

Combating Prescription Drug Abuse with a Secure Decentralized Application Built on Ethereum

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1. Abstract

On August 10, 2017 the opioid epidemic was declared a national emergency. While the problem is multifactorial, one of the primary issues contributing to this public health crisis is the use of an antiquated system of prescribing controlled medications that leads to prescriptions being easily altered in addition to difficulty monitoring patients and prescribers.

BlockMedx intends to be a novel e-prescribing platform that will provide secure transmission of prescriptions, a complete universal history of opioid prescriptions for patients, pharmacists, and providers, and incentives to reduce overprescribing and prescription fraud. Specifically, it aims to overcome problems with identity verification of medical providers, forged or altered prescriptions, and inadequate reporting of controlled substances. BlockMedx intends to achieve these goals by creating a decentralized application using the Ethereum blockchain, using novel identity verification methods to verify prescription information, and creating a real-time, complete record of controlled substances analysed by machine-learning algorithms.¹

2. Background – The Prescription Drug Abuse Epidemic

Prescription drug abuse, specifically of opioids, is the most significant public health crisis of the 21st century. Two million adults over the age of twelve have a substance abuse problem involving prescription pain relievers². The American Society of Addiction Medicine reports that drug overdose is the leading cause of accidental death in the United States, with almost half of those fatalities coming from prescription opioid abuse.¹ Leading projections indicate that up to half a million Americans could die from prescription opioid overdoses within the next 10 years³. This death toll rivals the projected fatalities from breast cancer and prostate cancer combined³. This crisis is similar to the AIDS epidemic of the 1980's in death toll and scope.² Drug overdose fatalities in the United States in 2016 exceeded the deadliest car collision death toll year on record.³ The time has come to put in place systems that will allow us to solve this enormous problem. BlockMedx intends to solve many of the systemic problems which are partly

responsible for this catastrophe.

In an attempt to curb this growing public health crisis, the CDC has recently issued new opioid prescribing guidelines⁵.

Unfortunately, these guidelines are not actively enforced and merely exist as suggestions for proper prescribing practices⁵.

The rampant overprescribing of opioid pain medications, prescription fraud, and a system of documentation and prescription generation which fundamentally relies on trust between the patients, prescribers, and pharmacies are just a few of the contributing factors that have led to this epidemic. Most often, opioid prescriptions are handwritten on paper and can be altered, outright forged, and/or duplicated. Pharmacies are forced to trust that the doctor is the one who physically wrote and signed the paper prescription often based on nothing more than professional judgment. Issues in interpreting handwritten prescriptions also cause medication errors and may result in prescriptions being filled improperly or incorrectly. Additionally, physicians are often unaware if the patient has received prescriptions from another doctor for the same medication, thereby doubling the patient's supply of medication. The current system for prescribing controlled substances is untrustworthy, in most instances untraceable, and unreliable. The roots of the problem run deep. Careless or corrupt providers overprescribe opioids while

abusers alter, forge, and duplicate paper prescriptions.

Responsible doctors and pharmacists often have no way of knowing whether they're providing drugs to a legitimate user, or someone with illegal intentions. Traditional arrangements relying on trust and goodwill have become untraceable and unreliable. Laws, regulations, and professional guidelines have all failed to solve the problem. In light of this, BlockMedx intends to develop a new way to make opioid prescriptions secure. A way to make sure medication gets to those who need it. A way to make a broken system accountable. BlockMedx intends to be the first company to bring blockchain technology to the prescription drug industry.

