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An AI-Enabled, Trauma-Informed Rehabilitation Model for Ethiopian Women with Complex Trauma: Programmatic Implementation, Early Outcomes, and Implications for Scalable Care in Africa

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ABSTRACT

The Lenegewa mental health treatment model is a Trauma-Informed, AI-enabled digital health model that integrates culturally relevant clinical mental health services and AI-enabled digital tools to address complex trauma among marginalized Ethiopian women. This study evaluates outcomes from the second cohort (N = 413) of the Lenegewa Women's Rehabilitation and Skill Development Center program, comprising women with histories of severe childhood adversity, multiple traumas, including sexual violence, and substance use disorders. The program achieved a high retention rate of 92%, significantly higher than in comparable programs. The Lenegewa model comprises three core components: (1) AI-enabled digital screening and risk stratification through ClarityConnect. This end-to-end AI-enabled digital platform integrates standardized self-report measures—including the PHQ-9, GAD-7, CAGE-AID, SDS, and the ACE questionnaire— alongside an innovative 30-second voice-based emotion-recognition algorithm designed to quantify emotional distress objectively; (2) a task-shared physician–coach care delivery system, in which trained Physician-Coaches provide frontline clinical services under psychiatric supervision; and (3) an integrated trauma and substance use treatment framework that combines motivational interviewing, trauma-focused cognitive behavioral therapy (TF-CBT), and evidence-based substance use disorder interventions. Quantitative findings show that 17% of participants required urgent psychiatric or SUD intervention, and 24% had comorbid SUD diagnoses with mixed treatment outcomes. The cohort experienced a 2.5% suicide attempt rate, prompting enhanced crisis protocols. Culturally responsive adaptations significantly improved treatment engagement, including collaboration with local religious entities and psychoeducation addressing local spiritual beliefs (e.g., evil-eye attributions). Implementation challenges included treatment resistance (110 missed therapy sessions), somatic symptom preoccupation, and infrastructure limitations. The study demonstrates the feasibility of this comprehensive model in low-resource settings. It provides critical insights for scaling trauma-informed care through a multidisciplinary team-based approach, AI-enabled digital tool integration, and culturally adapted mental health interventions. These findings have important implications for global mental health programs serving trauma-affected populations in resource-limited contexts.

Keywords
Trauma-informed care, Global mental health, Ethiopia, Women's health, AI-enabled digital mental health, Agentic AI, Psychogenic nonepileptic seizures (PNES), Evil eye (*buda*), Gender-Based Violence (GBV), Cultural and spiritual explanatory models, Substance use disorders, Trauma and dissociation, Residential rehabilitation, Social work integration, Mental health in the Global South, Africa, Street-based Sex Workers, People experiencing homelessness.

Introduction
Severe trauma and its psychological, social, and economic sequelae pose a significant public health challenge in low-resource settings, particularly for women who have experienced chronic violence, displacement, and structural marginalization. In many low- and middle-income countries, trauma exposure is compounded by limited access to mental health services, shortages of trained clinicians, and weak social protection systems, leading to high unmet need and persistent cycles of psychological distress and socioeconomic instability. Women who have survived complex trauma—often beginning in childhood and extending into adulthood—are disproportionately affected by depression, anxiety, posttraumatic stress, substance use disorders, and functional impairment, yet remain among the least served populations.

The AYA Trauma Innovation Center at Lenegewa in Addis Ababa, Ethiopia, was established to address these intersecting challenges through a holistic, trauma-informed rehabilitation model tailored for women with histories of complex trauma. The Lenegewa rehabilitation model integrates mental health care, medical and social work services, vocational training, and technology into an Intelligent Rehabilitation System—an approach designed to address both the psychological consequences of trauma and the socioeconomic conditions that perpetuate vulnerability. Rather than treating mental health in isolation, the model recognizes recovery as a multidimensional process that requires coordinated clinical care, skill development, and sustained social reintegration.

A defining feature of the Lenegewa model is the AI-enabled digital transformation of mental health and substance abuse services, implemented through ClarityConnect. This end-to-end digital platform supports standardized mental health screening, automated risk stratification, and measurement-based care. Through ClarityConnect, participants undergo structured assessments that enable early identification of high-risk cases, continuous monitoring of symptom trajectories, and data-driven prioritization of care in resource-constrained clinical settings. This digital infrastructure enables the program to move beyond ad hoc clinical judgment toward a systematic, repeatable approach to risk management and service allocation.

In this model, Lenegewa serves as the primary treatment provider for the residential rehabilitation and job training program, overseeing daily operations, vocational programming, and social reintegration services. AYA serves as the lead mental health provider, collaborating closely with Lenegewa's social work and medical center teams to deliver trauma-informed assessment, psychotherapy, medication management, and crisis response. This integrated partnership aligns psychosocial support, medical care, and vocational services, ensuring that mental health needs are addressed within the broader context of participants lived realities.

The program is positioned for scale. Lenegewa plans to adopt ClarityConnect across all rehabilitation and vocational training services for an upcoming cohort, expanding its reach from the second cohort's population of approximately 450 women to more than 1,000 women, with the capacity to serve up to 2,000 women at full scale. Central to this expansion is the program's physician–coach model, a task-sharing approach in which trained Physician-Coaches deliver psychotherapy and psychosocial support under the close supervision of on-site psychiatrists. This model directly addresses Ethiopia's severe mental health workforce shortage—approximately one psychiatrist per one million individuals [1]—by extending the reach of specialist care through structured training in motivational interviewing (MI), trauma-informed counseling, and person-centered therapeutic approaches. Evidence from global mental health research supports task-sharing as an effective strategy for delivering mental health services in low-resource settings when specialist availability is limited [2].

