



Blockchain: an accelerator for women and children's health?

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Keywords: blockchain; women and children; distributed ledger technology

The world is changing exponentially—never before in the history of human kind have we experienced such change. There is an unprecedented opportunity to connect creatively disruptive innovations to transform the world for the better. One such creative disruption is blockchain technology. Blockchain is a decentralized distributed ledger, which is immutable and unhackable. In August 2016, the World Economic Forum released a report calling blockchain technology a “mega-trend” that will shape society in the next decade, predicting that blockchains could store as much as 10% of global GDP by 2027 [1].

Blockchain can help leapfrog a number of challenges faced by poor women and children. Imagine a world where the poor have their own identity on the blockchain, which they can use to access essential services or finance. Imagine a world where the two billion unbanked poor, can access the global financial system through a simple mobile phone and crypto currencies [2]. Imagine a world where poor people who live on customary land, have it titled on a blockchain and can use that title to access finance. Imagine a world where poor women and children are able to live longer lives, and improve and grow their communities. Imagine a world where foreign aid goes directly to poor women and children under a smart contract. All this is possible with the advent

of blockchain technology. If we seize the moment, blockchain can make a transformative contribution to ending preventable deaths in women and children.

Considerable gains have been made in reducing preventable deaths in women and children. The number of women globally who die each year during pregnancy or childbirth has dropped substantially—from 523,000 deaths in 1990 to 289,000 in 2013. The global number of deaths of children under the age of five has dropped significantly as well, from nearly 12 million in 1990 to 5.9 million in 2015 [3, 4]. However, unacceptably high rates of maternal and child deaths still prevail in Asia and the Pacific. China and India together accounted for 16.4% (China accounted for 1.46% and India the other 14.92%) of the global number of maternal deaths [5]. *The Lancet* reported that 20% of under five deaths took place in India in 2015 [6].

The Global Strategy for Women's, Children's and Adolescents' Health and Global Investment Framework for Investing in Women's and Children's Health identify the evidence based interventions in the 74 high burden countries that together account for more than 95% of maternal and child deaths worldwide. These interventions could prevent more than 147 million child deaths, 32 million stillbirths and save more than five million maternal lives between 2013 and 2035 [7]. High impact

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interventions include expanded immunization; promotion of breastfeeding and improved nutrition; training and supervising health workers; ensuring that drugs get to rural populations by strengthening the supply chain; better collection of data through improving health information systems; allocating resources to supporting good governance through informed and transparent decision making; and investing in health financing mechanisms that reduce barriers to essential care and protect people from financial distress [8]. We explore how blockchain technology could be a transformative accelerator enabling many of these interventions to reach the poor.

What is blockchain?

The blockchain is basically an immutable, un-hackable distributed database, like a large spreadsheet that runs on millions of computers across the globe. Anyone can access it and it does not require intermediaries to settle or confirm transactions. The implications are enormous right across virtually every aspect of society. Mike Millard provides a simple explanation: “blockchain transactions are logged publicly and in chronological order. The database shows an ever-expanding list of ordered ‘blocks’, each time stamped and connected to the block that came before it, thereby constituting a blockchain. Crucially, each block cannot be changed, deleted or otherwise modified: it’s an indelible record that a given transaction occurred. That’s exactly what has many in healthcare excited about blockchain’s potential for data security. Its

open and decentralized nature could lend itself well to longitudinal managing and access to health records and proving identity and entitlement to services” [9].

