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A digital mobile health platform increasing efficiency and transparency towards universal health coverage in low- and middle-income countries

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Abstract

In low-and middle-income countries, achieving universal health coverage remains challenging due to insufficient, temporary and fragmented funding as well as limited accessibility to quality healthcare. Leveraging a mobile health platform can be a powerful tool to address these problems. This paper demonstrates how analysing data collected from a mobile health platform helps optimize healthcare provider networks, monitor patient flows and assess the quality and equitability of access to care. The COVID-19 pandemic reinforces the importance of real-time data on health-seeking behaviour. Between 2018 and 2019, as a Kenyan universal health coverage pilot was being planned, Kisumu County, with support from PharmAccess Foundation, implemented household-level digital registration for healthcare and collected socio-economic and healthcare claims data using the M-TIBA platform. In total, 273,350 Kisumu households enrolled. The claims data showed many patients visit higher-level facilities for ailments, that can be treated at primary care levels, unnecessarily. High-level estimate of the disease burden at participating facilities revealed rampant overprescription of pertinent medicines for highly prevalent malaria and respiratory tract infections, exemplifying clinical management deficiencies. M-TIBA data allowed tracking of individual patient trajectories. Analyses of data are shown at the aggregate level. The paper shows how mobile health platforms can be used to generate valuable insights into access to and quality of care. Funding for healthcare can be united through mobile health platforms, limiting the fragmentation in funding. They can be useful for funders, health managers and policymakers to improve the implementation of universal health coverage programs in low-and middle-income countries.

Keywords

universal health coverage, mobile digital health, Kenya, malaria, respiratory tract infections

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Introduction

According to the World Health Organization (WHO), universal health coverage (UHC) is defined as 'all people, irrespective of socioeconomic status, having access to health services they need, without encountering financial hardship'.[1] Health is a fundamental human right, therefore everyone should have access to health services regardless of factors such as socio-economic status.[2] Across the globe, countless efforts are being made to realize UHC.[3] Despite an overall global commitment, low- and

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middle-income countries (LMICs) are struggling to obtain these basic goals. Limited access, poor quality and unaffordable cost of quality health care delivery remain major obstacles to attaining a minimum basic package for everyone. Sustained political commitment and innovation remain a challenge in many LMIC settings,[4,5] further exacerbating the problem. Physical distance to health facilities, financial affordability of healthcare costs and social and cultural norms are key drivers limiting access for a large share of the population that requires a coherent approach. The COVID-19 pandemic shows the importance of near real-time data and makes it clear that this data is often not available and accessible. Quality of care is described by the WHO as 'the degree to which health services for individuals and populations increase the likelihood of desired health outcomes and are consistent with current professional knowledge'.[6] Data shows in many LMICs the quality of care is low – be it a lack of adherence to protocols, reduced accuracy or absence of diagnoses or use of substandard drugs.[7]

Low-income levels, limited participation in formal sector employment and thus a limited tax basis combined with a lack of coherent health financing policies have resulted in inadequate domestic funds available for healthcare in LMICs. In 2018, the average health spending per capita was $35 in low-income countries and $286 in middle-income countries compared to $5665 in high-income countries.[8] Besides overall insufficiency, healthcare funding streams in LMICs are highly fragmented due to the historic development of major, disease-specific fund posts for LMICs, unclear mixtures of pre- and post-payment mechanisms and the typical crowding-out effects of public versus private financing.[5] In most sub-Saharan African countries, only a small portion of the population is covered through health insurance. For instance, in Kenya, this number is 11%–15%, in Nigeria 3%, in Uganda 6% and in Tanzania 9%[9–11]. As a result, many people (post-)pay for care out of pocket after they fall ill. In 2016, the out-of-pocket expenditure in sub-Saharan Africa was 36.7% of total health expenditure. In Nigeria, this figure climbed to 75.1% compared to just 13.7% in high-income countries.[12] The consequence of these high out-of-pocket expenditure rates is healthcare-avoiding behaviour (e.g. the postponement of visits) which eventually triggers catastrophic healthcare expenditures and pushes people (further) into poverty.[3]