Given these constraints, the Lenegewa model is explicitly designed to mitigate clinical risk and improve treatment outcomes by proactively identifying and monitoring psychological distress. The AYA team uses a measurement-based care framework that emphasizes early detection of risk and timely escalation of services. Participants are systematically screened at multiple time points—once at program admission and again toward the end of the three-month residential rehabilitation period—enabling both baseline risk assessment and evaluation of change over time. Risk identification is operationalized using a structured battery of validated, culturally normed instruments in the Ethiopian context. These include the Patient Health Questionnaire (PHQ-9) to assess depressive symptom severity, the Generalized Anxiety Disorder scale (GAD-7) for anxiety, the Adverse Childhood Experiences (ACE) questionnaire to capture cumulative trauma exposure, and the CAGE-AID and the Severity of Dependence Scale (SDS) to assess substance use–related risk. Together, these tools support standardized risk stratification and guide clinical decision-making within the task-shared care model.

In addition to self-report measures, the screening process is piloting an innovative 30-second voice-based emotion recognition algorithm that serves as a novel digital biomarker rather than a standardized instrument. The algorithm analyzes acoustic and prosodic features of speech to quantify emotional distress objectively, providing complementary, non–self-reported data that enhance risk detection. By capturing indicators of psychological stress that may not be fully articulated through questionnaires—particularly in populations where distress is often expressed somatically or minimized due to stigma—the voice-based measure strengthens the system's capacity for objective, real-time risk detection stratification.

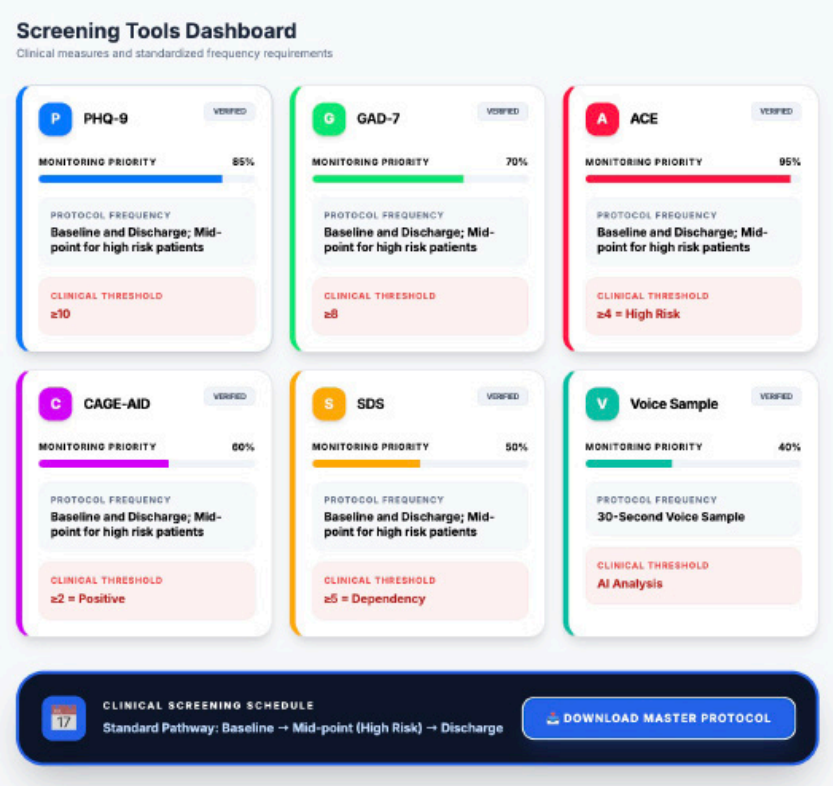

Figure 1: Screening Tools and High-Risk Scores.

Collectively, this multimodal screening and monitoring framework enables systematic, repeatable assessment and supports a dynamic, measurement-based approach to care in which clinical intensity is adjusted based on identified risk. In settings with limited specialist availability and high demand for services, this strategy allows the AYA–Lenegewa partnership to prioritize individuals requiring immediate intervention, maintain consistent oversight across large cohorts, and deploy scarce clinical resources more effectively while safeguarding participant safety.

Methods

Setting and Participants

This is a programmatic outcomes and implementation study focusing on the second cohort of women enrolled at the Lenegewa Women's Rehabilitation and Skill Development Center, a residential rehabilitation facility in Addis Ababa, Ethiopia. Lenegewa provides integrated psychosocial, mental health, medical, and vocational services to women from highly marginalized backgrounds. The residential rehabilitation program for this cohort began in November 2024. It was delivered over a three-month structured residential period, during which participants received coordinated clinical, social work, and vocational support within a trauma-informed framework.

The second cohort comprised 413 women, representing a population with profound social, economic, and health vulnerabilities. Participants were drawn from highly marginalized groups, including women living in extreme poverty, survivors of commercial sexual exploitation, individuals without stable housing, and returning migrant laborers who had experienced displacement, exploitation, or failed reintegration. Many participants entered the program after prolonged instability, limited access to healthcare, and repeated exposure to interpersonal and structural violence.