The disruptive aspect of blockchain technology is that its core functionality depends on the creation of an immutable ledger of all activity across peer-to-peer transactions. This has the potential to make the world a more transparent, efficient, and frictionless place. Its benefits have been recognized by global institutions and regulators [10]. Blockchain’s distributed nature makes it highly available and reliable, its secure, its transparent and transactions in the blockchain can be verified within minutes, not days [11]. This makes it a valuable resource for many government functions and for accelerating women’s and children’s health. Interest in blockchain solutions is growing rapidly and recent studies from IBM and Deloitte showed that 16 percent of health payer and provider executives expect to have a commercial blockchain application at scale in 2017, and that healthcare and life sciences plan the most aggressive deployments of blockchain across all industries, with 35 percent of respondents saying their company plans to deploy it within the next year [12, 13]. The Estonian Government, for example, has its citizens’ health identity data on a blockchain, to ease access to services by tracking the provenance of pharmaceuticals from manufacturing (anti-fraud, public health) all the way to consumer adherence [14]. The graphic below shows the rapidly developing range of development applications for blockchain (Figure 1).

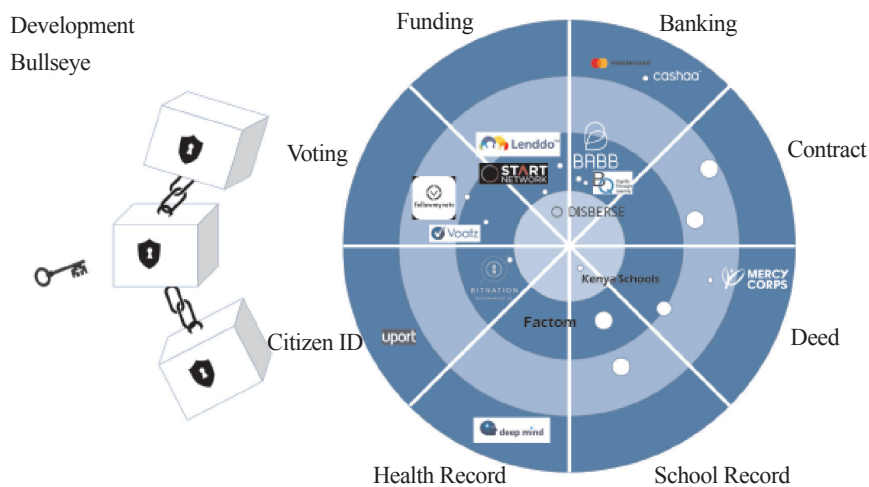


Figure 1 Blockchain development applications

Source: Abt Associates, 2017

How can blockchain accelerate improvements in women and children's health?

Blockchain applications and use cases are developing fast and we believe that blockchain has tremendous potential

to provide scalable solutions for ending preventable deaths in women and children by addressing the service needs of women and children and addressing issues of poverty which impact on health. Table 1 provides a range of blockchain applications for health.

Table 1 Blockchain applications for health

Opportunity	Why not a trusted intermediary?	Why blockchain?
Legal identity	Legal identity is too difficult for some governments to orchestrate but too sensitive to privatize	A secure, distributed identity system used across different government functions would create incentives for adoption without central rollout
Supply chains	Supplies often cross organizational and political borders	A transparent chain of custody can ensure proper handling while increasing efficiency. For example, small farmer organic crop sales could sell into developed markets with less friction
Counterfeit and substandard medicines	Multiple manufacturers reaching multiple difficult to coordinate receivers with little trust	Manufacture have vested interest in self-selecting for program to foil counterfeiters. Blockchain can execute payment on delivery of viable medicine
Personal and e-health records	Central government systems largely fail to create interoperability, private businesses do not want government control, patient left without control	Multiple people, moving between multiple companies, silos, served by multiple vendors. All need to build on previous transactions (e.g., X-rays) without trust
Financial remittances	Governments historically prefer financial services companies	Security risks and transaction costs have driven high fees. Blockchain promises lower cost
Digital currency	Many countries struggle with the technical challenges of financial inclusion	Currency requires high security and frictionless transactions