Moreover, of the total healthcare funds spent in low-income countries, roughly 25% is derived from development assistance, often intended for a specific medical condition (e.g. HIV, tuberculosis, malaria).[3] To deliver full accountability, these funds are managed independently, leading to inefficiencies in care delivery, parallel systems and higher transaction costs. Partly due to a lack of transparency on how public funds are used, individuals and donors are unwilling to voluntarily contribute to state-insurance schemes. Consequently, the lack of financial protection could manifest an increase in informal payments.[13] Limited and fragmented funding intensified by high financial overhead costs, results in limited investment and thus low-quality health services and limited access. Furthermore, the information systems for assessing healthcare delivery performance are vulnerable and provide little transparency or real-time feedback. All these challenges affect access to and delivery of quality of care ultimately leading to poorer health outcomes in LMICs.[3]

Innovative approaches, leveraging the full opportunity of digital and mobile technologies, are required to realize efficiencies: better access, quality and affordability in an accountable manner.[14] In the last decade, a digital revolution has taken place everywhere, including in the healthcare sector. To date, estimates indicate over 5 billion people worldwide own a mobile device.[15] In Africa, a continent with little digital legacy, this technology has leapfrogged and is rapidly transforming communication and financial spaces. Long before Organisation for Economic Co-operation and Development (OECD) countries and leading social media platforms were aware of the capabilities of mobile money,[14] in 2007, M-PESA was already created in Kenya. M-PESA is a mobile payment system that allows for 'bankless banking' and proves to be readily accessible (with more than 80% of the Kenyan population using it), highly trusted and treating personal data confidentially.

Built on the backbone of M-PESA, M-TIBA was created in 2014 to bring these so-needed features of trust and accountability via mobile technology to help in transforming healthcare in LMICs. M-TIBA is a platform connecting patients, healthcare providers and healthcare payers such as governments, donors and individuals. M-TIBA manages financial health(care) transactions and data exchanges, by linking semi-real-time information provided by healthcare providers, healthcare payers and patients into a single transparent digital pool.[16,17] On top of this digital backbone, additional applications can be tested and scaled. Put simply, M-TIBA powers a digital 'health wallet' on mobile phones, such that patients can save or remit money, pay their insurance premium or receive a subsidy to help cover their future healthcare needs. When the health wallet is used in a facility, the patient's healthcare utilization and claims data are uploaded by the facility. This data offers insights for healthcare providers, governments and donors, identifies inefficiencies and allows for targeted remedial actions. Ultimately M-TIBA, which operates at marginal costs, should facilitate health financing and service delivery in a more cost effective and transparent way.

Based on lessons learned from using the platform M-TIBA to manage a UHC pilot initiative in Kisumu County, Kenya, this article demonstrates how data collected from a mobile health platform can help register everybody

on UHC schemes, optimize healthcare provider networks, monitor patient flows, assess the equitability of access to quality care and contribute to the efficient management of funds and scaling of UHC interventions at a lower cost in Kenya as an LMIC.

Design of the UHC pilot

In Kenya, UHC is part of the Big Four development agenda announced by President Kenyatta in 2017. Between 2018 and 2019, a UHC design was piloted in four Kenyan counties. In Kisumu, the UHC design aimed to combine free public care for all with improved quality of care. Kisumu is known as the transport and commercial centre in Western Kenya with a population of 1.15 million in 2019.[18] On request of Kisumu County Government and the Kenyan Ministry of Health (MoH), PharmAccess Foundation supported the pilot with technical assistance, and was instrumental in designing and leveraging the M-TIBA platform to support the pilot. Experiences from this pilot were meant to inform scaling of digital health applications in the future.[19]

During 15 min sessions, enrolment assistants collected data on household composition, socio-economic status and preferred healthcare provider selection using a structured questionnaire. By training community health volunteers (CHVs) and community youth as enrolment agents and a region-by-region approach, up to 40,000 lives were enrolled per day. After the enrolment, a corresponding pilot was designed, involving four health facilities in North-West Kisumu. Three of these facilities are level 4 primary care hospitals, and one is a level 3 basic health centre. In these facilities, healthcare transactions were digitally entered into the M-TIBA system. During enrolment, individuals gave written consent on using their data, among others for the benefit of improving access to healthcare and to evaluate and improve the quality of healthcare services offered by healthcare providers.

