM, Lotrecchiano GR, Zocchi MS, Lazar D, Leedekerken JB, Margolis GS, et al. A conceptual model for episodes of acute, unscheduled care. Ann Emerg Med 2016;68(4):484–91.

[2] Thind A, Hsia R, Mabweijano J, Hicks ER, Zakariah A, Mock CN. Prehospital and emergency care. In: Debas HT, Donkor P, Gawande A, Jamison DT, Kruk ME, Mock CN, editors. Essential surgery: disease control priorities, third edition (Volume 1) [Internet]. Washington (DC): The International Bank for Reconstruction and Development /The World Bank; 2015 [cited 2023 Feb 7]. Available from: http://www.ncbi.nlm.nih.gov/books/NBK333513/.

[3] Mould-Millman NK, Dixon J, N S, A Y, Bg H, M H, et al. The state of emergency medical services (EMS) systems in Africa. Prehospital Disaster Med [Internet] 2017;32(3). Jun [cited 2022 Mar 10]Available from: https://pubmed.ncbi.nlm.nih.gov/28228178/.

[4] Burkholder TW, Bergquist HB, Wallis LA. Governing access to emergency care in Africa. Afr J Emerg Med 2020;10:S2–6.

[5] The Health Act, 2017 [Internet]. Kenya Gazette Supplement No. 101 (Acts No. 21) Jul 7, 2017. Available from: http://kenyalaw.org/kl/fileadmin/pdfdownloads/Acts/HealthActNo.21of2017.pdf.

[6] Lee JA, Wanjiku G, Nduku N, Aluisio AR, Kharel R, Simiyu JT, et al. The status and future of emergency care in the Republic of Kenya. Afr J Emerg Med 2022;12(1):48–52.

[7] Ministry of Health, Kenya. Kenya emergency medical care policy: 2020 - 2030. [cited 2021 Feb 27]. Available from: https://www.emergencymedicinekenya.org/wp-content/uploads/2020/11/KENYA-EMERGENCY-MEDICAL-CARE-POLICY.pdf.

[8] Ministry of Health, Kenya. Kenya emergency medical care strategy: 2020 - 2025. [cited 2021 Feb 27]. Available from: https://www.emergencymedicinekenya.org/wp-content/uploads/2020/11/KENYA-EMERGENCY-MEDICAL-EMERGNCY-STRATEGY_2020-2025.pdf.

[9] Nicholson B, McCollough C, Wachira B, Mould-Millman NK. Emergency medical services (EMS) training in Kenya: findings and recommendations from an educational assessment. Afr J Emerg Med 2017;7(4):157–9.

