

Digital PrEP Navigation for the “Tech-Savvy Middle-Aged”: Developing and Testing a Blockchain-Based or Secure Digital Platform for Discrete PrEP Consultation, Prescription, and Pharmacy Navigation for Professionals Aged 40-60 Concerned About Privacy

The Hong Kong Aids Prevention Society (HKAPS)

Executive Summary

Pre-exposure prophylaxis (PrEP) represents a highly effective biomedical intervention for HIV prevention, demonstrating efficacy rates exceeding 90% when taken consistently. However, significant disparities persist in PrEP uptake and retention, particularly among middle-aged professionals aged 40-60 who face unique barriers related to privacy concerns, stigma, and healthcare system navigation challenges. This comprehensive report examines the development and implementation of a secure digital platform specifically designed to address the discrete healthcare needs of this “tech-savvy middle-aged” demographic. Drawing on extensive evidence from digital health interventions, blockchain-based healthcare systems, telemedicine platforms, and PrEP delivery models, this report proposes an innovative solution that leverages secure technology to provide confidential PrEP consultation, prescription, and pharmacy navigation services while addressing the specific privacy and accessibility concerns of professionals in this age group.

1. Introduction: The Intersection of HIV Prevention, PrEP, and Middle-Aged Professionals

1.1 Background and Rationale

The global HIV epidemic continues to pose significant public health challenges, with approximately 37 million people living with HIV worldwide. Despite decades of prevention efforts, HIV incidence remains elevated in specific populations, necessitating innovative biomedical interventions beyond traditional behavioral approaches. Pre-exposure prophylaxis has emerged as a transformative HIV prevention tool, offering individuals at substantial risk of HIV acquisition the opportunity to protect themselves through daily or event-based antiretroviral medication. Since its approval in 2012, PrEP has been positioned as an integral component of combination prevention strategies globally.

However, PrEP uptake remains suboptimal across many populations, with significant disparities observed along racial, ethnic, geographic, and socioeconomic lines. While considerable attention has focused on PrEP implementation among young men who have sex with men (MSM), adolescent girls and young women, and other traditionally prioritized key populations, middle-aged professionals aged 40-60 represent an underserved demographic with distinct needs and barriers. This population often experiences high HIV risk due to relationship transitions, sexual network characteristics, and changing life circumstances, yet faces unique obstacles in accessing PrEP services related to privacy concerns, professional reputation considerations, and healthcare system navigation challenges.

1.2 The Unique Context of Middle-Aged Professionals

Middle-aged adults aged 40-60 occupy a distinct position in both the HIV epidemic and the healthcare landscape. This demographic demonstrates several characteristics that distinguish their PrEP needs from younger populations. First, professionals in this age range often maintain established careers where confidentiality and discretion regarding sexual health matters carry particular weight (Pipalia, 2025). The potential for HIV-related stigma to impact professional relationships, employment opportunities, and social standing creates substantial barriers to seeking traditional PrEP services. Second, this population

generally exhibits higher levels of digital literacy and technology adoption compared to older adults, while maintaining preferences for privacy and autonomy in healthcare decision-making that differ from younger generations. Research on digital literacy among middle-aged adults reveals that digital competence emerges as the highest contributor to eHealth literacy in this demographic, with significant associations between technology use and health information-seeking behaviors (Lee & Tak, 2022).

Furthermore, middle-aged professionals often face time constraints related to career responsibilities, family obligations, and complex schedules that make traditional clinic-based PrEP services challenging to access. The convergence of these factors—elevated privacy needs, digital competence, and accessibility barriers—creates both challenges and opportunities for innovative PrEP delivery models specifically tailored to this population.

1.3 Purpose and Scope of This Report

This report comprehensively examines the development, implementation, and testing of a blockchain-based or secure digital platform designed to facilitate discrete PrEP consultation, prescription, and pharmacy navigation for professionals aged 40-60. The analysis synthesizes evidence from multiple domains, including digital health technologies, blockchain applications in healthcare, telemedicine platforms, PrEP delivery models, privacy-preserving systems, and technology adoption among middle-aged adults. By integrating insights from these diverse fields, this report proposes a novel approach to addressing the specific needs of tech-savvy middle-aged professionals seeking confidential access to HIV prevention services. The report examines current PrEP delivery models and their limitations, explores privacy and stigma concerns affecting this demographic, reviews digital health technologies and their adoption patterns, analyzes blockchain and secure platform options for healthcare data protection, proposes a comprehensive platform architecture, and discusses implementation considerations, challenges, and future directions.

2. Background: PrEP as an HIV Prevention Tool and Current Delivery Models

2.1 PrEP Efficacy and Evidence Base

Pre-exposure prophylaxis for HIV prevention has been extensively studied through randomized controlled trials and implementation science research, establishing a robust evidence base for its effectiveness. Clinical trials have demonstrated that oral PrEP using tenofovir-based regimens can reduce HIV transmission risk by up to 92% when medication adherence is adequate (Elst et al., 2015). The biomedical intervention has shown efficacy across diverse populations, including MSM, heterosexual individuals, people who inject drugs, and serodiscordant couples. However, PrEP effectiveness in real-world settings depends critically on medication adherence, with efficacy declining substantially when adherence is suboptimal.