Source: Abt Associates, 2017

Addressing the service needs of women and children

Legal identity

Legal identity is a fundamental human right and is a prerequisite for financial inclusion, access to services, movement of people and a multitude of things we take for granted. Still, many millions of people worldwide do not have a legal identity. The potential to confer a permanent, immutable record of identity in the blockchain owned by individuals could be game changing. Without identity, poor women and children may be denied

access to government services, finance and fundamental human rights. Blockchain can be used to ensure women and children's access to these services and enable health rights. The identity data is held immutably on a blockchain, a web of trust "hardens" the data over time, the identity data remains in the ownership of the individual and individuals give permissions on who can see what data for what purpose and for how long. It's a transformative concept. Blockchain records can be used to establish an identity where no state identity exists or can be used. There is a distinction to be made between identity and credentials—governments issue credentials.



The distinction is one that becomes ever more important in the complex issues around a better identity system, ranging from the need for more secure single-use personae to the need for self-sovereign identity [15]. This technology has potential to be used in humanitarian emergencies, in remote poorly serviced populations, and can ensure that cash transfers and donor funds reach the intended beneficiaries. The Government of Canada is leading a global birth registration movement, now funded by the Global Financing Facility for Every Woman Every Child [16]. IDBox is developing a simple, low cost solution which can be used with basic analogue phones and does not require electricity or the internet [17].

Supply chains for distribution of vaccines and medical supplies

Getting quality medicines to poor women and children in a timely manner is critical to their success. Blockchain offers the capacity for purchasers to see every part of the journey their product took before arriving in their hands. It also enables supply chain companies to identify attempted fraud more easily, because once a block is on the blockchain—it cannot be altered. To illustrate, we use the example of the Port of Rotterdam, which is implementing a blockchain supply chain solution. Each participant in a supply chain ecosystem can view the progress of goods through the supply chain, understanding where a container is in transit. They can also see the status of customs documents, or view bills of lading and other data. Detailed visibility of the container's progress through the supply chain is enhanced with the real-time exchange of original supply chain events and documents. No one party can modify, delete or even append any record without the consensus from others on the network. This level of transparency helps reduce fraud and errors, reduce the time products spend in the transit and shipping process, improve inventory management and ultimately reduce waste and cost. The solution enables the real-time exchange of original supply chain events and documents through a digital infrastructure, or data pipeline that connects the participants in a supply chain ecosystem. This promotes sustainable transport by integrating shipping processes and partners, and establishing evaluation frameworks through increased transparency

and trusted access [18].

IBM offers a service which allows customers to test blockchain solutions to track high value items on supply chains. This service is being used by Everledger to promote transparency into the diamond supply chain [19]. A company called Provenance is working with Ethereum and Bitcoin to enable companies to be more transparent about where their products are made and by whom and environmental impacts [20].

Fake drugs can be a major issue in emerging markets where there is poor regulation and certification, and blockchain offers a supply chain solution which allows end-to-end track and trace. At the end of the chain, the patient suffers and worse still may die if efficacious drugs are not provided. Blockverify is working to upend the counterfeiting of drugs which cause thousands of lives to be lost. Blockchain can be used to confirm that vaccines are genuine, not out of date and the vaccine record can be linked with individual ID record to confirm vaccine delivery. It could also be used to unlock payment to providers as well as provide incentive to parent (i.e., confirmed vaccination allows access to other service/benefit) through use of crypto-currencies [21]. These solutions need to be tested in emerging markets and applied for women's and children's health supply chains.

Data and health records

Blockchain technology has the potential to address the interoperability challenges currently present in health IT systems and to be the technical standard that enables individuals, health care providers, health care entities and medical researchers to securely share electronic health data [22]. Blockchain is based on open standards and provide the necessary data security, while also assuring patient identity and verification of services covered by insurance and rendered by providers. Blockchains offer a solution that not only enables secure data exchange but that places a person's health records more within their reach and control, rather than being fragmented and oftentimes inaccessible to the patient in some far-removed central database. There is even the potential for patient owned longitudinal health records based around patient ID. Medical histories on a blockchain cannot be lost or altered without the patient's permission and the patient



can have access via a mobile App.