M-TIBA outcomes

More than 273,350 Kisumu households were enrolled in 2018 and 2019, and 42,000 healthcare transactions were digitalized over 4 facilities in Kisumu. PharmAccess data staff performed descriptive analyses on aggregate level on the data entered in M-TIBA. The following sections provide examples of the most outstanding results derived from using M-TIBA for registration, digital real-time data management and transactions of customers.

Suboptimal referral

Figure 1(a) shows the location of public facilities in Kisumu and indicates the user's utilization preferences. For UHC purposes, households had to pick one preferred facility, which became their standard facility for primary care. It appeared most households preferred central higher-level facilities (county and sub-county hospitals) instead of primary care facilities that are much closer to their standard facility for primary care. This shows households accept longer transportation times and costs to the next high-level facility rather than going to primary care facilities that are nearer by. The M-TIBA claims data confirm this picture and show that many conditions treated in the higher-level facilities could have been treated in the primary care facilities (Figure 1(b)). This can imply households feel more comfortable choosing a facility that offers a wide variety of services, apart from only primary care services, as it might be more convenient when multiple conditions are present within households. Another explanation could be the gatekeeper function of primary care facilities, to lower the costs and to avoid overcrowding of higher-level facilities, did not function well.

Disease burden

Figure 2 provides frequencies of diagnosis of conditions and corresponding costs in Kisumu; the surface of the circles indicates the percentage of the total health costs in the county. Across the four Kisumu healthcare providers, costs vary between expensive complicated delivery (average costs of Kenyan Shilling (KES) 5004) at low frequency (1.7% of all treatments) to a high frequency of affordable malaria treatments (KES 363, 30.1%). Also, infectious diseases (15.4% of all treatments at an average cost of 510 KES) and respiratory tract infections (17.0% at an average cost of 275 KES) both significantly impact the total costs of care. The graph provides an easily interpretable profile of disease burden across a county, which can be related to its geography, demographics and socio-economic status. Similar graphs for other counties can support the informed development of county health budgets under UHC.

Adherence to protocols

Figure 3 compares data on antibiotic prescriptions for upper respiratory diseases against Kenyan National Guidelines on antibiotic prescriptions. Across the four Kisumu health facilities, between 69.4% and 90.0% of antibiotic prescriptions were issued without a clear positive diagnosis (over-prescription). Under-prescription remained in the marginal <1% range. Data shows only 10%–29.1% of antibiotics prescriptions are according to guidelines. This has many implications, such as people not receiving adequate care they need, potential waste of antibiotics, unnecessary costs and a growing antibiotics resistance.

Patient flows

M-TIBA data also allows for following individual patient trajectories. Figure 4 shows the journeys of malaria patients