Beyond individual protection, PrEP contributes to population-level HIV prevention when implemented as part of combination strategies. Modeling studies estimate that worldwide, a 20-25% reduction in HIV incidence among MSM could be achieved through PrEP implementation, potentially averting up to 1 million new infections over 10 years (Elst et al., 2015). These projections underscore PrEP's potential as a game-changing prevention tool, yet realizing this potential requires addressing the substantial gaps between PrEP awareness, uptake, adherence, and persistence observed in current implementation efforts.

2.2 The PrEP Care Continuum and Attrition Challenges

Similar to the HIV care continuum for treatment, researchers have conceptualized a PrEP care continuum encompassing sequential steps from awareness through sustained use. This continuum typically includes awareness of PrEP, access and linkage to PrEP services, initiation of medication, adherence to the prescribed regimen, and persistence in PrEP use over time. Each stage of this continuum presents opportunities for attrition, with substantial loss observed between awareness and actual PrEP use. Research examining PrEP uptake among diverse populations reveals that while awareness has increased substantially in recent years, significant barriers prevent translation of awareness into initiation and sustained use (Garrison & Haberer, 2021).

Studies documenting PrEP implementation have identified multiple points of attrition throughout the care continuum. Among individuals expressing interest in PrEP, many do not initiate services due to access barriers, cost concerns, stigma, or navigation challenges (Pipalia, 2025). Among those who initiate PrEP, adherence and persistence present ongoing challenges, with discontinuation rates particularly high in the first months of use. A comprehensive review of interventions aimed at improving PrEP uptake, adherence, and persistence found that individual-level and structural-level approaches showed promise, including technology-based interventions, alternate delivery strategies, and integration with other healthcare services (Garrison & Haberer, 2021). However, the review also noted that more robust study designs are needed to establish evidence-based best practices for supporting individuals throughout the PrEP care continuum.

2.3 Current PrEP Delivery Models and Their Limitations

Traditional PrEP delivery has primarily occurred through clinic-based models, typically in sexual health clinics, HIV specialty care settings, or primary care practices. These models generally require in-person visits for initial consultation, laboratory testing, prescription, and ongoing monitoring. While clinic-based delivery has successfully reached many individuals, significant limitations exist. Systematic reviews of PrEP service delivery models have identified barriers including centralized service provision in clinical settings, limited hours of operation, geographic inaccessibility, and requirements for multiple visits (Vanhamel et al., 2020). These barriers particularly affect individuals with work schedules, transportation challenges, or concerns about being seen at specialized sexual health facilities.

Recognizing these limitations, innovative delivery models have emerged. Community-based approaches have demonstrated feasibility and acceptability, with peer-led delivery, drop-in centers, and mobile health clinics showing promise for reaching underserved populations (Rousseau et al., 2021). Pharmacy-led PrEP delivery has been explored as a de-medicalized, confidential option that can provide services at extended hours in community locations (Kennedy et al., 2022). Telemedicine and digital platforms represent another innovation, with virtual PrEP services demonstrating effectiveness during the COVID-19 pandemic and beyond (Patel et al., 2022). Studies of technology-based

interventions for virtual PrEP service delivery have identified effective, feasible, and acceptable approaches including SMS messaging, smartphone applications, telehealth platforms for virtual visits, and training programs for healthcare workers (Patel et al., 2022).

3. Privacy and Stigma as Critical Barriers to PrEP Access for Professionals

3.1 The Multidimensional Nature of HIV-Related Stigma

HIV-related stigma continues to function as a fundamental barrier to prevention, testing, and treatment services despite decades of awareness and intervention efforts. Stigma manifests at multiple levels, including internalized stigma experienced by individuals themselves, interpersonal stigma in relationships and social interactions, and structural stigma embedded in policies and institutional practices (Nyblade et al., 2022). In the context of PrEP specifically, stigma operates through several mechanisms. First, PrEP stigma connects to persistent HIV stigma, with PrEP users sometimes labeled as promiscuous, irresponsible, or engaging in high-risk behaviors (Dubov et al., 2018). Research with MSM who use PrEP has documented experiences of rejection by sexual partners, stereotyping, and labeling of both PrEP users and the medication itself. These stigmatizing attitudes and behaviors can discourage PrEP uptake and create barriers to sustained use.

Second, PrEP stigma intersects with other forms of stigma including homophobia, transphobia, and stigma associated with substance use, creating compounded effects for individuals at the intersection of multiple marginalized identities (Watson et al., 2022). For middle-aged professionals, the potential for stigma related to sexual health or HIV risk to intersect with concerns about professional reputation, social standing, and family relationships creates particularly complex barriers. Studies examining PrEP awareness and decision-making have identified stigmatization as a significant barrier at both individual and structural levels, with concerns about being judged by healthcare providers, community members, or family members deterring individuals from seeking PrEP services (Garca & Harris, 2017).

3.2 Privacy Concerns in Healthcare Settings

Privacy and confidentiality represent critical considerations in healthcare delivery generally, but assume heightened importance in the context of sexual health services and HIV prevention. For middle-aged professionals, privacy concerns operate at multiple levels. At the most basic level, individuals may worry about being seen entering or exiting sexual health clinics, with fears that such observation could lead to assumptions about their sexual practices or HIV risk. Research examining barriers to HIV and STI testing among rural MSM found that privacy and confidentiality concerns, along with perceived stigma from providers and community members, constituted major impediments to accessing screening services (Hubach et al., 2020).