Participants were primarily young adults, ranging from 18 years of age through the early 30s, a developmental period marked by heightened vulnerability to mental health disorders, substance use, and trauma-related sequelae. Nearly all women reported histories of complex trauma, often beginning in childhood and continuing into adolescence and adulthood. Trauma exposures included early neglect, physical and sexual abuse, forced migration, intimate partner violence, coercion, and repeated social exclusion. These cumulative adversities shaped both psychological functioning and patterns of help-seeking at the time of admission.

As part of the intake process, all participants completed a standardized Adverse Childhood Experiences (ACE) screening, which revealed pervasive and severe early adversity across the cohort. A substantial proportion of women scored in the high-risk range (ACE ≥ 4), a threshold consistently associated with elevated risk of psychiatric disorders, substance use disorders, chronic medical illness, and functional impairment in adulthood. High ACE scores in this cohort indicated not only individual trauma exposure but also broader structural and intergenerational vulnerabilities, including poverty, family disruption, and limited access to protective social institutions [3].

The clinical significance of these findings is substantial. Extensive evidence shows that cumulative childhood adversity is linked to dysregulation of stress response systems, increased vulnerability to depression, anxiety, posttraumatic stress disorder, and substance use disorders, and heightened risk of chronic disease and premature mortality later in life [3]. Within the Lenegewa cohort, high ACE scores provided critical context for understanding the severity, chronicity, and complexity of presenting symptoms, as well as the need for intensive, trauma-informed, and developmentally sensitive interventions.

Taken together, the setting and participant characteristics reflect a high-acuity residential population shaped by intersecting social marginalization, early and repeated trauma exposure, and limited prior access to comprehensive care. These contextual factors are essential for interpreting subsequent findings on clinical risk, engagement patterns, and service utilization within the program outcomes and implementation study.

Program Design and Interventions

Upon admission, all participants entered a comprehensive 3-month trauma-informed rehabilitation program that integrated mental health treatment with socioeconomic empowerment. The core interventions included trauma-focused psychotherapy, SUD treatment, psychiatric care, social work services, and vocational training. The first 45 days focused on rehabilitation, and the second 45 days combined vocational training with ongoing treatment. The program offers at least 18 different certifications for women.

In addition to individual sessions, the treatment model included structured group therapy (e.g., trauma psychoeducation, coping skills, relapse-prevention, and process groups) that reinforced peer support, normalization, and skills practice within the residential milieu. The program provides a multidisciplinary approach to address the complexity of the presenting issues:

Task-Shared Care Delivery: The program utilized a physician–coach model. Physician-Coaches, trained in basic counseling and supervised by licensed psychiatrists, provided the bulk of one-on-one counseling and psychoeducation. One part-time psychiatrists were embedded on-site to oversee psychotropic medications, manage detoxification protocols, and support the coaches and the medical team with complex cases. This collaborative team approach allowed extension of specialized care to more participants than psychiatrists alone could reach, aligning with global evidence on task-sharing in mental health care [4,5].

Trauma-Focused Psychotherapy: Participants engaged in individual therapy (including TF-CBT and narrative exposure techniques) and group counseling sessions focused on trauma recovery—interventions targeted at processing traumatic memories, developing coping skills for PTSD symptoms, and

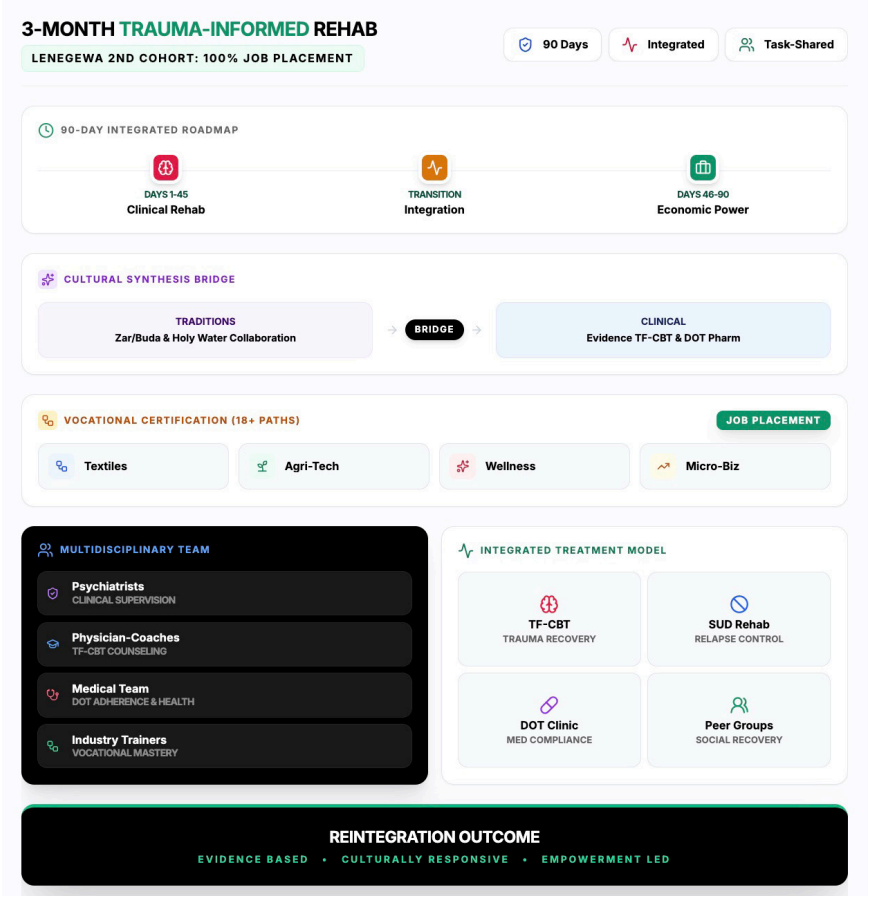

Figure 2: Program Design.

addressing grief and loss. Treatment plans were individualized by symptom severity, with high-risk cases receiving intensive therapy from the outset.