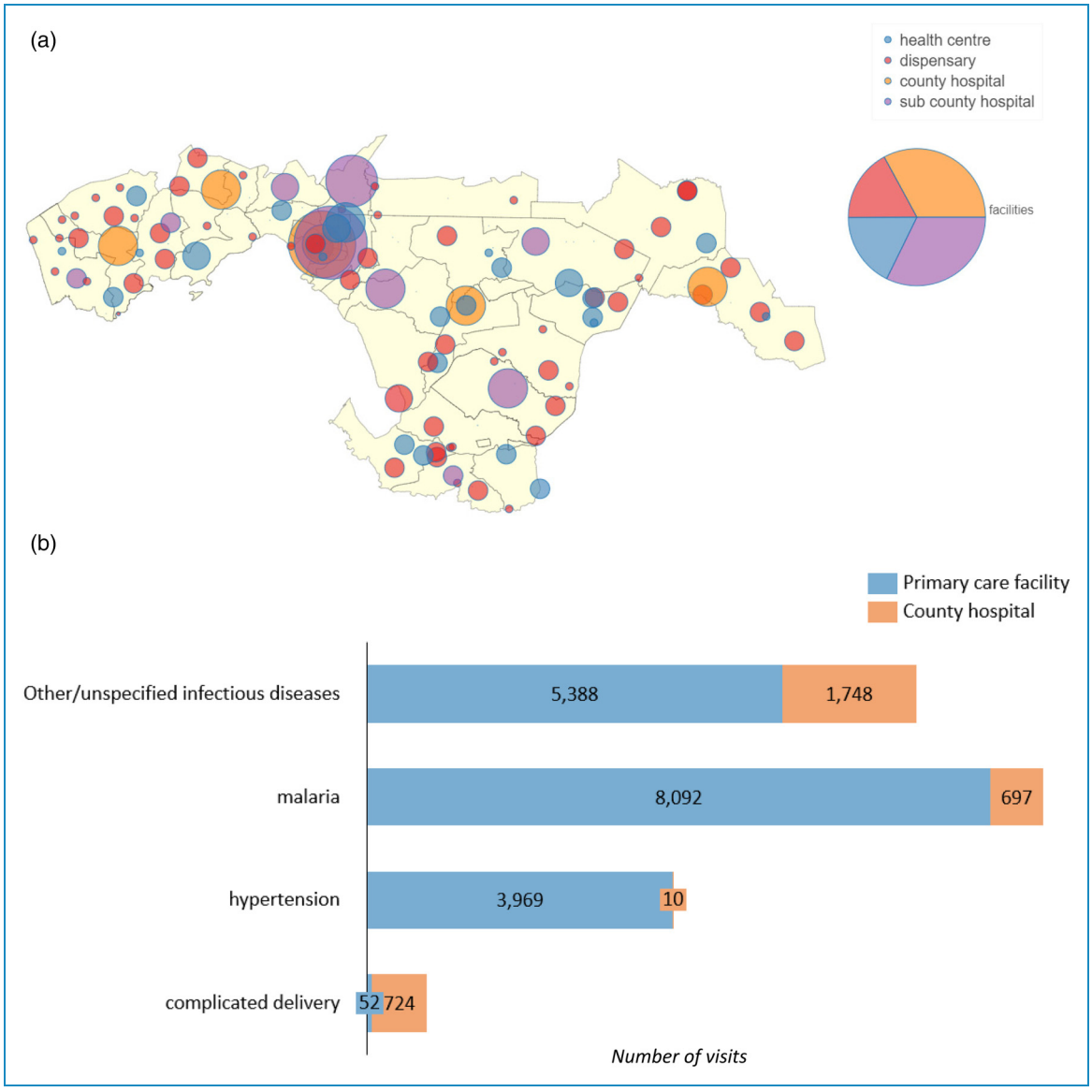

Figure 1. (a). The locations of Kisumu (public) health facilities are colour-coded by type. Preferential use by households is depicted by the bubble size, representing the number of households selecting the pertinent facility for primary care. (b) County hospital claims. Number of services that could have been treated at a primary care facility in blue.

from getting tested to return visits 2 weeks after receiving medications. In these four public facilities, a total of 10,753 (86.9%) patients with clinical malaria diagnoses appeared tested for malaria, while 1616 were not (brown and red bars at the left). A total of 9361 (75.6%) of all patients received medication for malaria, including 695 (5.6%) patients who were not tested. This prescription rate is 200% higher than malaria prevalence rates in Kisumu and 400% higher than our recent survey of private sector facilities in Kisumu.[20] Figure 4 also demonstrates a 1.8% prescription rate of second-line antimalarials, which is in the range of the Kenyan National Malaria Guidelines.[21] The plot ends with the number of patients who had a repeat visit within 2 weeks or not, showing only 2.6% of the patients revisit the facility within 2 weeks.