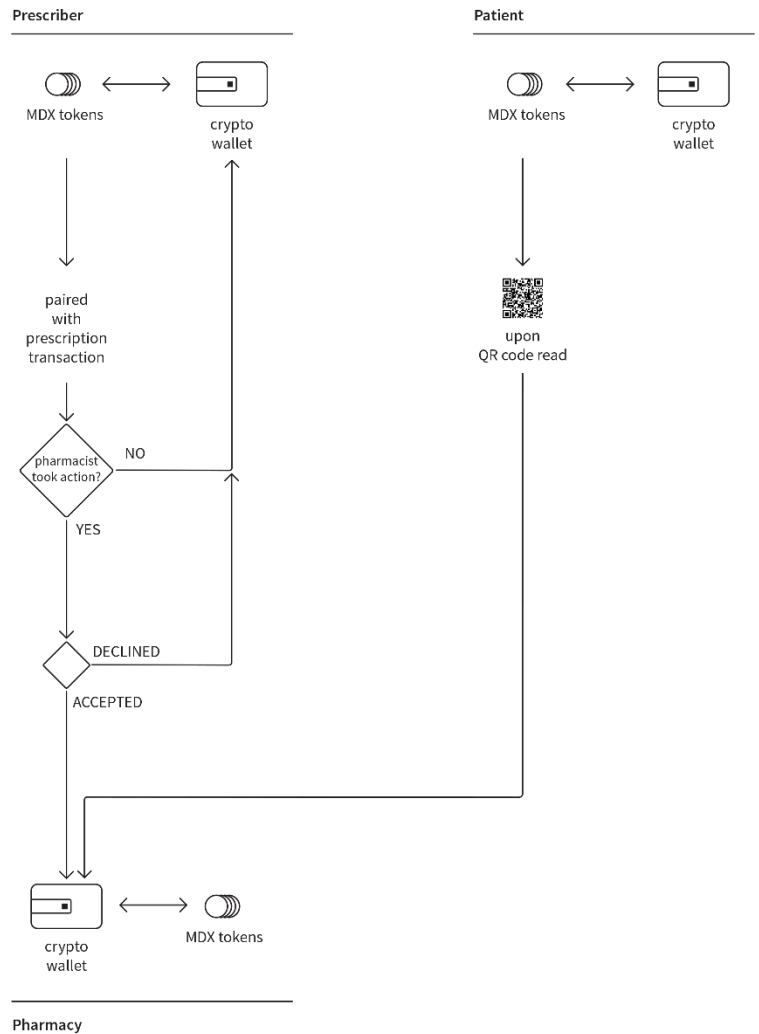
3. Proposed Solution

BlockMedx intends to change the way opioids are prescribed and supplied by creating a secure and effective method and system for providers, pharmacists and patients. Running on the Ethereum blockchain, BlockMedx intends to be a cryptographically secure, HIPAA compliant, end-to-end prescribing platform. Prescriptions will be securely transmitted and recorded on the blockchain accompanied by an MDX token. A token will be paired to each specific prescription, securely verifying the prescription's origin

from the point of creation by the physician. Physicians, pharmacies, and patients will login to a website using a username and password. This website will have access to the Ethereum blockchain. Physicians and pharmacies will have an Ethereum address generated for them when on-boarding the system. This will be necessary for them to interact with the smart contract and hold MDX tokens. An MDX token will be a crypto-currency token that will be required to issue prescriptions and issue payments in the BlockMedx system. The website will provide physicians and pharmacies and patients with their MDX balance and allow them to transfer their tokens; similar to existing crypto-currency wallets. The platform will initially be optimized for processing the most tightly controlled C-II prescriptions, however further functionality will be built in the future and the goal will be a system which can process every DEA class of prescription. BlockMedx intends to evolve to be a fully functional, full service prescription platform running on the Ethereum blockchain.

3.1. For Physicians

Physicians will have the ability to view their own prescribing history and the entire



prescription history of the patients that they are approved to view. Physicians will access the BlockMedx distributed application (D-App) in their office to generate a new prescription.

Physicians will have the ability to issue new prescriptions by filling out the necessary auto-populated fields on an electronic form. The physician will sign the prescription using a non-invasive biometric identity recognition method which will be paired to their private key on the network. The unique verification method BlockMedx intends to use will ensure that only the actual physician can sign and

transmit prescriptions. This ensures total identity integrity for that physician's prescribing authority. Next, they must specify the pharmacy that is to receive the prescription. This user interface will have a superior user experience compared to all existing e-prescribing solutions.

To issue a new prescription the physician must pay a fee in MDX tokens. They will be able to view their available MDX token balance and the required fee for creating the prescription. Physicians will be required to obtain MDX tokens in order to facilitate the secure transmission of their controlled prescriptions using the BlockMedx D-App.

The prescription will be digitally signed by the BlockMedx platform for the physician; similar to hosted cryptocurrency wallets. By signing the prescription, BlockMedx will verify that the prescription is valid and that the physician has been authenticated with sufficient means (depending on prescription type).

When a prescription is issued by a physician, it is in a "pending" state, waiting for signature by BlockMedx. Once BlockMedx digitally signs the prescription on the Ethereum blockchain, it is sent into an "approved" state. The prescription is then committed to the Ethereum blockchain.

Physicians will be able to view a list of their prescription history which will include the

prescription's current status: pending, approved, revoked, declined, or accepted. Physicians will also see if the patient attempted to use his/her prescription at more than one pharmacy. If a prescription is in a pending or approved state, the physician may revoke it which would cause it to enter a revoked state. If a prescription is revoked, or if it is declined by the pharmacy, the MDX tokens will be returned to the physician as tokens to be issued. At no point can the physician use MDX tokens other than for transmitting prescriptions. Only the Pharmacies can move MDX tokens freely. This is important as it makes it difficult for physicians to use the MDX tokens for anything else other than transmitting prescriptions.

