Vacci-Chain: The Smart Contract Powered Vaccine Storage and Monitoring System

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Outline

- Introduction
- Limitations
- What is the Solution?
- The Proposed System
- Future Work
- Conclusion
- References
Vaccine Temperature

- Vaccine: a delicate biological substance
- Recommended temperature: 2 °C - 8 °C
- Sensitive: freezing temperature or exposure to heat

Figure: Vaccine Storage Temperature*

Vaccine Storage

- Purpose-built vaccine refrigerator
- Domestic refrigerator
- Portable vaccine refrigerator

Vaccines

References

† http://www.labfreez.com/MPR-series-portable-refrigerator
Data Collection and Monitoring

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Vaccine Temperature

Vaccine Storage

Data Collection and Monitoring

Data Logger†

Max/Min Thermometer†

Manual Data Log†

Hardware Issues

✔ Purpose-built vaccine refrigerators
  - No in-built monitor and/or logger in some models
  - No battery backup facility in some models
  - Need to use a min/max thermometer

✔ Domestic refrigerators
  - Temperature fluctuations
  - Non-uniform temperature
  - Must use a min/max thermometer & data logger
Technical Issues

✓ **Purpose-built vaccine refrigerators**
  - Manually reset thermometer
  - Compromise/Manipulate data downloaded to a computer
  - Compromise in-built system

✓ **Domestic refrigerators**
  - Very hard to deal with temperature changes
  - Use manual data log in most cases

NEED A SAFE, TRANSPARENT and TRACEABLE SOLUTION FOR VACCINE STORAGE AND MONITORING SYSTEM
Vacci-Chain System

Fig: Vacci-Chain entities and their relationships
System Architecture

- Temperature Sensor
- Domestic Refrigerator
- Data Logger
- Aggregator
- Distributed Ledger
- Miners

**Vacci-Chain System**

**System Architecture**
Smart Contract Powered Solution

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Smart Contract Powered Solution

Benefits

```
function tempReceive(int _temp, uint _fridgeID) {
    temp = _temp;
    tempUpdateDate = now;
    if (temp >= tempRange.max || temp <= tempRange.min) {
        for (uint i = 0; i < Vials.length; i++) {
            if (Vials[i].fridgeID == _fridgeID) {
                Vials[i].fault = true;
            }
        }
    }
}
```
Benefits

✓ **Transparency**- every block in the chain is visible

✓ **Traceability**- can trace the origin of vaccines, manufacturing & expiry date etc.

✓ **Accuracy**- temperature data is stored accurately

✓ **Fault Tolerance**- distributed ledger eliminates SPoF

✓ **Security**- blockchain is immutable and irrefutable

✓ **Ease of Access**- easily can check the history, availability etc.
Future Work

- Transportation in refrigerated vans or cool boxes
- Vaccine manufacturer
  - Storage method: Transit storage
- Primary vaccine store
  - Storage method: Cold rooms
- Health center
  - Storage method: Refrigerators
- Immunization venue
  - Storage method: Cold boxes
- Patient
Conclusion

✓ Safe, secure and transparent system

✓ Better traceability

✓ Cost effective solution
References


Thanks for your attention !!!