Beyond physical privacy in healthcare settings, concerns about information privacy and data security affect willingness to engage with health services. Traditional healthcare systems often involve multiple points where personal health information might be accessed, shared, or potentially breached, creating legitimate concerns about confidentiality (Nyblade et al., 2022). For professionals whose careers or social standing could be affected by disclosure of HIV risk or PrEP use, these privacy vulnerabilities represent substantial barriers. Studies of healthcare provider attitudes and behaviors have documented instances of breaches in confidentiality, stigmatizing treatment of patients, and insufficient attention to privacy protections, underscoring the legitimacy of these concerns (Geter et al., 2018).

3.3 Stigma in Healthcare Delivery and Provider Attitudes

Healthcare providers' attitudes, knowledge, and behaviors significantly influence PrEP access and retention. Research examining healthcare workers' perspectives on PrEP delivery has revealed several challenges. First, provider knowledge about PrEP eligibility, prescribing protocols, and monitoring requirements varies substantially, with many non-specialist providers lacking confidence in PrEP delivery (Wheelock et al., 2012). This knowledge gap can lead to missed opportunities for PrEP provision or inappropriate gatekeeping that prevents eligible individuals from accessing services.

Second, provider biases and stigmatizing attitudes affect the quality of PrEP services. Studies examining provider perspectives on PrEP for specific populations have identified

biases regarding who should access PrEP, with some providers expressing judgmental attitudes about sexual behavior or questioning the appropriateness of PrEP for certain individuals (Pilgrim et al., 2018). These biases can manifest in differential treatment, inadequate counseling, or discouragement of PrEP use. For middle-aged professionals who may already experience discomfort discussing sexual health matters with providers, encountering stigmatizing attitudes can reinforce barriers to care.

Third, the purview paradox in PrEP delivery creates structural challenges (Pinto et al., 2018). HIV specialists often do not see HIV-negative patients who might benefit from PrEP, while primary care physicians who serve uninfected patients may lack training or comfort in providing PrEP services. This gap in service provision particularly affects individuals seeking discrete PrEP access outside traditional sexual health clinic settings.

4. Digital Health Technologies and Middle-Aged Adult Adoption Patterns

4.1 Digital Literacy and eHealth Engagement Among Middle-Aged Adults

Understanding technology adoption and digital health engagement among middle-aged adults is essential for designing effective interventions for this population. Research on eHealth literacy focusing on digital literacy components among middle-aged adults in South Korea found that digital competence emerged as the highest contributor to eHealth literacy, while digital skills alone were not significantly associated with eHealth literacy (Lee & Tak, 2022). This finding suggests that the ability to critically evaluate and apply digital health information matters more than technical proficiency alone. The study also revealed that eHealth literacy was positively associated with increasing age within the middle-aged cohort, female gender, and higher education levels, indicating heterogeneity within this demographic that should inform intervention design.

Smartphone ownership and interest in mobile health technologies have been documented across diverse middle-aged populations. A cross-sectional survey of patients with chronic heart failure found that 68% of participants owned smartphones, with racial and ethnic minorities reporting higher ownership rates than anticipated (Leigh et al., 2021). This challenges assumptions about digital divides and suggests that smartphone-based interventions can potentially reach diverse middle-aged populations. The study also found

high interest in using mHealth technologies for self-monitoring of health parameters, with physical activity monitoring, blood pressure tracking, and medication management identified as priority areas for digital health support.

4.2 Factors Influencing Digital Health Technology Adoption

Multiple factors influence middle-aged adults' uptake and engagement with digital health interventions. A systematic review examining influences on uptake of and engagement with health and well-being smartphone apps identified 26 factors related to capability, opportunity, and motivation (Szinay et al., 2020). Under capability, digital literacy and skills emerged as foundational factors, along with awareness of available apps and guidance on information quality. The review found that well-designed prompts and features to reduce cognitive load in self-monitoring facilitated engagement, suggesting that user interface design significantly impacts sustained use.

Opportunity factors included availability at low or no cost, personalized content, positive tone in messaging, and social networking possibilities (Szinay et al., 2020). These findings indicate that financial accessibility, tailored content, and opportunities for peer support can enhance adoption. Motivation factors encompassed feedback and rewards, goal-setting features, and perceived utility of the intervention. Research on technology acceptance in mobile health has emphasized that multiple predictors show significant associations with mHealth usage intentions, including individual dispositions toward mobile service innovations, perceived health conditions, and existing healthcare services utilization (Rai et al., 2013).

For middle-aged adults specifically, studies suggest that age-appropriate design considerations, attention to privacy preferences, and alignment with existing healthcare routines enhance adoption (Kruse et al., 2020). A systematic review of utilization barriers and medical outcomes commensurate with telehealth use among older adults identified technical literacy, lack of desire to use technology, and cost as the most common barriers (Kruse et al., 2020). However, the review also noted that interventions decreased psychological stress and increased autonomy, suggesting that when barriers are addressed, digital health tools can provide meaningful benefits for middle-aged and older populations.

