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Digital Empowerment for Health Workers and Implications on EMRs Utilisation

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Background and Purpose: Utilization of Electronic Medical Records (EMRs) bring many benefits to patient record handling. Previous research has shown that medical doctors in hospitals in Africa had poor IT skills, partly disabling their use of EMRs. Working in health centres, we wanted to know how to improve the digital skills of their personnel.
Methods: Qualitative methods including interviews, informal discussions and observation were used for data collection. The study was conducted in three health facilities in Malawi, selected purposively as these were the ones implementing the EMR under study. The study targeted all staff that were capturing data at point of care using the app between January and June 2019.
Results: Personnel in the health centres were computer illiterate, even if they used phones, and some smart phones. After computer training, they were still not comfortable using EMRs because their typing speed was delaying the process. Improving the typing speed allowed the users to comfortably use the EMRs. Three levels of EMR empowerment were identified; being able to 1) use EMR where typing speed is less relevant, 2) use EMR at point of care, 3) guide colleagues on their EMR use and find new ways of exploiting the technology. For reaching level 2, 50-100 hours of typing practice would be necessary.
Conclusions: Health workers who lack computer skills tend to shy aware from using EMRs. Even if falling prices of equipment will enable more EMRs in rural areas, the digital empowerment process will still require significant resources.

Keywords: Electronic Medical Record, Digital Empowerment, Computer Literacy, Keyboard Typing.

1 Introduction

In health care, the patient record is at the center of everything [1]. Over the years, different information systems have been developed to improve the way of handling the patient records. One of the ways is the introduction of Electronic Medical Records (EMRs). "The electronic medical record has been pursued as an ideal by so many, for so long, that some suggest that it has become the Holy Grail of Medical Informatics" [2]. Further, some believe that handling the increased complexity of health care processes is almost impossible without the use of electronic records. Literature has shown that utilization of EMRs bring many benefits which include quality enhancement; efficiency of care; easing labour shortages; medical error reduction; providing accurate, up-to-date, and complete information about patients at the point of care; enabling quick access to patient records for more coordinated, efficient care; securely sharing electronic information with patients and other clinicians; improving patient and service provider interaction and communication; and reducing costs through decreased paperwork [3, 4]. Much as there are so many benefits associated with the use of electronic records; these benefits are realized once the requisites are in place. *Just like a car owner cannot drive his car without having driving skills; and may not enjoy driving if he has minimal driving skills;* In the same vain, a health worker who is not digital

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literate or has minimal digital skills may not be able to achieve the full benefits of an electronic system even if it were made available to them. They have to be digital empowered first.

Digital empowerment, is developing digital mastery in your particular field. In this paper we focus on health workers using EMRs. We argue that the health workers should have the digital literacy and skills to be able to competently use the EMRs. Kuek and Hakkennes [5] confirm that staff with low digital literacy adversely affects the safety and quality of patient care where EMRs are in use and they strongly recommend training of such staff prior to implementation of an EMR. Digital experience of the health worker matters in this case. In this study, we use health workers in Malawi as a case.

1.1 EMR Utilisation Gap in Malawi

Utilisation of EMRs in Malawi dates back to 2001. However, a study conducted by Msiska et al. [6] reveal that in the two main referral hospitals, some health workers still prefer to use paper-based records to EMRs. One of the factors hindering progress of EMR utilization is low digital skills amongst health workers. A global study revealed that the root cause of many issues is due to the fact that employees are not digital literate enough [5, 7, 8]. This is where this paper zeros in, critically analyzing the impact of digital experiences for health worker on EMRs utilization and discussing some processes and practices that can help in digital empowerment of health workers. A number of pilots have demonstrated that use of EMRs is possible and that they can expand to manage hundreds of thousands of patients. One important thing that needs to be taken into consideration is the time it takes to capture these records against the number of patients waiting to be served.