Substance Use Disorder Treatment: Given the high prevalence of comorbid substance misuse in this population, the program offered integrated SUD services. These services included on-site detoxification for alcohol or drug withdrawal (with medical management, such as benzodiazepines for alcohol withdrawal), daily structured SUD counseling (e.g., motivational interviewing and relapse prevention therapy), and peer support groups. Notably, trauma and SUD were treated simultaneously rather than sequentially, consistent with best practices for comorbidity [6]. Participants with co-occurring PTSD and SUD received coordinated care plans that addressed both conditions in parallel.

Psychiatric Medication Management: On-site psychiatrists evaluated participants for pharmacotherapy as indicated. Antidepressants, anxiolytics, or antipsychotics were prescribed for severe depression, anxiety, PTSD, or psychotic symptoms, and opioid antagonists or other medications were provided for select SUD cases. Medication adherence was closely monitored by nursing staff and coaches. For high-risk patients, medications were initiated within the first 1–2 days of admission to stabilize acute symptoms, and direct observation therapy (DOT) was implemented initially to ensure compliance among those reluctant to take medication.

Vocational Rehabilitation: In addition to clinical treatment, women participated in vocational training and education programs to improve their economic self-sufficiency. Among the 18 certificate-based vocational training programs were tailoring, agriculture, cosmetology, and small business management. This parallel track was intended to empower participants with income-generating skills and a sense of purpose, which in turn can bolster mental health recovery. The rehabilitation center provided a structured daily schedule that balanced therapy sessions, skills workshops, and educational classes.

Culturally Responsive Practices: The model was adapted to local cultural contexts to enhance engagement. Program staff acknowledged and worked with prevalent cultural and spiritual beliefs about trauma and mental illness. For instance, many Ethiopian participants and their families interpret unexplained illnesses or behavioral disturbances through an alternative lens (e.g., attributing severe trauma-based emotional distress with physiological symptoms to spirit possession or the "evil eye," locally called "Buda"). Instead of dismissing these beliefs, the program integrated them by allowing patients to continue positive spiritual practices (prayer, visiting holy water sites) as complementary to therapy. Counselors encouraged discussions about faith, curses, or traditional healing in sessions, then gently introduced psychological explanations in parallel, bridging the two perspectives [7,8]. In practice, the center forged liaisons with local religious leaders (a pastor, an Imam, and an Orthodox priest) who occasionally visited or accepted referrals, creating a partnership between traditional healing and biomedical care. This collaborative approach built trust and was informed by evidence that combining religious and psychiatric care can be acceptable and beneficial in Ethiopia [9].

Assessments and Data Collection

All participants underwent comprehensive baseline screening upon entry. ClarityConnect, a cloud-based, AI-enabled digital platform accessible via campus tablets, facilitated the programmatic outcomes and implementation study. The platform administered a battery of standardized instruments to assess mental health and psychosocial risk factors:

Mental Health Screening: Each woman completed the PHQ-9, ACE, GAD-7, CAGE, and SDS, and provided a 30-second voice sample. The questionnaires assessed baseline depression, trauma, SUD, and anxiety symptom severity, respectively. ClarityConnect provided real-time scoring and clinical recommendations based on severity scores; any indication of a persistent history of substance abuse or suicidality triggered immediate clinical follow-up.

Substance Use Screening: The CAGE-AID questionnaire (adapted to include drug use) and the Severity of Dependence Scale (SDS) were used to identify local substances, such as Khat. Positive screens prompted a more detailed substance use assessment by the medical team.

Biopsychosocial Assessment: For participants classified as moderate to high risk (based on screenings or acute clinical presentation), a thorough biopsychosocial (BPS) assessment. This assessment gathered information on medical health (e.g., chronic illnesses, HIV status), psychiatric history, substance use patterns, family and social support, education, and economic situation. BPS assessments were periodically updated to track progress across these domains [10,11]. This holistic, programmatic outcomes and implementation study aimed to inform personalized care plans and ensure that legitimate medical issues were addressed alongside psychological care.

Ongoing Monitoring: The program embraced a measurement-based care approach, administering symptom measures at least twice during the program to inform treatment adjustments. For high-risk participants, the PHQ-9 and GAD-7 were retaken at regular intervals (monthly) to monitor improvement or detect worsening of depression/anxiety. Session attendance and participation were meticulously logged in ClarityConnect, enabling analysis of engagement patterns. Critical incidents (such as suicide attempts, aggressive outbursts, or medical emergencies) were documented in a centralized database for review at weekly team meetings.