4.3 Telemedicine and Virtual Care Models

The COVID-19 pandemic dramatically accelerated telemedicine adoption globally, providing substantial evidence about feasibility, acceptability, and effectiveness of virtual care models. Studies of telemedicine implementation during the pandemic documented that healthcare providers and patients generally demonstrated high acceptance of telemedicine services, with benefits including maintained access to care, reduced infection risk, and convenience (Mahmoud et al., 2022). A scoping review of telemedicine in low- and middle-income countries during COVID-19 found that telemedicine improved healthcare provision and reduced infection risk while highlighting technological, regulatory, and economic barriers that required attention (Mahmoud et al., 2022).

Specific to sexual health services, research examining the impact of COVID-19 on access to needed sexual health services in British Columbia found that alternative service delivery models, particularly online testing services, proved highly acceptable (Gilbert et al., 2021). The study found that internet-based testing services (GetCheckedOnline) users had lower odds of having unmet sexual health needs compared to traditional clinic users. This suggests that digital service delivery models can effectively complement traditional approaches, particularly for individuals facing access barriers.

Studies of virtual PrEP service delivery during COVID-19 demonstrated that telemedicine platforms, smartphone apps, and other technology-based interventions proved effective, feasible, and acceptable for PrEP delivery (Patel et al., 2022). A systematic review summarized 19 studies of virtual service delivery of PrEP, finding examples of effective technology-based interventions including SMS messaging apps (with outcomes such as 50% reduction in PrEP discontinuation), telehealth and eHealth platforms for virtual visits, and training platforms for healthcare workers (Patel et al., 2022). These innovations, which occurred before COVID-19 but gained new relevance during the pandemic, suggest potential for strengthening HIV prevention service delivery by engaging traditionally hard-to-reach populations and reducing stigma through more accessible healthcare platforms.

5. Blockchain and Secure Digital Platforms for Healthcare Privacy

5.1 Blockchain Technology Fundamentals in Healthcare Applications

Blockchain technology has emerged as a promising solution for addressing security, privacy, and data integrity challenges in healthcare systems. Fundamentally, blockchain provides a decentralized, distributed ledger system that enables secure, transparent, and tamper-resistant record-keeping without requiring central authority (Guan et al., 2025). In healthcare applications, blockchain offers several key advantages. First, the immutable nature of blockchain records ensures data integrity, as once information is recorded on the blockchain, it cannot be altered or deleted without detection. This characteristic provides strong protection against unauthorized modification of medical records or health data.

Second, blockchain's decentralized architecture eliminates single points of failure that characterize traditional centralized healthcare information systems. This distribution enhances system resilience and reduces vulnerability to data breaches or system attacks (Wang et al., 2021). Third, blockchain enables fine-grained access control through smart contracts, allowing patients to maintain sovereignty over their health data while selectively granting access to specific providers or services (Tanwar & Thakur, 2023). This patient-centric approach aligns well with the privacy needs of middle-aged professionals seeking discrete healthcare services.

Research on blockchain applications in healthcare has documented diverse use cases, including electronic health record management, secure data sharing, medical device integrity tracking, and pharmaceutical supply chain management (Guan et al., 2025). A blockchain-enhanced data privacy preservation scheme for healthcare IoT demonstrated that combining improved homomorphic encryption with symmetric searchable encryption techniques and Bloom filters could enable secure data computation and analysis while maintaining privacy (Guan et al., 2025). The study showed that the proposed scheme reduced encryption and decryption time by an average of 34% compared to conventional approaches, while maintaining constant ciphertext retrieval time, indicating that blockchain-based privacy preservation can be both effective and efficient for real-world healthcare applications.

5.2 Privacy-Preserving Technologies for Medical Data

Beyond blockchain specifically, various privacy-preserving technologies offer potential for protecting sensitive health information in digital platforms. Homomorphic encryption techniques allow computation directly on encrypted data without requiring decryption, reducing the risk of data leakage during processing or sharing (Guan et al., 2025). This capability enables healthcare providers or research institutions to perform necessary analyses on patient data while maintaining confidentiality. Symmetric searchable encryption enables users to search encrypted data without exposing the underlying content, facilitating efficient information retrieval while preserving privacy.

Attribute-based encryption schemes provide another approach to privacy preservation, enabling fine-grained access control based on user attributes and policy matching (Tan et al., 2022). Research on blockchain-empowered security and privacy protection schemes for COVID-19 medical records demonstrated that ciphertext policy attribute-based encryption combined with blockchain could provide secure and privacy-preserving data sharing (Tan et al., 2022). The proposed scheme performed blockchain for uniform identity authentication, storing public keys and revocation lists on the blockchain, while the cloud service provider stored encrypted medical records and generated intermediate decryption parameters using policy matching.

Zero-knowledge proofs represent an advanced cryptographic technique that enables one party to prove to another that a statement is true without revealing any additional information beyond the validity of the statement itself. In healthcare contexts, zero-knowledge proofs could enable patients to demonstrate eligibility for services or compliance with protocols without disclosing specific medical details. Secure multi-party computation techniques allow multiple parties to jointly compute functions over their inputs while keeping those inputs private, enabling collaborative data analysis or decision-making without compromising confidentiality (Xia et al., 2024).

5.3 Blockchain-Based Healthcare Systems: Current Implementations and Lessons Learned

Multiple blockchain-based healthcare systems have been developed and tested, providing valuable insights about implementation challenges and success factors. An efficient secure

sharing system for electronic health records using IoT-based Hyperledger blockchain demonstrated that permissioned blockchain frameworks can effectively support healthcare data management (S. et al., 2024). The study proposed a Modified Key Policy Attribute-Based Encryption system that outperformed traditional approaches for various file sizes, requiring 4008ms for encryption and 4138ms for decryption. This implementation highlighted the importance of balancing security with performance in real-world healthcare applications.