2 Literature Review

2.1 EMR Utilisation

Globally, EMR utilization is on the increase and have been widely adopted [9]. An EMR is an individual's health-related record, generated and managed using computer software, and used by authorized healthcare workers. Many researchers have testified that EMRs offers numerous benefits to the healthcare sector where it comes to patient record management; others are of the contrary view and to them, EMRs are "*a known source of frustration, stress and burnout for physicians*" [10]. Kunzmann [10] argument is based on a number of surveys: 1) where John Prunskis, MD, asked his staff of 75 health care providers a simple question: Which was better—their new EMR system, or the record-keeping system it replaced and not a single member of his staff could throw their support behind the EMR. 2) Another assessment conducted in July 2017 of 1752 practicing family physicians found that 44.6% (782) believed they spend an excessive or moderately high amount of time working on EMRs at home. 3) A cohort study of 27 ophthalmologists from November 2017 reported that a mean of 27% of an ophthalmologist's time with a patient is spent on EMR use —equating to nearly four hours per day. 4) When the question: "*are EMRs a boon or a bane your spine practice?*" was posed to Spine doctors and all of them felt it was bane to a larger extent; emphasizing that the EMRs can only become boon if fully implemented. Although most Medical Doctors view EMRs as being bane, EMR implementation has several benefits. Expected benefits must be weighed against the cost of software, hardware, and training as well as the ongoing costs of updating all three [11]. The benefits include: minimizing missing information and error reduction [12]. Castelnuovo et al. [12] allude to the fact that the improvements came about given the long implementation which allowed the clinic staff to gain knowledge and experience, as well as data quality awareness

2.2 EMR Implementation Cost

As EMR utilization is being widely adopted in developed countries, the same is true in developing countries. However, there is one notable difference between EMR development and implementation in the developed and developing countries. In developing countries EMR implementation is externally funded and failure of such implementations has far reaching implications both to the implementer and the funder. Ironically, the cost of implementing an EMR can be very high. Fraser et al. [6] estimate the cost of implementing an EMR in rural Haiti at $45,000; Humpage [11] discuss a major EMR initiative that will allow doctors from any institution access their patient's complete EMR in Mexico called the NECE

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(nuevo expediente clínico electrónico) with two components - software and hardware infrastructure to receive and provide information from diverse EMR systems, and a legal framework to regulate EMRs and guarantee their interoperability. This system is estimated at US$450 million over five years.

2.3 EMR Challenges

Amidst the many benefits of EMRs, there are also some challenges, if not properly handled, these may lead to failure. In developing countries, the problem of limited resources begs several questions whether this use of technology is practical beyond a few well-funded pilot sites and whether it has a beneficial impact on patient care or the management? [13, 14]. Further, in developing countries, there is a long history of healthcare information systems being used for generating aggregate statistics for higher levels [15]. EMRs are also believed to require comprehensive personnel training - personnel have to be trained on opportunities related to computer utilization [16]. Castelnuovo, Kiragga [12] found that usage of mandatory fields in an EMR has the danger of information being "invented or faked" to be able to continue with data entry. Further, EMRs are believed to have high adoption costs [16]. Further, a study conducted by Mohammed, Andargie [17] in Ethiopia recommend that the association between computer knowledge/skill and health care delivery competence should be studied. Another challenge is when the EMRs are provided from different vendors since every vendor has its own expertise [18]. Achieving high standards is also considered to be a particular challenge in sites with limited computer literacy and experience and it erodes the data quality [13, 14]. It is also believed that EMRs which are complex to use, the problem arises due to not properly thought through designs.

2.4 Digital Empowerment

The concept Empowerment has been used to express ideals related to changes, both for outcomes and the process itself, the latter often expressed as Empowering. In a literature review of Empowerment as outcomes in change processes in ICT for development, Pandey and Zheng [19] identified six categories:

- Community – mobilization to go beyond traditional limitations
- Psychological – self-esteem, self-perception, self-efficacy, participation, perceived control
- Gender – equal rights, voice, freedom of expression, independence
- Cultural – freedom of expression of cultural identities, rituals, tradition, language narratives
- Economic – basic goods, freedom from misery and dependence
- Political/structural – civil society mobilization

The operationalisation indicated in each category points to new capabilities being achieved. These six categories do neither address use of EMRs in any specific ways nor identify levels of empowerment.