As the numbers of maternal and child deaths decline, it becomes increasingly important to be able to identify and track the most marginalized and impoverished populations where mortality is highest. Blockchain solutions will enable accurate databases of local populations with identity, population level vaccine and medical intervention studies without any potential breach of privacy and improved health outcomes through better data exchange.

Tracking donor funds through smart contracts

Significant sums of money are allocated by governments and donors for women's and children's health, but we have limited means of ensuring that it reaches the intended beneficiary. Smart contracts provide a viable method of issuing and tracking ownership of unique digital representations of value, which we call money. Smart contracts are computer programs that act as agreements where the terms of the agreement can be pre-programmed with the ability to self-execute and self-enforce. The main goal of a smart contract is to enable two anonymous parties to trade and do business with each other, usually over the internet, without the need for a middleman [23]. Behlendorf, executive director of Hyperledger, describes them as: "simple software programs that run across all nodes in the network and can extend the validation logic at each node in a way that is automatable and undeniable" [24].

Using smart contracts, blockchain can be used to ensure that donor funds reach intended recipients in a transparent way without middlemen and leakage along the way. Aid delivery can be tracked with transparently recorded "way-stations" showing location in supply chain and ultimate delivery. A smart contract could unlock a delivery payment when a service is delivered to intended recipient (using a blockchain enabled identity). A blockchain record can support donor funds by providing a specific record of care achieved through the funding.

Applications are being tested to improve the flow and targeting of donor funds. Disberse is a fund management platform for the global development sector, built on blockchain technology. It drives the transparent, efficient and effective flow and delivery of development

and humanitarian aid. It enables donors, governments and NGOs to transfer and trace funds through the whole chain, from donor to beneficiary, via intermediaries. It has potential to be used for social cash transfers to enable mobile money transfers and voucher schemes for the most vulnerable and for any development and humanitarian projects that involve the transfer of funds between two or more stakeholders [25]. Another blockchain application, StoneBlock, is a secure decentralized platform tying funds to agreed-upon actions to ensure mutual accountability. It provides transparent and tamper-proof 'metering' service of development aid flows at a range of scales: a project, programme, portfolio, and national, regional, and international [26]. Applied to the many millions of dollars that target women's and children's health, these platforms will be able to significantly enhance targeting and accountability.

Addressing issues of poverty

Addressing poverty is a critical aspect to improving women's and children's health. The poor of the world need assistance with cross-border and internal payments, and multiple successful initiatives (e.g., mobile money) have contributed to increased financial inclusion for this population. Blockchain's unique characteristics allow financial institutions to tailor their products and services to promote ease of use for the unbanked and underbanked. A Philippine company, Coins.ph, offers a good example of blockchain's potential. Situated in the country ranked third in the world for receiving remittances (totaling about \$ 30 billion a year), Coins.ph provides Filipino users a mobile, blockchain-based platform to allow them to send money at a more affordable and faster rate. Blockchain allowed Coins.ph to build an application to facilitate fund transfers without reliance on existing bank infrastructures and to be more agile in their services at a more affordable price [4].

Current remittance processes are slow and expensive. Digital currency remittances can move funds from remitter or donor to recipient almost instantaneously with low transaction costs. CASHAA is already operating in India and Nigeria and transmits remittances at no cost to the consumer. Recent experience from Bangladesh shows that women actually prefer to receive



payments by phone, rather than cash [27]. In order to be possible this will rely on the confirmation of the identity of the recipient, emphasizing the criticality of solving the identity piece. With blockchain enabled digital currencies and identity, financial inclusion can be provided to the two billion unbanked in the world [2]. Blockchain would reduce the transaction costs for remittances, giving the unbanked access to financial systems and ensuring that funds intended for the poor actually reach them.