MedShare, a privacy-preserving medical data sharing system using blockchain, proposed a decentralized framework for secure EHR sharing that utilized smart contract techniques to establish a platform where healthcare centers could share encrypted EHRs (Wang et al., 2021). The system devised a constant-size attribute-based encryption scheme where access policies were embedded in ciphertexts stored on the blockchain, and an efficient searchable encryption scheme enabled authorized users to perform multi-keyword boolean operations over encrypted EHRs. Evaluation results demonstrated that MedShare could provide secure, privacy-preserving data sharing while maintaining acceptable performance.

Several critical lessons have emerged from blockchain healthcare implementations. First, scalability remains a challenge, as blockchain systems must handle large volumes of healthcare data and transactions (Fugkeaw et al., 2023). Solutions such as off-chain storage combined with on-chain hash anchoring can address this limitation while maintaining data integrity. Second, regulatory compliance and interoperability with existing healthcare systems require careful attention (Mahammad & Kumar, 2023). Third, user experience design is critical for adoption, as complex cryptographic operations must be abstracted into intuitive interfaces that healthcare providers and patients can navigate easily (Tanwar & Thakur, 2023). Fourth, governance models must clearly define roles, responsibilities, and dispute resolution mechanisms in decentralized systems.

6. Proposed Digital PrEP Navigation Platform: Architecture and Core Features

6.1 Platform Architecture and Technical Infrastructure

The proposed digital PrEP navigation platform for middle-aged professionals would employ a hybrid architecture combining blockchain technology for sensitive health data

management with conventional cloud infrastructure for non-sensitive operational functions. The core system would utilize a permissioned blockchain network, such as Hyperledger Fabric, which provides enterprise-grade security while enabling controlled access based on participants' roles (Oladele et al., 2024). This choice balances the privacy and security benefits of blockchain with the practical requirements of healthcare service delivery.

The platform architecture would comprise several integrated components. First, a patient-facing mobile application and web interface would provide the primary user interaction points, offering intuitive access to consultation scheduling, educational resources, prescription management, and pharmacy navigation tools. These interfaces would be designed with user experience principles specific to middle-aged adults, emphasizing clarity, simplicity, and privacy controls (Lee & Tak, 2022). Second, a provider portal would enable licensed healthcare professionals to conduct virtual consultations, review medical histories, order laboratory tests, prescribe medications, and monitor patient progress securely.

Third, blockchain-based medical record storage would maintain encrypted health information including consultation notes, laboratory results, prescription histories, and monitoring data (Guan et al., 2025). Smart contracts would govern access permissions, ensuring that data could only be accessed by authorized parties based on patient-defined consent parameters. Fourth, secure communication channels would facilitate HIPAA-compliant messaging between patients and providers, with end-to-end encryption protecting sensitive discussions. Fifth, an integration layer would connect with external systems including laboratory partners, pharmacy networks, and electronic prescribing platforms, enabling seamless care coordination while maintaining privacy protections.

The platform would implement multiple layers of security including multi-factor authentication, encryption at rest and in transit, regular security audits, and compliance monitoring (Hewa et al., 2020). All personally identifiable information would be encrypted using industry-standard cryptographic protocols, with encryption keys managed using secure key management systems. Audit logs maintained on the blockchain would create an immutable record of all data access and system activities, enabling accountability while detecting unauthorized access attempts.

6.2 Core Features for Discrete PrEP Consultation and Navigation

The digital platform would provide comprehensive features specifically designed to address the privacy, accessibility, and navigation needs of middle-aged professionals seeking PrEP services. The consultation module would offer multiple pathways for initial PrEP assessment and ongoing care. Anonymous screening tools would allow individuals to assess their HIV risk and PrEP candidacy without providing identifying information, reducing initial barriers to engagement. Once users decided to proceed, secure account creation would employ privacy-preserving registration that minimizes data collection while establishing authentication credentials.

Virtual consultation scheduling would provide flexible appointment times including evening and weekend options, accommodating professional schedules (Smith & Badowski, 2021). Consultations would occur via secure video conferencing with licensed healthcare providers experienced in sexual health and PrEP delivery. The platform would support both synchronous video visits and asynchronous messaging consultations, allowing users to choose formats aligned with their preferences and circumstances. During consultations, providers would conduct comprehensive HIV risk assessments, discuss PrEP benefits and risks, order necessary baseline laboratory testing, and develop personalized PrEP initiation plans.

The prescription and pharmacy navigation component would address critical gaps in current PrEP delivery models. Following PrEP approval, the system would enable electronic prescribing to the patient's pharmacy of choice, with options for mail-order delivery to enhance discretion (Kennedy et al., 2022). A pharmacy network finder would identify PrEP-friendly pharmacies in the user's area, providing ratings and reviews from other platform users. For individuals concerned about local pharmacy privacy, the platform would facilitate connections with specialty pharmacies experienced in discrete HIV prevention medication delivery. Automated refill reminders would support medication adherence, while the system would alert users to approaching monitoring visit requirements.