With a case of health management information system, a taxonomy with two levels of digital competence were identified; Skills as the basis level, while the Advanced level included the abilities of Problem Solving, Learning, Helping others and Technical communication [20]. These covered the three areas Technology, Health Information and Use of functionality for work tasks.

A recent taxonomy introduced the six domains Technology, Health information, Digital identity and safety and security, Creation and Innovation, Teaching and learning, and Communication and collaboration [7]. Each domain had four levels, thus this is a much more fine-grained taxonomy. Considering Empowerment, we will say that for each domain, each level represents a level of empowerment from none up to the expert level. The expert level, which corresponds to the Advanced level in [20] has the characteristics of IT users called super-users [21, 22], power-users [23] and peer-coaches [24].

For empowerment in this study, the levels of basic technical skills to carry out the work (Level 1 in the technological domain in both models) and super-user (Advanced or Expert) will suffice as the basis for this study.

2.5 Digital Experience and EMR Implementation

Most studies find that the digital experience (computer knowledge and utilization) for most staff/users in the health facilities in developing countries is low [18] [17, 25]. Training instils confidence in the usage

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of the EMRs among users as it increases the knowledge and utilization of computers and facilitates the rate of diffusion of the technology to the health sector.

3 Methodology

3.1 Approach

An interpretive approach was used to analyse the data collected in this study. Other than assuming that meaning is socially constructed; interpretive research approach is concerned with understanding what is specific, interesting and unique about the social phenomena. The phenomena in this case is the implications on EMRs when health workers are or are not digital empowered. The empirical data from Malawi. The broad mHealth4Afrika project deployed co-design approach. Co-design is a well-established approach with its roots in the participatory design techniques, used as an umbrella term for participatory, co-creation and open design processes.

3.2 Methods

Qualitative methods were used to collect the data as they place great emphasis on the data collection methods. The methods included interviews, informal discussions and observation. Interviews were chosen as they allow for investigation of issues in an in-depth way and also allowed the researcher to probe why the health workers were or were not utilizing the EMR and probe the opinions they hold towards its implementation. Observation on the other hand provided the researcher liberty to use their senses to examine the behaviour and utilization patterns, and the interactions they were having with the EMR in the health facilities. It gave the researcher an opportunity to verify whether what they said, corresponded with the way they interacted with the system and gave information that goes beyond mere sayings.

3.3 Study Site

The study was conducted in two districts in the southern part of Malawi – Machinga and Zomba districts through an mHealth4Africa Project [26]. A total of three health facilities were studied – one in Machinga called Gawanani and two called Bimbi and Magomero in Zomba districts. The three healthy facilities were selected purposively as these were the ones implementing the mHealth4Afrika App, the EMR under study.

3.4 Data Collection

The study targeted all staff that were capturing data at point of care using the mHealth4Afrika EMR. Data was collected between January and June 2019. Interviews formed the main data collection tool in this study. Participants were interviewed during both the system implementation period, before the project ended, and after the project life. The interviews were conducted with the health workers eligible to be utilizing the system during implementation and the same number of health workers were also interviewed after implementation. The idea was to find out from the participants their opinion about the EMR, and if the way the EMR implementing project processes had a positive, neutral or negative effect towards the project's success. In total, 25 interviews were conducted, 15 during project implementation and 10 after projects life. In addition, observations were done on a daily basis by one of the authors. The data collected from interviews and observation was complemented with the number of transactions captured by a single health worker per day over a period of time.

3.5 Data Analysis

Data analysis was "based on the experiences and processes revealed by the text data" [27] collected. The analysis was based on the following: Usage vs number of patient records captured; number of patients captured vs digital experience at a particular point in time; opinions on EMR utilization etc.

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3.6 Ethics

Ethical approval for the mHealth4Afrika project was obtained from the National Health Sciences Research Committee of Malawi.