Data Analysis and Predictive Modeling: In addition to descriptive analysis of outcomes, the AYA team is developing predictive capabilities using local data. The model will incorporate anonymized cohort data, and researchers will retrospectively examine patterns linked to poor outcomes (e.g., whether missed sessions in the first month predicted later dropout). Furthermore, the program's data scientists simulated projections for scaled-up

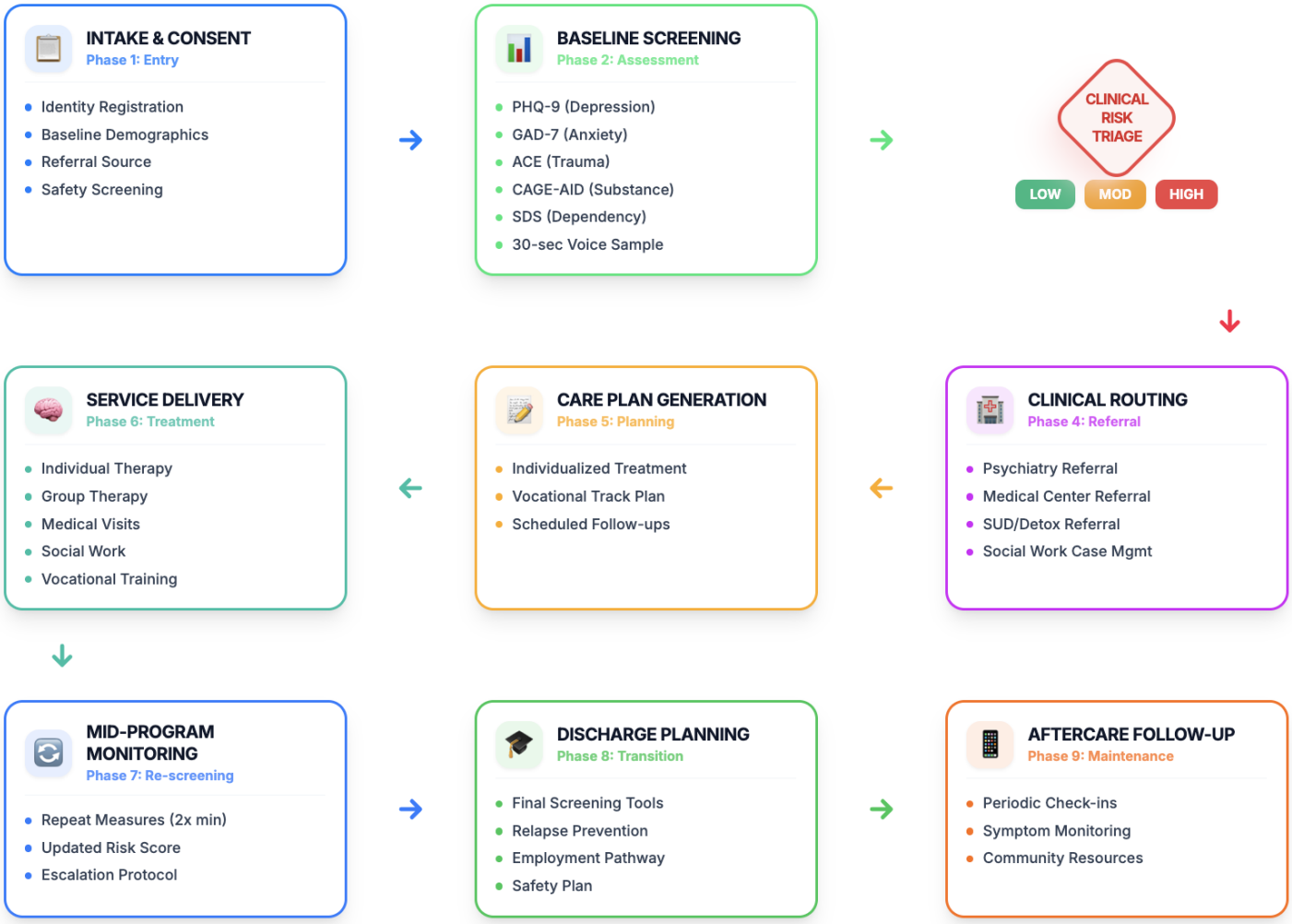

Figure 3: Clinical and Data Collection Workflow.

cohorts. For example, based on the observed 2.5% suicide attempt rate among 400 women, they estimated the number of attempts and potential fatalities if the cohort size doubled to 800 [12,13]. These predictive exercises will strengthen the program's risk management protocols in anticipation of expansion.

Ethical Approval and Oversight: Ethical approval for the programmatic outcomes and implementation study was obtained through a formal, detailed Memorandum of Understanding (MoU) between AYA-Innovation and the Lenegewa Women's Rehabilitation Center. The assessment was also approved by the St. Paul's Hospital Millennium Medical College (SPHMMC) IRB. The MoU outlined data governance procedures, participant protections, and responsibilities for the ethical conduct of the study. All study activities were reviewed and approved in accordance with SPHMMC IRB requirements and relevant ethical standards for human subjects' research.

All participants provided digital informed consent before participating, including explicit consent to use de-identified clinical and programmatic data for the study. Participation in the assessment did not affect access to services, and individuals retained the right to withdraw consent at any time without penalty or impact on their care.

Participant safety was prioritized throughout the study through continuous clinical oversight. On-site psychiatrists provided real-time monitoring, and structured weekly clinical supervision reviewed screening results, clinical observations, and emerging risk indicators. Any concerning findings—such as suicidal ideation, imminent suicide risk, or acute psychiatric decompensation—triggered an immediate clinical response and escalation in accordance with established safety protocols. This layered oversight framework ensured that ethical obligations were upheld and that participant welfare remained central to all study activities.