6.3 Privacy-Preserving Features and User Control

Central to the platform's design would be robust privacy-preserving features that give users granular control over their health information. A privacy dashboard would provide transparent visualization of data collection, storage, and sharing practices, enabling users to understand exactly what information exists in the system and who can access it (Iwaya et al., 2020). Users could set differential privacy preferences for various types of information, potentially maintaining stricter controls over identifying information while allowing more open sharing of de-identified health outcomes data for quality improvement purposes.

Selective disclosure capabilities would enable users to share specific information with specific providers without exposing their complete medical history (Wang et al., 2021). For example, a user might grant a consulting provider access to PrEP-related information while restricting access to unrelated health conditions. Smart contracts governing data access would automatically enforce these permission structures, ensuring that privacy preferences are technically implemented rather than relying solely on policy compliance.

Anonymous consultation options would allow individuals to initially engage with the platform without creating permanent identifiable records, potentially using pseudonymous identifiers until they decide to proceed with PrEP initiation (Adeagbo et al., 2019). This feature addresses concerns about leaving a permanent record of HIV risk assessment or PrEP interest. Secure deletion capabilities would enable users to request permanent deletion of their data if they discontinue platform use, with cryptographic verification of deletion provided to ensure compliance.

Communication security features would protect all messaging, ensuring that discussions about sexual health, HIV risk, or PrEP use could not be intercepted or disclosed. End-to-end encryption would prevent even platform administrators from accessing message content (Alrebh et al., 2024). Disappearing message options could provide additional privacy for particularly sensitive discussions. The platform would clearly communicate these security features to users, building trust that their privacy is protected by technical safeguards rather than policy promises alone.

6.4 Adherence Support and Longitudinal Care Features

Recognizing that PrEP effectiveness depends critically on adherence and persistence, the platform would incorporate evidence-based features to support sustained use (Garrison & Haberer, 2021). Personalized medication reminders would use machine learning to optimize timing and messaging based on individual patterns, avoiding one-size-fits-all approaches that may not align with users' routines. The system would allow users to customize reminder preferences, including delivery channels (push notifications, SMS, email), timing, and message content.

Adherence tracking tools would enable users to log medication taking, providing data for self-monitoring and discussions with providers. However, the platform would implement these tools in a non-judgmental manner, emphasizing support rather than surveillance (Wei et al., 2020). Gamification elements such as streak tracking or achievement badges could provide positive reinforcement, though research suggests these features should be optional to avoid creating pressure that might discourage some users.

Educational content would be continuously available, covering topics including PrEP mechanism of action, side effect management, adherence strategies, risk reduction counseling, and STI prevention (Benny et al., 2021). Content would be tailored to middle-aged adults, avoiding assumptions about familiarity with sexual health topics while respecting users' intelligence and autonomy. Interactive decision aids would support informed decision-making about PrEP use, including tools to evaluate whether PrEP continues to align with an individual's current risk profile.

Peer support features would create opportunities for users to connect with others using PrEP, reducing isolation and building community while maintaining privacy protections. Anonymous discussion forums, moderated by healthcare professionals, would allow users to share experiences, ask questions, and offer mutual support (Swendeman et al., 2019). Optional matching with peer mentors who have successfully maintained PrEP adherence could provide personalized guidance based on lived experience.

7. Implementation Considerations for Middle-Aged Professional Populations

7.1 Regulatory and Legal Framework Requirements

Implementing a digital PrEP navigation platform requires careful attention to regulatory compliance across multiple domains. In the United States, healthcare privacy regulations including the Health Insurance Portability and Accountability Act (HIPAA) establish strict requirements for protecting patient health information. The platform must ensure that all data collection, storage, transmission, and sharing practices meet HIPAA standards (Daruwalla et al., 2014). This includes implementing required administrative, physical, and technical safeguards, conducting regular risk assessments, establishing breach notification procedures, and executing business associate agreements with any third-party service providers that handle protected health information.

Telemedicine licensure requirements create additional complexity, as healthcare providers must typically be licensed in the state where the patient is located at the time of the consultation (Wright & Caudill, 2020). The platform would need to implement geographic verification systems to ensure compliance with these requirements, potentially restricting service availability to states where participating providers hold active licenses. During the COVID-19 pandemic, many jurisdictions temporarily relaxed interstate licensure restrictions to facilitate telemedicine access, but permanent reforms remain under discussion. Platform implementation would benefit from engaging with advocacy efforts to promote licensure reciprocity or other mechanisms that could expand geographic access while maintaining quality standards.

Electronic prescribing regulations govern the transmission of prescription information, including requirements for e-prescribing controlled substances when applicable (Wright & Caudill, 2020). The platform must integrate with certified e-prescribing systems that meet Drug Enforcement Administration (DEA) and state requirements. Additionally, pharmacy board regulations in various states may impose specific requirements on mail-order pharmacy operations or interstate prescription transfers that would affect platform functionality.

7.2 Clinical Integration and Provider Engagement

Successful platform implementation requires engagement of qualified healthcare providers willing to deliver PrEP services through digital channels. Provider recruitment strategies should target clinicians with sexual health expertise, cultural competence in serving diverse populations, and comfort with telemedicine delivery modalities (Sharma et al., 2018). Training programs would prepare providers for platform-specific workflows, privacy-preserving practices, and effective virtual consultation techniques.