4 The Case

The study used an application developed through the mHealth4Afrika project through a consortium funded by the EU Horizon 2020. mHealth4Afrika Application is a HL7 FHIR-compliant comprehensive, scalable, and adaptable patient-centric health platform that interacts with a data model set up in DHIS2 via a WebAPI [26]. DHIS2 is a generic toolkit that supports Ministries of Health to configure a data structure that can be used to store aggregate monthly program indicator related data for analysis [28]. In Malawi, DHIS2 is used as the Health Management Information System. mHealth4Afrika application was co-designed and validated with Ministries of Health, District Health Officers, Clinic Managers and Health Workers in four countries (Ethiopia, Kenya, Malawi and South Africa). It integrates electronic medical record (EMR) functionality with the use of medical sensors, and analytical, visualisation and decision support tools to facilitate monitoring and interpretation of patient results. The aim of the mHealth4Afrika Application is to support the efficiency and effectiveness of both management and healthcare professionals in primary healthcare facilities.

The development process started with one programme, but due to the co-design nature, the health workers asked for a holistic Application, with all programmes [29, 30]. Currently, the mHealth4Afrika Application has the following programmes: Medical History, Maternal Health (Antenatal Care, Delivery, Postnatal Care), Family Planning, Child Under 5, Tuberculosis, ART, and Outpatient Department. Essentially, the development process was iterative, started with alpha version, got feedback and re-designed the UIs, developed beta version. During the pre-beta validation in June 2017 the health centres asked for a more comprehensive health information system that allows a patient to be registered once and then enrolled in multiple programs depending on their health conditions over a period of time, to facilitate holistic monitoring of a patient's well-being. The health centres needed a platform that supported a range of interdependent services to facilitate holistic monitoring of a patient. Feedback from the beta version led to the development of the second iteration of the beta platform, Beta v2. This version has a number of repeatable stages around the core areas of Growth & Nutrition, Immunisation and Childhood Illnesses. A third iteration of the beta platform followed. It included a new user interface and refined workflow; updated Clinic related functionality, updated Patient list, Clinic appointment list, Program specific Access rights for healthcare workers; and updated Patient related functionality. Most importantly, it included program reporting for individual patients. Final refinements were done in Beta v4. In the requirements solicitation phase, it was found that health workers in the facilities spend an average of 5 to 7 person days each month per clinic to manually count relevant data sets across multiple manual paper-based registries; a necessary exercise to prepare the aggregated statistics that are provided to the district health office each month. However, this data was found to be extremely inaccurate. The functionality to automate this count based on electronic patient records and provide access to this anonymised aggregate data on a monthly basis across programs will save the health workers a considerable amount of time (60 to 84 working days per clinic – the equivalent of three or four months) across a calendar year.

During the implementation of the mHealth4Afrika project, a number of implementation and adoption challenges were identified, experienced and addressed in different ways. The challenges related to infrastructure, digital literacy skills, technologies, and access to reliable power among others. For the purpose of this paper, we will focus on the challenges of digital literacy skills and technologies. This learning curve helped the researchers identify processes and procedures to solve these challenges, in the process, learning and building on to the good practices.

5 Findings

Much as we were set out with the mind that automation of the patient records will save the health workers a considerable amount of time, this was not the case in the first instance. It was discovered that there were several other critical factors; digital skills being one of them.

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5.1 Characteristics of Study Participants

A total of 15 health workers participated in the study, 9 female and 6 males. Three clinical officers (one from each health facility); 6 nurses; and 6 community health workers. Most health workers have worked with a particular program they were responsible for capturing data for more than 2 years. Out of the total, none of the health workers had a computer for their work and over 80% were not digital literate at the inception of the mHealth4Afrika project. All of the participants (100%) had mobile phones; however, only 27% had smart phones. None of the health workers had proficient typing skills.

5.2 Challenges Encountered During Implementation

After training the health workers how to use the EMR, it was found that despite their being enthusiastic about electronic system, some of the health workers were shying away from using the EMR. Upon probing, it was established that they were not comfortable using the EMR on their own; and whenever they tried, they found that they were too slow, hence delaying the patient queue.

The slowness was yet another factor that led to health workers stop using the EMR. There were cases where the health workers knew all the procedures and how to navigate through the system; however, they were very slow in typing. Due to the original qualitative study design, measurements of typing speed were not taken, it was only observed to be slow. The slow speed meant that the patient queue would grow and the patient would have a long wait on the queue. In cases where the health workers persisted and continued using the system; the long waits on the queue would discourage some of the patients and they would start complaining; some talking against the system.