Results

Summary of Key Findings: The second cohort enrolled 413 women in late 2024, and 380 remained actively engaged on campus by mid-2025, yielding an overall retention rate of approximately 92%. This high retention is notable given the population's vulnerability and indicates strong program adherence. Attrition

(about 8%) was primarily due to a small number of participants leaving against medical advice or for pressing family reasons. The cohort's baseline profiles underscored the severity of trauma exposure and mental health needs.

- **Screening and Risk Identification:** 375 women (91% of the cohort) completed AI-enabled digital screenings. Of these, 69 women (17%) were identified as high priority for urgent psychiatric or SUD interventions, triggering immediate care plans.
- **Symptom Improvements:** Participants who engaged in treatment showed notable average reductions in PHQ-9 and GAD-7 scores, along with qualitative improvements in mood, anxiety, and daily functioning. Many case examples highlighted restored hope, social reintegration, and the development of coping skills.
- **Suicide Attempts:** Ten suicide attempts occurred (2.5% attempt rate). All were non-fatal; each was managed with crisis intervention and safety planning, and the individuals remained in the program with intensified support—this data-informed, scaled risk-prevention strategies.
- **SUD Prevalence and Outcomes:** Approximately 24% of women had SUDs. Of those, about half achieved sustained abstinence or a significant reduction in use by program end, while the rest relapsed or disengaged. Integrated trauma-SUD treatment produced success stories but also underscored ongoing challenges, such as relapse triggers and the need for aftercare.
- **Missed Appointments:** Over 110 therapy sessions (~35% of all scheduled individual sessions) were missed, underscoring engagement issues. However, the rate of missed sessions declined in later months as trust and understanding of therapy grew.

These outcomes demonstrate both the feasibility and the complexity of implementing a comprehensive trauma rehabilitation model in a low-resource setting. Significant gains in mental health and functioning are achievable, but they require sustained efforts to engage participants and tailor approaches to local cultural realities.

Mental Health Outcomes and Case Examples

By the end of the cohort period (3 months later), clinical outcomes showed promising improvements among participants who engaged consistently in therapy. The program's mental health services—centered on TF-CBT, individual counseling, group therapy, and medication management—produced measurable symptom reductions for many women.

- Regular PHQ-9 and GAD-7 screenings were integrated into care to facilitate measurement-based treatment adjustments. This approach aligns with evidence that routine symptom monitoring can accelerate improvement and reduce dropout [14].
- Many participants experienced substantial decreases in their PHQ-9 depression scores over the course of treatment. Although aggregate analysis is ongoing, interim data showed that among those who completed at least eight therapy sessions (n ≈ 300), the average PHQ-9 score declined by an estimated 5 points (from ~12 at intake to ~7 at follow-up), indicating a shift from moderate to mild depression on average.
- Similarly, GAD-7 anxiety scores declined; many women reported markedly fewer panic attacks, better sleep, and improved concentration by the program's end. Staff observations and participant self-reports of improved mood and daily functioning corroborated these quantitative improvements.

Mental Health Case Vignettes

Case 1: A 23-year-old survivor of sexual assault, who entered the program with severe depression, profound hopelessness, and a prior suicide attempt, showed dramatic improvement after 12 sessions of individual CBT. Initially, she was withdrawn, scored 21 on the PHQ-9 (severe depression), and said she saw "no future."

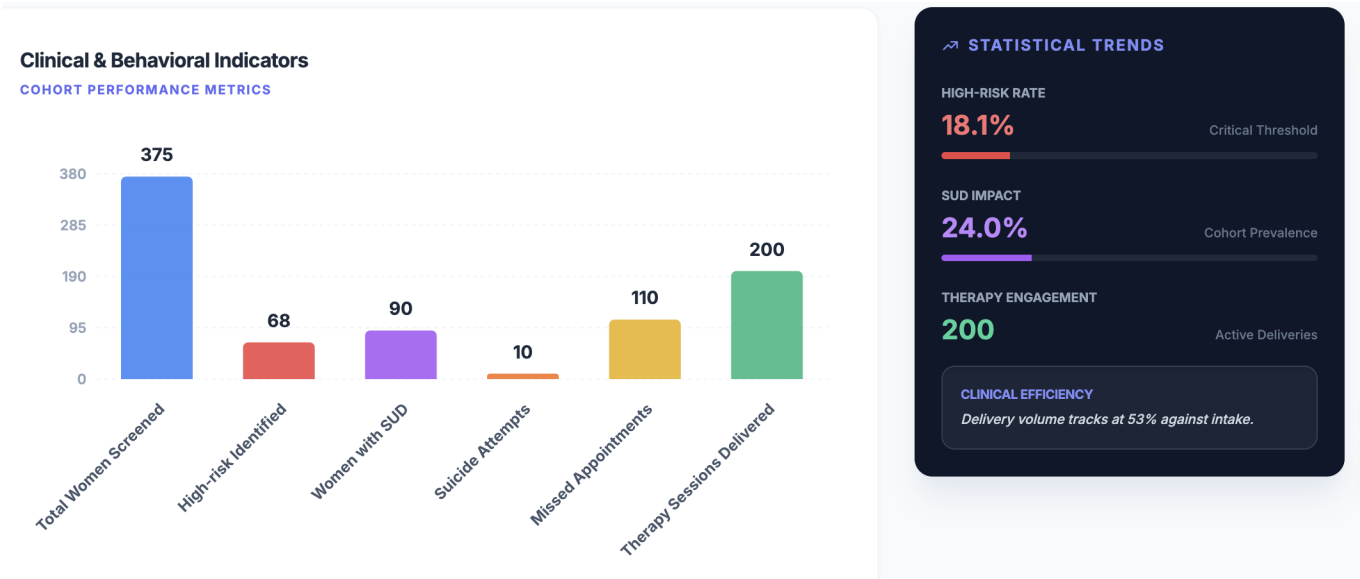

Figure 4: Cohort Statistics.