More women in elected positions will trigger greater attention to female poverty, death and discrimination. Blockchain applications are now being used in innovative ways in Afghanistan and Nigeria to fund women to run for public office in a safe and transparent way [28]. Giving women voice in parliamentary processes is critical to addressing women's and children's health.

Lifting women out of poverty will be critical to the sustainability of efforts to improve their health. The World Bank reports that formal small and medium-sized enterprises (SMEs) contribute up to 45 percent of total employment and up to 33 percent of national income (GDP) in emerging economies. According to bank estimates, 600 million jobs will be needed in the next 15 years to absorb the growing global workforce, mainly in Asia and Sub-Saharan Africa. In emerging markets, most formal jobs are with SMEs, which also create 4 out of 5 new positions. However, access to finance is a key constraint to SME growth; without it, many SMEs languish and stagnate [29]. Policy dialogue with governments on improving SME financing should be an essential part of the global strategy for accelerating women's and children's health.

A new lense on financing

The Global Strategy for Women's and Children's Health has traditionally relied on donor funded programs. This is both unsustainable and insufficient. As poverty declines the remaining poor are likely to be split between middle-income countries and fragile states [30]. Traditional poverty alleviation efforts will not work in countries where aid is already becoming irrelevant as domestic resources grow. Mobilization of domestic financing and private financial flows will be critically important. Traditional development assistance will not be core to

solving global development problems in the future.

There will be an increasing importance of non-aid sources of financing from high-income to developing countries: non-concessional loans from development banks (multilateral and national) for development investments focused on growth and job creation; and transfers from high-income to developing countries in support of global public goods [31]. The private sector is a critical source of employment, influence and ideas and presents opportunities for partnerships in women's leadership, financial services for the poor, health services, prevention of violence against women and building entrepreneurship.

Exploration of new sources of finance for Maternal, Newborn and Child Health (MNCH) will also be essential for success, including crowd funding, more dynamic funding mechanisms from private finance markets, with tax mechanisms and incentives to encourage private sector to invest e.g. tax credit schemes, credit flows back to investor. Another example is mobilizing global efforts to tap into pension funds, and advocating with governments to give tax relief to pension funds that pursue social investment, transparently recorded on the blockchain. To mobilize private money will also necessitate efforts to create better measurement of social return (big data management and tracking). More funding is needed in venture capital to support the development and testing of new technologies with socio-economic investment with longer time horizons and lower financial returns and higher social returns for global problems.

Increasingly the world needs innovators who are employing complex systems approaches to rethink and improve aid efforts. We need to reward people for developing imaginative ideas that draw on the complexity of the real world, as opposed to the value for money and results conveyor belt that dominates so much development thinking currently [32]. Partnerships with technology companies offer opportunities to test whether some digital successes models from can be replicated. We need to proactively identify private sector partnerships and develop an innovative portfolio of partnerships leverage the ideas, capabilities and reach of the private sector for women, children and adolescents.



Conclusion

Blockchain's potential for social impact is yet to be realized, with few use cases in developing countries. The focus of the global community needs to move from the underlying technology to exploring use cases, and looking for solutions that can scale. There are many practical questions to be answered in settings with little internet access and electricity. We need to reach out even more to connect innovative ideas, with the local private sector, and social finance organizations to encourage innovation, entrepreneurship and action for pressing development challenges for women, children and adolescents. We urgently need to unite the ecosystem which connects the blockchain systems in advanced economies with those that work with the intractable problems of poverty and inequality.

How do we bring the women's and children's health challenges together with the community who are reimagining the world "on the blockchain"? We saw how when a relatively small group managed to bring together the world in 2010 to make saving the lives of women and children a global priority with strong leadership, technical convergence and a highly professional and organized advocacy campaign. We believe that with similarly strong leadership and a deliberate proactive connection between the international development world and the blockchain ecosystem—transformative change is possible. It's bold, it's confronting and compelling—a game changer for anyone who is thinking about transforming women's and children's health.

Additional file

Competing interests

The author declares no conflicts of interest.

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