Another group of health workers would stop using the EMR and postpone the electronic data capturing to later time. However, considering the workloads, the health workers already would knock off late, making it difficult to find time later for data capturing.

5.3 Feedback through Co-design

Co-design being an open design process, provides a lot of room for interactions between the researchers and participants. These interactions provided the health workers a good platform to provide feedback which is the issues highlighted in section 5.3. The health workers were honest enough to explain that they were digital illiterate. This was explained after the initial situation analysis. After they underwent a digital literacy training, they gave more feedback that their pace of typing is causing delays and leading to patients complaining of long waits.

6 Discussion

Implementing an EMR, is one thing, having the EMR fully implemented and fully utilized is another. As mentioned by Braa and Hedberg [15], healthcare information systems in developing countries have been driven mostly by the need to report aggregate statistics for ministry or funding agencies; in this case, EMRs bring a new paradigm where each patient record has to be captured in the system. The capturing of the data requires both digital skills and typing proficiency – be it trained or acquired through experience.

6.1 Role of Co-Design in Digital Empowerment

In this study, we used co-design to design and develop the mHealth4Afrika Application. Research has shown that there is a paradox of technology where electronic systems are introduced as a solution and later the very solution brings more challenges [31]. In this study, the co-design allowed for two-way interaction between the implementers/researchers and the facility staff, discussing the possible solutions to the challenges encountered there and then. A combination of adopting co-design and agile development was beneficial in facilitating responsiveness to inputs based on active stakeholder engagement and proved to be very valuable. For any innovation to take shape, prerequisites should be set [31]. In the absence of the co-design that provides for interaction, the health workers would end up shying away completely from using electronic system and relying mainly on paper-based registers and forms to collect and report routine data. This emphasize what Nguyen, LeFevre [32] found.

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6.2 Problematizing Digital Skills Gap amongst Health Workers

In most cases, electronic systems are deployed in health facilities with a requisite of few days training on how to use the system. The findings indicate that none of the health workers had a computer; over 80% were not digital literate; only 27% had smart phones and none had proficient typing skills. This is a clear indication that most health workers would struggle to competently use electronic system despite having a few days training.

The progression while learning a skill normally follows a hyperbolic curve reaching a plateau. The findings suggest that we have to consider two aspects of the computer skill learning separately. First, the health personnel learned the sequence of operations and where to locate these quite quickly, corresponding to the shape of the blue curve in Figure 1. This curve is an illustration and is not based on quantitative observations. Second, getting up to speed of typing follows a more gradual learning curve, reaching the required speed to carry out the typing at point of care after a much longer period of practice. A study of the learning speed of keyboard typing showed that after 20 hours of practice, the speed was around 7 words per minute (WPM), and thereafter a linear increase to around 35 WPM minute after 80 hours [33], illustrated by the red curve. The learning speed is thus 1 additional WPM after 2 hours of practice. Training will speed up the learning somewhat, but practicing for 40-80 hours may be needed to achieve typing skills which are useful at point of care. The lack of digital experience hinders the health workers using the electronic systems. This can lead to the health workers abandoning a system that is functioning properly.

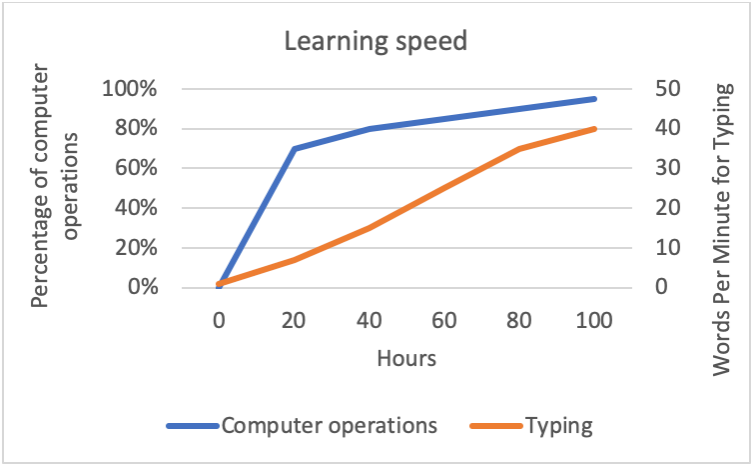

Figure 1. Learning curves for learning computer operations and typing

The observed difference in speeds of learning also points to inadequacies in the first level of digital competence in both of the taxonomies referred to [7, 20]. Their first levels should include typing and also which speed of typing that is required for the tasks to be carried out.