Implications

Create transparency to increase access, improve quality and enhance affordability

Analysing digital mobile data from household enrolment and healthcare claims helps identify gaps, inefficiencies and quality issues. This allows health managers and policymakers to better target interventions towards UHC. The household facility selection pattern and the corresponding

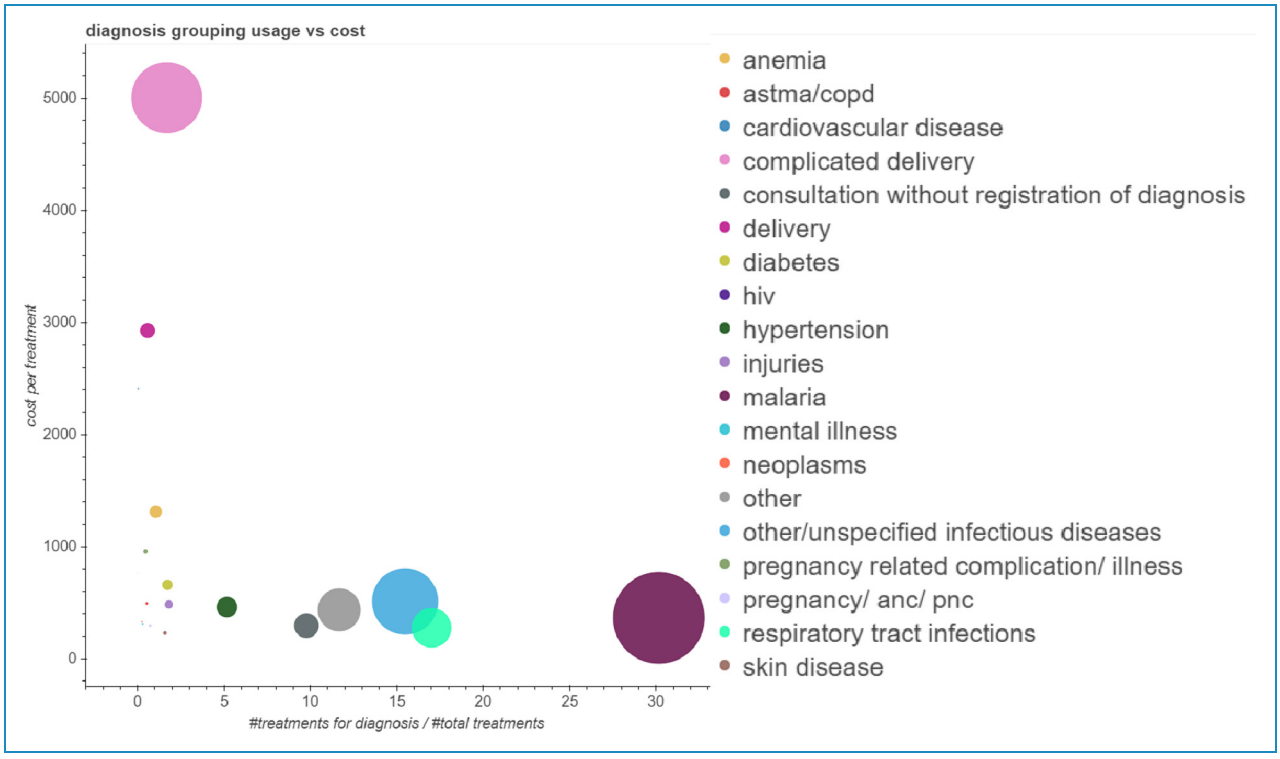

Figure 2. Frequency of diagnosis of conditions and corresponding costs in Kisumu. The colour of the circles presents one of the conditions displayed in the legend on the right. The surface of the circles indicates the percentage of the total health costs in the county. A large circle represents a higher percentage of the total costs.