Provider compensation models must be established that fairly reimburse clinicians for their services while maintaining platform affordability for users. Options include fee-for-service arrangements where patients pay directly, insurance billing for covered services, or platform subsidization of services for users lacking coverage or ability to pay. Research on PrEP financing indicates that cost represents a significant barrier for many potential users, necessitating solutions to ensure accessibility (Arnold et al., 2017).

Clinical protocols would standardize care delivery while allowing flexibility for individual patient needs. Evidence-based guidelines for PrEP eligibility assessment, laboratory monitoring, adherence counseling, and side effect management would guide provider practice (Kamis et al., 2019). The platform would incorporate clinical decision support tools that alert providers to important considerations such as drug interactions, contraindications, or abnormal laboratory results requiring follow-up.

Quality assurance mechanisms would monitor clinical care quality, patient outcomes, and provider performance (Mahammad & Kumar, 2023). Metrics might include PrEP initiation rates among eligible individuals, adherence levels, retention in care, HIV seroconversion events, and patient satisfaction. Regular review of these metrics would enable continuous quality improvement and identification of areas requiring additional provider training or system enhancement.

7.3 Financial Sustainability and Payment Models

Developing sustainable financial models represents a critical challenge for digital health platforms. Multiple potential revenue sources could support platform operations. Patient fees could fund consultations, with pricing structures designed to be affordable while

covering provider compensation and operational costs. Sliding scale fees based on income could enhance accessibility for lower-income professionals (Kennedy et al., 2022). Insurance billing for PrEP services covered by health plans would be pursued, though reimbursement rates and coverage policies vary substantially across payers.

Pharmaceutical manufacturer support represents another potential funding mechanism, as several companies have established patient assistance programs to promote PrEP access. However, such partnerships must be structured carefully to avoid conflicts of interest or perceptions that commercial interests are influencing clinical recommendations. Grant funding from public health agencies or philanthropic organizations could support platform development and initial implementation, though long-term sustainability typically requires diversified revenue.

Subscription models offering premium features could generate revenue while maintaining free access to basic services. For example, enhanced features such as priority appointment scheduling, unlimited provider messaging, or advanced privacy tools could be offered through paid subscriptions while core consultation and prescription services remain accessible to all. Value-based payment arrangements linking reimbursement to health outcomes such as PrEP retention rates or HIV prevention could align financial incentives with quality objectives.

7.4 User Experience Design and Accessibility

Platform design must accommodate the heterogeneity of middle-aged adults in terms of digital literacy, accessibility needs, and preferences (Lee & Tak, 2022). User interface design should emphasize clarity, intuitive navigation, and minimal cognitive load, avoiding unnecessary complexity that could deter engagement. Accessibility features including screen reader compatibility, adjustable text sizes, high-contrast display options, and captioning for video content would ensure the platform serves users with vision, hearing, or cognitive impairments.

Multi-language support would enable service delivery to non-English-speaking populations, recognizing that language barriers constitute significant obstacles to healthcare access for many individuals. Professional translation of all platform content and

access to interpretation services for consultations would be essential. Cultural adaptation of content and communication styles should reflect the diversity of middle-aged professionals, avoiding assumptions about users' backgrounds or experiences.

Onboarding processes would introduce new users to platform features while respecting their time and autonomy. Interactive tutorials, video demonstrations, and readily accessible help resources would support users in navigating the platform effectively. Technical support channels including phone, email, and chat assistance would address questions or difficulties that arise.

8. Challenges and Barriers to Implementation

8.1 Technical and Infrastructure Challenges

Despite blockchain technology's promise for healthcare applications, several technical challenges must be addressed. Scalability limitations of blockchain systems can create performance bottlenecks when handling large volumes of healthcare transactions or data (Monrat et al., 2019). Solutions such as off-chain storage with on-chain anchoring, layer-2 protocols, or alternative consensus mechanisms may be necessary to achieve adequate throughput for a growing user base.

Interoperability with existing healthcare systems remains challenging, as blockchain platforms must integrate with electronic health record systems, laboratory information systems, pharmacy networks, and insurance billing platforms that utilize diverse technical standards and protocols (AlJaroodi & Mohamed, 2019). Developing robust interface specifications and data exchange protocols requires significant technical expertise and ongoing maintenance as external systems evolve.

Data migration and legacy system integration present obstacles for platforms seeking to enable users to import existing health records or share platform-generated data with other providers. Ensuring seamless information flow while maintaining security and privacy requires careful architectural design.

Network infrastructure dependencies mean that platform functionality depends on reliable internet connectivity and computing resources. For users in areas with limited broadband

access or for those using devices with limited processing power, performance may be degraded (Mahmoud et al., 2022). Mobile-optimized design and offline functionality for certain features could partially mitigate these limitations.

8.2 Privacy and Security Risks

While blockchain and encryption technologies provide strong security foundations, no system is entirely immune to breaches or attacks. Vulnerabilities in smart contract code could be exploited by malicious actors, potentially compromising data access controls or system integrity (Salman et al., 2018). Rigorous code auditing, penetration testing, and bug bounty programs would be necessary to identify and remediate security flaws.

Social engineering attacks targeting users or providers could circumvent technical security measures. Phishing attempts, credential theft, or insider threats represent ongoing risks requiring user education, provider training, and monitoring systems to detect suspicious activities. Key management challenges arise with cryptographic systems, as loss of encryption keys could result in permanent loss of access to health data. Secure key backup and recovery mechanisms must balance security with usability.