6.3 Implication of Digital Empowerment on EMRs

The findings showed that health workers were shying away from using EMRs as they were trying to balance between using an EMR and attending to the high patient volume. Of interest in this paper is the revelation that digital empowerment plays a critical role in the success of EMRs. According to the findings, all what the health workers knew was that the EMR was going to ease their work, learning from the benefits cited in literature, only to find out later that without typing skills, it is very hard to use an EMR. This is emphasizing Norman's [34] sentiments that much as technology is supposed to simplify our lives, what it provides can also complicate the same lives it is supposed to simplify.

The range of domains where the concept Empowerment has been used was summarised in section 2.4, and none of these captured the specifics of learning EMRs. Based on our findings, we would rather suggest the three levels of empowerment for health workers' EMR practice in Table 1. At point of care, the health worker has to type and operate the computer with a speed corresponding to that of writing in paper registers, not to delay the flow of patients. In an administrative setting, where no clients are

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waiting, speed has less relevance, such that slow speed during the first months of using a computer system can be tolerated. For health personnel, we will thus identify two levels of ICT competence, for administrative and care tasks respectively. The distinction between levels 1 and 2 concerns the higher speed of operation needed for point of care.

Table 1. Empowerment levels for health personnel concerning electronic medical records

1	Being able to use the EMR in an administrative setting.
2	Being able to use the EMR at point of care.
3	Being able to guide colleagues on their EMR use

Bringing the same ideas over to the social life, a person at level 1 could use the computer for browsing, since little typing is needed. For the task of writing an application, this would require some typing speed or take very long time. Social media, where quick responses may be expected, might require a typing speed corresponding to that of point of care. Level 3 correspond to people being able to help their family and friends using with computers and suggest using ICT where appropriate.

In Section 2.4, digital empowerment was defined at two levels; basic technical skills to carry out the work and super-users who help others. Typing speed is a general digital skill and can hence be distinguished from specific competencies required for one application. Adequate speed of operating computers could therefore constitute a basic level of digital empowerment, since this general skill empowers people to use IT for other purposes, while inadequate speed would mean a disempowered computer user. We will therefore refine the empowerment definitions into the two levels in Table 2.

Table 2. General empowerment levels for computer use.

1	Technical skills at adequate speed empowering the person to productively use computer applications.
2	Super-user helping others learn computer use, suggesting new ways of using the technology, and adapting the ICT.

The second general level, corresponding to EMR empowerment level 3, might only be reached by some people who experience ICT as particularly interesting and relevant.

7 Conclusion

EMRs may have the potential to offer so many benefits to health workers, however, if the prerequisites such as necessary skills are not in place, this remains a mere dream.

We extended the list of domains for empowerment from [19] to include digital empowerment, meaning adequate capacity to use computers, and at a more advanced level, to help others use computers.

In their recent literature review on adoption of EHR in Africa, Odekunle et al. [8] report that medical doctors had poor IT skills, including low typing proficiency referring to publications up to 2013. This study addressed health centre workers, all of whom were below the medical doctor level of education. Unsurprisingly, seven years later, the digital literacy amongst lower level health worker cadres in rural area is inadequate. Also, there was little transfer of skills from smart phones to computers, partly due to the much higher need for typing on computers and also the experienced complexity of computers versus phones. Kuek and Hakkennes [5] also found that one third of hospital personnel in Australia were not so confident in using the information systems in the hospitals. This seems to indicate that this problem is not only for health personnel in rural Africa.

Prices of computer hardware and solar power are falling, the internet is extended by mobile phone operators, and the smart phone is penetrating into rural areas. Computer literacy levels are to a minor degree influenced by these developments, however. Significant resources are therefore needed to empower health workers to become efficient and effective computer users, and even to help others, suggesting new ways of using the computer and adapting the systems on their own.

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