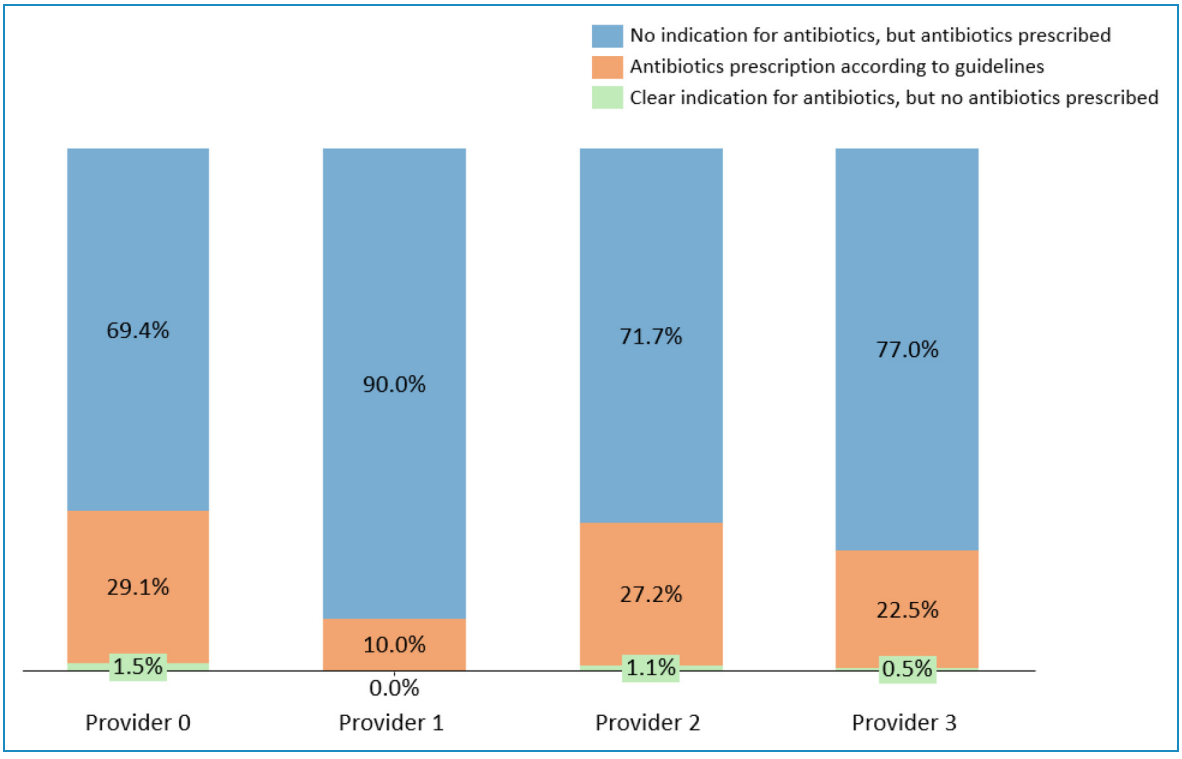

Figure 3. Antibiotic prescriptions (%) for upper respiratory diseases in public health facilities in Kisumu. Overprescription in orange, under-prescription in green, correct prescription in blue.

types of claims in the higher-level facilities showed enrollees might feel more assured choosing a facility with a wide range of services next to primary care services, regardless of the longer travel distance. It could also indicate lower-level facilities are not adequately acting as gatekeepers. Enhancing primary care facilities will increase affordability and access. Understanding the disease burden helps form the UHC package. Granular and county-specific data is required, as geographic and economic differences will likely impact the disease burden across counties. For wealthier and higher-altitude counties, we expect to find increased shares for diabetes and hypertension and limited malaria expenditures. We detected the inefficiency of overprescribing malaria and respiratory tract infections medicines, thereby confirming existing research.[22,23] The costs of these incorrect practices should not be underestimated; they waste medicines, drive antimicrobial resistance (AMR) and lead to additional healthcare challenges and costs.[4] Primarily, incorrect prescription implies patients are not treated correctly for their ailments, leading to repeat visits and deteriorating conditions with increased morbidity and mortality as a consequence.[8,24] To reach and retain UHC, a general understanding of (inter)national (treatment)protocols and enforcement of compliance with these protocols is required. To realize the needed healthcare capacity for UHC, including private/faith-based facilities into the system will be essential. The transparency created by the mobile platform will be one enabler to facilitate this.