After three months of therapy, she reported improved mood stability, regained self-worth, and a renewed sense of purpose. By discharge, her PHQ-9 had fallen to 5 (minimal symptoms), and she no longer experienced suicidal ideation – as she put it, *"I now look forward to life and believe in my future."* This transformation was attributed to processing her trauma, learning cognitive techniques to challenge self-blame, and gradually re-engaging with social supports, including reconnecting with a supportive aunt. Her story highlights the potential for resilience and recovery when evidence-based treatment is combined with a safe, supportive environment.

Case 2: Another participant was a 27-year-old who initially presented with moderate depression and profound social withdrawal. She rarely spoke, avoided eye contact, and isolated herself in her dorm, prompting staff to worry about her engagement. After 10 weeks of trauma-focused CBT and adjunct mindfulness training, she showed a notable behavioral shift. She began actively communicating with peers and instructors, volunteering answers in group therapy, and even leading a prayer session in her dorm – behaviors unimaginable at intake. Her PHQ-9 score improved from 15 (moderate) to 6 (mild).

Not all participants achieved such dramatic recoveries, but overall trends were positive among those retained in care. Notably, integrating on-site psychiatric care enabled treatment of more severe cases that might not have improved with therapy alone. Approximately 17% of the cohort (around 69 women) were categorized as high psychiatric risk at intake – many with debilitating PTSD symptoms, psychotic features, or in acute substance withdrawal. These women were prioritized for immediate interventions. Psychiatrists initiated pharmacotherapy (e.g., SSRIs for severe depression or PTSD, antipsychotics for trauma-related psychosis) and closely monitored these cases. The combination of medication and therapy facilitated stabilization; for example, several women with severe depression who might have required inpatient care were instead successfully managed on-site with antidepressants and intensive counseling, allowing them to continue vocational training. Close monitoring of medication adherence (including pill counts and supervised dosing in early weeks) helped ensure that improvements were not undermined by non-compliance.

Substance Use Disorder Outcomes and Case Examples

Comorbid substance use posed a significant challenge and was a focal point of the program's integrated care model. At intake, approximately 24% of participants had a diagnosable SUD (primarily alcohol use disorder, khat dependence, or sedative misuse), a prevalence consistent with other Ethiopian clinical settings serving traumatized women [15]. The program's dual-focus approach – treating PTSD and SUD together – produced mixed outcomes, reflecting the complexity of addiction recovery in a communal rehab environment:

- **Detoxification and Early Intervention**: Of the 413 women, 69 (17%) were flagged for urgent SUD intervention on admission due to signs of withdrawal or unstable substance use behavior [16]. These cases underwent immediate detoxification protocols. For example, those with alcohol dependence received benzodiazepines, thiamine, and hydration to manage withdrawal safely over 3–7 days. On-site medical staff were critical; no severe withdrawal complications (e.g., seizures or delirium tremens) occurred, and all detoxifications were completed successfully. Rapid intervention likely prevented medical crises and laid the groundwork for engagement in longer-term SUD treatment.
- **Integrated Therapy for SUD**: Following detox/stabilization, women with SUD participated in specialized individual and group counseling modules. Motivational interviewing (MI) enhanced commitment to sobriety, while cognitive-behavioral strategies helped them identify triggers and develop relapse-prevention plans. These sessions were delivered by the same coaches/therapists providing trauma counseling, ensuring a cohesive therapeutic alliance. Notably, counselors simultaneously addressed trauma and substance use themes, given the intertwined nature of these issues (many participants used substances to self-medicate trauma symptoms). This integrated therapy approach is supported by research showing that combined PTSD–SUD treatment can reduce both substance use and trauma symptoms more effectively than treating either in isolation [17]. Nonetheless, SUD recovery often followed a nonlinear path.

Substance Use Disorder Case Vignettes

Case 3: A subset of women maintained a strong commitment to sobriety throughout the program. Among them was a 22-year-old with a history of polysubstance abuse (alcohol, khat, and inhalants) stemming from early trauma. She engaged fully in both trauma therapy and SUD counseling, completed a 3-month residential stay without relapse, and transitioned into a community reintegration phase. At entry, she was anxious and distrustful, but by the end, she had developed strong emotional regulation skills and completed vocational training in sewing. She left the program "confident, interactive, and optimistic about [her] future," securing an apprenticeship with a local tailor. Her case demonstrates that even those with substantial addiction histories can recover when given comprehensive support that addresses both psychological and physical aspects of dependence.