Regulatory compliance risks exist if the platform fails to meet evolving privacy and security requirements. Ongoing monitoring of regulatory changes and prompt implementation of compliance updates would be essential. Data breach notification obligations require established incident response procedures to ensure timely notification of affected individuals and regulatory authorities in the event of security incidents.

8.3 Adoption and Engagement Barriers

Even well-designed platforms face challenges in achieving widespread adoption and sustained engagement. Digital literacy variations among middle-aged adults mean that some potential users may struggle with platform navigation despite user-friendly design (Lee & Tak, 2022). Providing multiple support channels and options for guided assistance could help, though these add to operational costs.

Competing demands on users' attention and time may limit engagement with adherence support features, educational content, or community resources. Research on digital health

interventions has consistently found that engagement tends to decline over time, requiring ongoing innovation to maintain user interest (Szinay et al., 2020).

Provider skepticism or resistance to telemedicine may limit the availability of willing clinicians, particularly in specialties where virtual care is less established. Building evidence for the quality and outcomes of platform-delivered care would help address these concerns (Harst et al., 2019). Limited awareness of PrEP or the platform among potential users necessitates marketing and outreach efforts to reach the target population. However, marketing sexual health services requires sensitivity to avoid reinforcing stigma or privacy concerns that the platform aims to address.

8.4 Social and Structural Barriers

Beyond technical and operational challenges, broader social and structural factors affect platform implementation. Persistent HIV stigma and discrimination may deter individuals from seeking PrEP services even through discrete digital channels (Dubov et al., 2018). Comprehensive stigma-reduction interventions at societal levels remain necessary complements to individual-level privacy protections.

Healthcare system fragmentation can create coordination challenges when platform users need to access services outside the platform, such as in-person specialty care or emergency services (Pinto et al., 2018). Establishing referral networks and care coordination protocols would be important for seamless integration with the broader healthcare ecosystem.

Socioeconomic barriers including cost, insurance coverage limitations, and financial instability affect PrEP access regardless of delivery channel (Pipalia, 2025). While digital platforms can reduce some costs associated with clinic-based care, medication expenses and laboratory testing costs remain substantial for uninsured or underinsured individuals. Addressing these financial barriers requires policy solutions beyond platform design, such as expanding insurance coverage for PrEP, strengthening patient assistance programs, or implementing public health programs that subsidize PrEP for at-risk populations.

Legal and policy barriers including criminalization of HIV transmission in some jurisdictions, discrimination based on sexual orientation or gender identity, and lack of legal protections for PrEP users create chilling effects on care-seeking (Lehman et al.,

2014). Advocacy for policy reforms to address these structural barriers represents an important complement to service delivery innovation.

9. Recommendations and Future Directions

9.1 Phased Implementation Strategy

Implementing a complex digital health platform for PrEP navigation should follow a phased approach that allows for iterative development, testing, and refinement. An initial pilot phase would launch the platform with a limited user population in select geographic areas, enabling intensive monitoring of technical performance, user experience, and clinical outcomes. This phase should prioritize user feedback collection through surveys, interviews, and usability testing to identify areas requiring improvement (Wei et al., 2020).

The pilot should include both quantitative and qualitative evaluation components. Quantitative metrics would track user registration and engagement, consultation completion rates, PrEP initiation among eligible individuals, medication adherence levels, retention in care, and adverse events or seroconversions. Qualitative research would explore user experiences with the platform, perceived barriers and facilitators to use, privacy and security perceptions, and suggestions for enhancement. Provider experiences would similarly be assessed to identify workflow challenges, training needs, or technical issues requiring resolution.

Based on pilot findings, platform refinements would be implemented before expanding to broader populations. A phased geographic expansion could gradually increase service availability while managing operational capacity and ensuring quality is maintained. Feature enhancement would continue throughout implementation, with new capabilities added based on user needs and technological advances. Partnership development with additional healthcare systems, laboratories, pharmacies, and payers would expand the platform's reach and integration with the healthcare ecosystem.

9.2 Research Priorities and Evidence Generation

Robust research is needed to establish the evidence base for digital PrEP navigation platforms and inform best practices. Randomized controlled trials comparing platform-

delivered PrEP services to traditional clinic-based care would provide definitive evidence regarding effectiveness, with outcomes including PrEP initiation, adherence, persistence, HIV seroconversion, and user satisfaction. Such trials should be adequately powered and of sufficient duration to detect meaningful differences in these outcomes.

Implementation science research would examine factors influencing platform adoption, engagement, and sustained use, generating insights to optimize implementation strategies (Pinto et al., 2018). Mixed-methods approaches combining quantitative analysis of usage patterns with qualitative exploration of user experiences would provide comprehensive understanding. Cost-effectiveness analyses would assess whether digital platforms represent efficient use of resources compared to alternative PrEP delivery models, considering both healthcare system costs and societal costs such as averted HIV infections.

Health equity research would examine whether digital platforms reduce or exacerbate disparities in PrEP access across racial, ethnic, socioeconomic, and geographic dimensions. Special attention to potential digital divides and accessibility barriers for marginalized populations would be critical. Long-term cohort studies following platform users over extended periods would provide data on PrEP persistence, HIV incidence, sexual health behaviors, and quality of life outcomes.

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