Future possibilities of mobile health platforms in LMICs

M-TIBA real-time data collection is promising considering pandemic preparedness, as it gives near real-time transparency on health-seeking behaviour.[25] For example, allowing to monitor adjustments in COVID-19-related diagnoses such as pneumonia at a granular level, as well as changes in ordinary health visits. The real-time data collection could also improve the national district health information systems (DHIS-2) in Africa, which currently collects retrospective information twice per year, and often from paper files.[26] A recent publication among 6235 public and 3143 private facilities in Kenya identifies its DHIS-2 to still suffer from major data gaps like under-reporting of malaria cases by facilities (~50% in public sector; ~23% private sector) and incompleteness of reporting. Platforms such as M-TIBA can markedly improve this process at marginal costs. Digital algorithms could be developed that export health exchange platform data directly into the national formats of DHIS-2.

M-TIBA can contribute to better services at the primary care level while enforcing a gatekeeping function at primary care facilities, enhancing the efficiency of the scarce funds available for healthcare.[27] Patient streams that disproportionately rely on higher-level health facilities can be identified. Simple SMS messages could be transmitted to mobile phones directing patients to the correct facilities for the correct medical concerns. Reimbursement could be made conditional on adherence to treatment, leading to large cost savings from current overprescription and to improved health outcomes and the opportunity to manage funds much more effectively.[28,29]

To address overprescription, protocols can be programmed into M-TIBA that support clinical decision-making in semi-real-time, reducing overprescription of antibiotics and thus resistance to antibiotics. AMR is a complex, multicausal public health threat of medical and economic concern, countries will benefit from combating this issue.[30,31] Moreover, when mobile health exchanges platforms register the consumption of diagnostic kits and medicines, supply chain management can be improved.

Digitizing the backbone of the health system can also help transform how healthcare is financed by creating full transparency and accountability on how funds are spent. A large share of the currently available donor funding for healthcare is managed separately per condition such as President's Emergency Plan for AIDS Relief (PEPFAR) (for HIV), the Global Fund (for malaria, tuberculosis and HIV). Healthcare exchange platforms can allow multiple donors to replenish their funds in a single (risk)pool offering general healthcare and UHC to the patient at the front end while reporting separately on the spending of money streams to pertinent funders at the back end. More than 10 years ago, we experimented with similar constructions, creating a 'risk equalization fund' for HIV in the context of general healthcare insurance in Namibia.[32] This intervention was non-digital and non-mobile, but the principle remains the same: vertical funds become more effective when added to horizontal general healthcare funds while equalizing the risks these funds were designed for. To ensure the digital opportunity is truly captured to drive health outcomes in LMICs, it is essential that digital interventions become part of a larger digital ecosystem, instead of having all independently developed solutions that are hard to integrate within one health system. Mobile health platforms could give local and national governments a powerful and real-time tool to assess the impact of their interventions and steer towards improvements through targeted interventions.

There are also still shortcomings in the use of the platform. First, the data entry process needs to be further aligned with existing processes, where possible further integrated with existing patient management systems. Initially, it might take some time to have the mobile health platform well-integrated in facilities. Trainings on the platform could potentially help with this. Another shortcoming in using the platform is that it remains prone to human errors in terms of data entry. The right incentives should be put in place to ensure complete and accurate data entry. Trust among users (patients, healthcare providers) is another potential barrier, as patient data is digitally entered and saved in a database. Users should trust