3.2. For Pharmacies

Pharmacies will be presented with a queue of approved prescriptions that have not yet been accepted, declined, or revoked. The receiving pharmacy will open the BlockMedx D-App from any one of their computers to access the network. For each prescription, the pharmacy will be given the prescription information, and the ability to view a comprehensive list of the patient's prescription history. They will have the option to accept or decline each prescription that is present in their queue.

Upon acceptance, the pharmacy will be

provided with the MDX tokens issued by the physician. The MDX token will be deposited in the pharmacy's integrated token wallet. A pharmacy employee will sign a confirmation of the receipt for the prescription using a non-invasive biometric identity recognition method. They will then be able to print the prescription. This will include a QR code which can be used to validate the prescription, or they will receive the equivalent QR code from the patient, as printed by the physician at the physician's office. The QR code will correspond to a transaction ID denoting the fact that the prescription has been transmitted to a pharmacy, filled by that pharmacy, and is no longer valid. The transmission of the prescription will essentially constitute a micro-transaction of the MDX token from the physician to the pharmacy.

Pharmacies will be able to accept MDX token payments from patients for their prescription co-pays through the BlockMedx application as well. Credit card fees are steep for small co-pay transactions, therefore small cryptocurrency payments from the patients to the pharmacies presents another unique opportunity for cost-saving to pharmacies. Additionally, credit cards may be difficult for certain patient populations to obtain, therefore the MDX token provides an electronic payment method that has a lower

barrier to entry. Pharmacies will also be able to see prior payments from that particular patient as well as request payments via QR codes and NFC (on specific devices).

The pharmacy will be able to move their MDX tokens freely in and out of their cryptocurrency wallet.

3.3. For Patients

Patients will be able to see their prescription history after login. They (or anyone else with credentialed access to the system) can also scan the QR code on their printed prescription (if one was given) to verify that the prescription has been filled by a particular pharmacy and thereby verify which pharmacy fulfills the prescription. Patients will receive alerts when a new prescription is created and transmitted for them by a physician, when a prescription is accepted and filled by a pharmacy, and also when they may be eligible for a refill of their prescription.

Patients will also be able to hold MDX tokens on their device just like any other cryptocurrency wallet. MDX tokens can be used by patients to pay their co-pay payments at the pharmacy. Patients pay with MDX tokens by scanning a QR code or tapping their device on the Pharmacy's device for NFC functionality (on some devices). The MDX tokens provide a unique

electronic payment method for patients to pay for their prescriptions at the point of sale.

3.4. For Auditors

Auditors can be any type of third party entity, be that private or government, which legally are required to audit any such prescription transactions as would be contained in the BlockMedx system. Examples could include the DEA or the healthcare organizations to which the physicians belong. Prescription records on the BlockMedx D-App will be auditable by boards of pharmacy, the pharmacies themselves, and the physicians. The physicians will be able to access an immutable record of the prescriptions they have written and sent using the platform, and the pharmacies will be able to access an immutable record of prescriptions they have received using the platform.

Auditors are able to request from the BlockMedx platform identity and prescription verification. They can also access the complete prescription history associated with a patient, physician, or pharmacy on the BlockMedx platform. Boards of Pharmacy and the DEA will have immediately auditable records of prescribing practices for each physician. Additionally, machine-learning algorithms will be utilized to generate alerts of suspicious activity that will then be reported to the relevant regulatory bodies. Suspicious or reckless prescribing or dispensing

practices, previously unnoticed, will now be in full view of regulatory authorities who can shine a light on any untoward activity.

4. MDX Token Details

The native token for use on the BlockMedx network will be the MDX token. The token will use the new Ethereum token standard. A pre-defined fraction of an MDX token will be paired with each prescription being transmitted on the BlockMedx network. The MDX tokens will be utilized to facilitate prescription transmissions on the network, as well as being a native currency for payments inside the healthcare system. The MDX token transaction fee utilized on the BlockMedx network can be adjusted up or down as BlockMedx sees fit. Imposing an economic cost on sending these highly controlled drugs will hopefully encourage physicians to limit their prescribing of these drugs to only patients who absolutely need them.

Organizations who employ physicians (or in the case of independent physicians, the physicians themselves) will be required to pay a small monthly subscription fee to BlockMedx in order to gain credentialed access to the BlockMedx network. If a healthcare organization fails to pay their monthly subscription fee, their access to the BlockMedx network will be revoked.