[10] Wachira BW, Mwai M. A baseline review of the ability of hospitals in Kenya to provide emergency and critical care services for COVID-19 patients. Afr J Emerg Med 2021;11(2):213–7.
[11] Giansanti D. WhatsApp in mHealth: an overview on the potentialities and the opportunities in medical imaging. mHealth 2020;6:19.
[12] Kibuacha F. Mobile penetration and growth in Kenya [Internet]. GeoPoll 2021 [cited 2023 Feb 7]. Available from: https://www.geopoll.com/blog/mobile-penetration-kenya/.
[13] Astarcioglu MA, Sen T, Kilit C, Durmus HI, Gozubuyuk G, Kalcik M, et al. Time-to-reperfusion in STEMI undergoing interhospital transfer using smartphone and WhatsApp messenger. Am J Emerg Med 2015;33(10):1382–4.
[14] What countries are the biggest WhatsApp users? [Internet]. Verint. [cited 2023 Feb 7]. Available from: https://www.verint.com/blog/what-countries-are-the-biggest-whatsapp-users/.
[15] Social media trends 2020, latest trends & statistics report - GWI [Internet]. [cited 2023 Feb 7]. Available from: https://www.gwi.com/reports/social-2020.
[16] Zinke-Allmang A, Hassan R, Bhatia A, Gorur K, Shipow A, Ogolla C, et al. Use of digital media for family planning information by women and their social networks in Kenya: a qualitative study in peri-urban Nairobi. Front Sociol 2022;7:886548.
[17] Giordano V, Koch H, Godoy-Santos A, Dias Belangero W, Esteves Santos Pires R, Labronici P. WhatsApp messenger as an adjunctive tool for telemedicine: an overview. Interact J Med Res 2017;6(2):e11.
[18] Coleman E, O'Connor E. The role of WhatsApp® in medical education; a scoping review and instructional design model. BMC Med Educ 2019;19(1):279.
[19] Barnes T, Rennie SC. Disrupting clinical education: WhatsApp-ened to patient handover? Clin Teach 2020;17(5):493–6.
[20] Gulacti U, Lok U, Hatipoglu S, Polat H. An analysis of WhatsApp usage for communication between consulting and emergency physicians. J Med Syst 2016;40(6):130.
[21] Williams V, Kovarik C. WhatsApp: an innovative tool for dermatology care in limited resource settings. Telemed J E-Health Off J Am Telemed Assoc 2018;24(6):464–8.
[22] Lo Bue E, Maugeri R, Iacopino DG, Somma T, Graziano F. Other apps beyond WhatsApp. World Neurosurg. 2019;130:567.
[23] Kauta NJ, Groenewald J, Arnolds D, Blankson B, Omar A, Naidu P, et al. WhatsApp mobile health platform to support fracture management by non-specialists in South Africa. J Am Coll Surg 2020;230(1):37–42.
[24] Stahl I, Dreyfuss D, Ofir D, Merom L, Raichel M, Hous N, et al. Reliability of smartphone-based teleradiology for evaluating thoracolumbar spine fractures. Spine J Off J North Am Spine Soc 2017;17(2):161–7.
[25] Infotrak research. Garissa County | County Trak Kenya [Internet]. [cited 2022 Mar 22]. Available from: http://countytrak.infotrakresearch.com/garissa-county/.
[26] Kenya National Bureau of Statistics. 2019 Kenya population and housing census volume i: population by county and sub-county [Internet]. [cited 2021 Apr 28]. Available from: https://www.knbs.or.ke/?wpdmpro=2019-kenya-population-and-housing-census-volume-i-population-by-county-and-sub-county.
[27] County Government of Garissa. Second Garissa county integrated development plan (2018-2022) [Internet]. p. 470. Available from: https://repository.kippra.or.ke/bitstream/handle/123456789/467/2018-2022%20Garissa%20County%20CIDP.pdf.
[28] County Government of Garissa. Health & sanitation services – Garissa county [Internet]. Health Sanitat Serv 2023 [citedDec 23]. Available from: https://garissa.go.ke/health/.
[29] N'Gbichi C, Ziraba AK, Wambui DW, Bakibinga P, Kisiangani I, Njoroge P, et al. "If there are no female nurses to attend to me, I will just go and deliver at home": a qualitative study in Garissa, Kenya. BMC Pregnancy Childbirth 2019;19(1):332.
[30] Ngera R. Factors affecting the of use mobile banking in Kenya: a case of equity bank Garissa branch [Internet]. University of Nairobi; 2013 [Thesis][cited 2023 Feb 7]. Available from: http://erepository.uonbi.ac.ke/handle/11295/77057.
[31] Mwanyumba PM, Wahome R, Macopiyo L, Njuki P. Pastoralist livelihoods, resources and strategies in Garissa County, Kenya. Livest Res Rural Dev. 2015;27.
[32] Gould G, Nilforooshan R. WhatsApp doc? BMJ Innov. 2016;2(3):109–10.
[33] Johnston MJ, King D, Arora S, Behar N, Athanasiou T, Sevdalis N, et al. Smartphones let surgeons know WhatsApp: an analysis of communication in emergency surgical teams. Am J Surg 2015;209(1):45–51.
[34] Mars M, Morris C, Scott RE. WhatsApp guidelines - what guidelines? A literature review. J Telemed Telecare 2019;25(9):524–9.
[35] Neogi S, Panda SS. Using Whatsapp to Facilitate Inter-institutional Patient Transfer. Indian Pediatr 2020;57(11):1084–5.
[36] Razis DV. Medical confidentiality. Qual Assur Health Care Off J Int Soc Qual Assur Health Care 1990;2(3–4):353–7.
[37] Republic of Kenya. The data protection act, 2019 [Internet]. Kenya Gazette Supplement 2019:49. Nov 8Available from: http://kenyalaw.org/kl/fileadmin/pdfdownloads/Acts/2019/TheDataProtectionAct_No24of2019.pdf.
[38] Morris C, Scott RE, Mars M. Security and other ethical concerns of instant messaging in healthcare. Stud Health Technol Inform 2018;254:77–85.
[39] Vulav. Secure medical chat & patient referrals [Internet]. Vula - Secure medical chat. [cited 2021 Nov 4]. Available from: https://www.vulamobile.com.
[40] RapidDeploy. RapidDeploy [Internet]. RapidDeploy. [cited 2021 Nov 4]. Available from: https://www.rapiddeploy.com.
[41] Twiage prehospital communication and coordination [Internet]. [cited 2023 Feb 8]. Available from: https://www.twiagemed.com/.
[42] Pulsara. Pulsara - communication & logistics for better patient care [Internet]. [cited 2023 Feb 8]. Available from: https://www.pulsara.com.
[43] what3words. The what3words app [Internet]. [cited 2021 Nov 4]. Available from: https://what3words.com/products/what3words-app.