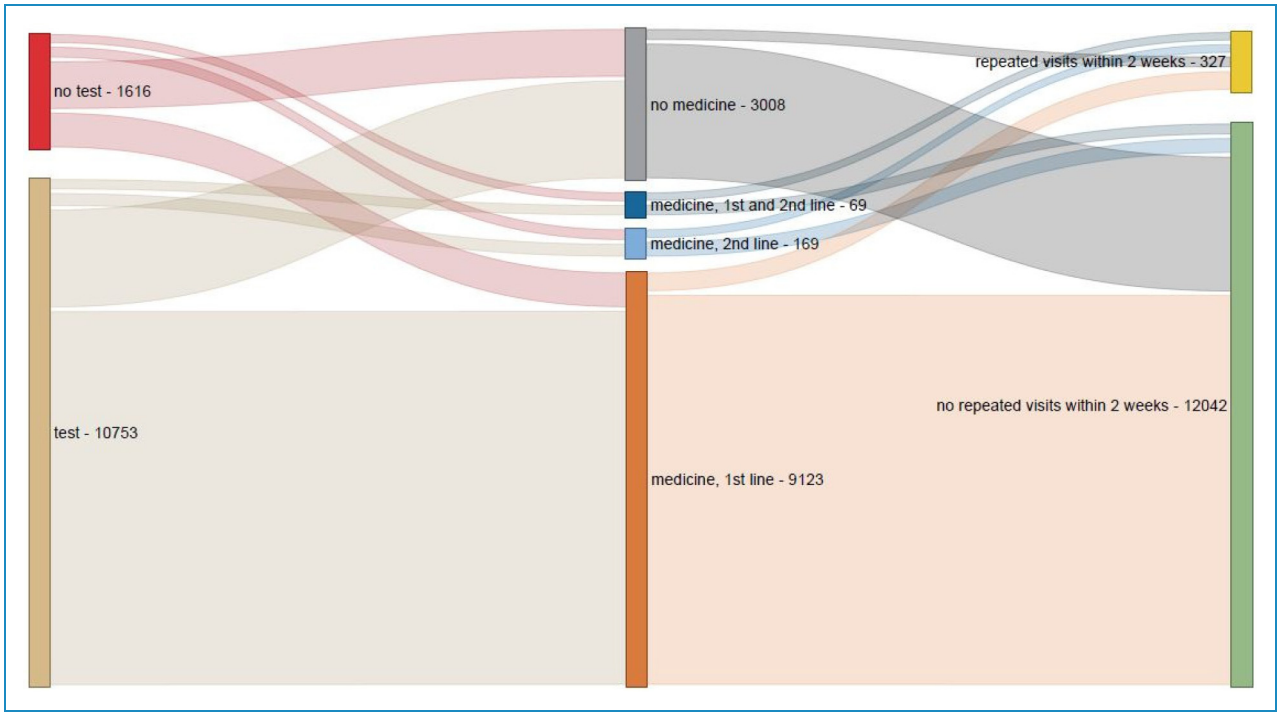

Figure 4. Sankey plot showing the flows of malaria tests versus medicine (width of lines is proportional to numbers of cases following pertinent trajectory).

this data is stored safely and remains anonymous. When introducing the platforms to users, information on save data storage can be clearly explained. We also realize that not everybody benefits from increased transparency and, often linked to that, digitizing revenues, which leads to some instances of data entry boycotts on the ground. In the coming years, we will continue to address these issues.

Conclusion

In conclusion, mobile health platforms can be used to collect data and generate valuable insights for healthcare providers, governments, health managers, funders and patients. This approach addresses key issues in attaining UHC, both in realizing sustainable financing, in driving quality improvements that reduce unnecessary costs and creating transparency to act in times of pandemics like COVID-19. We advocate for a global approach to UHC, including digital health innovations as an enabler for transforming health systems. Progressing towards UHC not only requires more funding but also getting more value from existing funds. We need to move beyond vertical funds addressing single problems. Utilization of the mobile health platforms opportunities can provide the financial protection and improvement of quality in healthcare necessary for making UHC within reach of all populations worldwide, and eventually reduce human suffering caused by deficiencies in health systems.

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Ethical approval: This study was conducted on request of Kisumu County and the Kenyan Ministry of Health. Confidentiality of research subjects and personnel records was ensured by anonymizing data collection and safeguarding sensible information according to GDPR. No individual participant data is disclosed within this manuscript in any form.

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