Pharmacies will also pay a small subscription

fee to gain credentialed access to the BlockMedx network. For each prescription a pharmacy receives, the corresponding amount of MDX tokens attached to that prescription will be deposited in the pharmacy's integrated wallet. The transmission of a prescription from a physician to a pharmacy will constitute a micro-transaction of MDX tokens from the physician's wallet to the pharmacy's wallet. Pharmacies will also receive MDX tokens from patients in the form of payments for goods and services received at the pharmacy. Instead of paying at the register for their prescriptions or other goods with cash or credit card, patients will use MDX tokens that have been stored in their BlockMedx application's integrated cryptocurrency wallet. The pharmacy may then do with its MDX tokens as it pleases. Pharmacies will be able to move MDX tokens freely in and out of their wallet as they please.

The tokens will represent no ownership share in BlockMedx, will provide no voting rights to token holders, and will represent no entitlement to dividends from BlockMedx. The MDX tokens will solely be used for securing prescriptions on the BlockMedx network and as a secure payment method for patients to utilize with their pharmacies.

5. Benefits (Incentives)

5.1. Pharmacies

The BlockMedx system constitutes a completely new revenue stream for pharmacies, in that it is the first model of direct payments from physicians to pharmacies. Before BlockMedx, the only source of revenue for pharmacies was reimbursements from Pharmacy Benefit Management (PBM) companies, insurance companies, or co-payments from patients at the point of sale. Often, pharmacies must wait months for reimbursement from these entities, in addition to having extremely slim, or non-existent margins on their sale of drugs. BlockMedx will be a brand new way for pharmacies to be paid for filling prescriptions. Additionally, BlockMedx will be a new, virtually fee-less payment channel that pharmacies may utilize to accept payments for goods and services from their patients.

Pharmacies will adopt the BlockMedx network because of their falling prescription reimbursement rates and ever-tightening margins. BlockMedx provides a brand new revenue stream that will revitalize the pharmacy industry. E-prescribing of DEA Controlled Drug prescriptions on the BlockMedx network will also save pharmacists a great deal of time and energy that was previously spent on verifying the

authenticity of paper prescriptions. The authenticity and source of prescriptions will no longer be in question.

5.2. Physicians

Physicians will adopt the BlockMedx network because they will re-gain complete control over their prescriptive authority of controlled drugs. This control can only be generated with the trustless BlockMedx system and its non-invasive biometric identification methods. Additionally, they will have access to a complete, immutable record of prescriptions for their patients (even prescriptions written outside their healthcare system), allowing them to have complete knowledge of the patient's prescription history to better inform their prescribing practices. BlockMedx intends to represent a significant cost savings to healthcare organizations as well. By preventing costly drug overdose ER visits and hospitalizations by encouraging safe and responsible opioid prescribing practices, a significant loss-leader can be seriously reduced by organizations that adopt the BlockMedx prescribing platform.

6. Security

In order for a transmission to be generated on the network, the data packet containing the prescription must be paired with the pre-

determined amount of the MDX token to be accepted by the network and transmitted. This adds an extra layer of security to transactions sent on the network, since it would be cost prohibitive to either spam the network or attempt to falsify prescriptions on the network.

Patients will be able to securely access their own prescription records via a mobile application on their Android or iPhone. The patient's identity will be verified using a combination of Social Security Number, name, and birthdate during the process of setting up their personal account. After account verification, they will access the application using a username and password of their choice.

7.1 Business Model

The BlockMedx platform business model intends to be a user-friendly experience that connects physicians, pharmacies, and patients. All of these parties will be able to access the BlockMedx protocol and smart contract on the public Ethereum chain. The current state of healthcare software is dismal, with significant UI/UX problems in almost every application. BlockMedx intends to deliver a superior experience, coupled with game-changing technology and information access to all parties involved. Finally,

BlockMedx will charge a software service subscription fee to physicians and their healthcare organizations, as well as pharmacies, in order to use the platform.

7.2 Value and Network Effect

We believe that this software service network will have a very strong effect between physicians, healthcare organizations, and pharmacies. The healthcare organizations will essentially mandate that physicians use any software that is compatible with the BlockMedx Ethereum subscription protocol because of the powerful information that BlockMedx intends to obtain and curate. Since BlockMedx intends to be the first to offer such software, it will quickly and easily become the standard. This means that by getting a few very large healthcare organizations on board we can expect an exponential number of pharmacies on board, as well. This means that for marketing and business development purposes, the biggest return on investment will be from non-scalable marketing towards healthcare organizations. These will be door to door sales and presentations. Pharmacies won't require individual sales, they will follow suit after their local healthcare organizations and

prescribers have signed on. BlockMedx LLC as a company will be valued as a software service business rather than a blockchain business. Net present value of the business will reflect a multiple of the predicted monthly revenue from subscriptions.

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