Case 4: This case illustrates the challenges of treating substance abuse, even in a residential treatment setting. It involved a 17-year-old (S.T.) who had endured childhood abandonment and had lived on the streets. She coped with heavy use of alcohol, cannabis, inhalants, and khat. Despite entering Lenegewa and receiving a tailored care plan – including detox medication (diazepam for alcohol withdrawal), antidepressants for underlying depression, and weekly counseling – she struggled to stay. She absconded from the center multiple times to seek substances, relapsing repeatedly. Each return attempt was met with revised strategies (e.g., assigning a peer "buddy," increasing one-on-one sessions). Still, the pull of addiction proved too strong, and she dropped out permanently. This "failure case" highlights the powerful hold of addiction even

when structural support is provided, especially for youth who have known only chaos and self-medication as survival mechanisms. **Case 5:** She was a 32-year-old with severe alcohol dependence who initially showed promise in the program but became increasingly resistant. She frequently complained about minor issues (e.g., food quality) and sought off-campus passes for alleged medical needs. During one weekend leave, she relapsed on khat and subsequently experienced brief psychotic episodes (likely substance-induced). Her condition deteriorated, and she left the program prematurely, exploiting gaps in supervision (e.g., obtaining repeated passes without proper follow-up). This case highlighted programmatic weaknesses in managing those who begin to disengage, including insufficient enforcement of pass policies and a lack of early intervention when dissatisfaction is expressed.

Overall, approximately one-quarter of the cohort had SUDs, and outcomes ranged from complete recovery to ongoing struggle. By the program's end, roughly half of the SUD subgroup benefited from treatment in a locked facility, while the other half had at least one relapse or did not complete treatment. These results align with patterns in the literature: women with co-occurring PTSD and SUD often struggle with retention and may require multiple treatment episodes to achieve sustained recovery [18,19]. The mix of successes and setbacks prompted the team to reinforce relapse-prevention strategies and, with the Lenegewa team, tighten campus rules (e.g., clearer consequences for bringing substances onto campus and more structured off-campus pass protocols). It also underscored the need for coordinated follow-up after program exit, as some who succeeded in the structured setting could still be at risk once back in the community.

Clinical Complexities and Challenges

In addition to the substantial psychiatric, substance-related, and psychosocial vulnerabilities previously described, the clinical profile of the Lenegewa Second Cohort was further complicated by a high burden of untreated or poorly managed physical health conditions at admission. Many participants entered the program with chronic pain syndromes, untreated medical illnesses, or longstanding somatic complaints that had received little or inconsistent medical attention before enrollment. These physical health concerns were not ancillary but intersected directly with mental health symptoms, substance use patterns, and engagement in care, thereby amplifying overall clinical acuity.

A clinically significant subset of participants—approximately 5% of the cohort—was HIV-positive, and several had not been consistently engaged in HIV care before admission. For these women, gaps in antiretroviral therapy, limited follow-up, and fragmented medical histories heightened vulnerability, both medically and psychologically. HIV-related stigma, fear of disclosure, and competing survival priorities further complicated engagement in medical and mental health services. In response, physical health needs were incorporated into individualized care plans, including on-site linkage to basic medical services and facilitated connections to HIV treatment and follow-up. However, integrating medical care into an already resource-constrained mental health setting required careful coordination and further strained the limited clinical capacity.

Beyond identifiable medical diagnoses, somatic preoccupation was a prominent feature of the baseline presentation. Many women described their distress primarily through physical symptoms—such as persistent headaches, chest or "heart" pain, gastrointestinal discomfort, diffuse bodily weakness, or unexplained fatigue—rather than through affective or psychological language. This pattern aligns with well-documented cultural tendencies in low-resource, high-stigma settings to express psychological suffering somatically, particularly where emotional distress may be socially constrained or less readily recognized as a legitimate health concern [20]. For many participants, bodily symptoms were the most accessible and culturally sanctioned vocabulary for communicating distress.

Clinically, this somatic mode of expression posed significant diagnostic and therapeutic challenges. Providers were required to conduct careful, repeated medical evaluations to differentiate among true medical pathology, substance-related physical effects, trauma-mediated somatic symptoms, and stress-induced physiological responses. In some cases, unresolved trauma, chronic anxiety, or depressive symptoms appeared to exacerbate pain perception and drive recurrent medical complaints. In others, legitimate medical needs risked being overlooked if symptoms were prematurely attributed to psychological causes. This delicate balance required a cautious, integrative approach that avoided both medical neglect and over-investigation while maintaining patient trust and engagement.

The overlap among somatic symptoms, substance use, and psychiatric distress further complicated treatment participation. Chronic pain and physical discomfort often interfered with therapy attendance, concentration during sessions, and emotional tolerance for trauma-focused work. Somatic symptoms also prompted frequent help-seeking outside scheduled therapy, placing additional demands on staff and sometimes reinforcing crisis-driven rather than planned engagement. For participants with co-occurring SUD, physical symptoms were occasionally difficult to distinguish from withdrawal effects, intoxication, or long-term substance-related health consequences, further obscuring clinical assessment.

Significantly, physical health comorbidities also interacted with risk trajectories. For women living with HIV or with unmanaged chronic illness, psychological distress and inconsistent engagement in care increased the risk of medication non-adherence, disease progression, and medical complications. These medical vulnerabilities, in turn, exacerbated feelings of hopelessness, bodily alienation, and perceived loss of control, reinforcing cycles of distress and disengagement. In this way, physical illness functioned not merely as a parallel concern but as a multiplier of psychiatric risk, particularly in the context of suicidality, trauma exposure, and substance use.

Taken together, the convergence of untreated medical conditions, culturally mediated somatic expression, psychiatric distress, and substance use underscores the multidimensional complexity of the Lenegewa Second Cohort. The clinical picture cannot be adequately understood through a single diagnostic lens; rather, it reflects the entanglement of mind, body, and social context in shaping suffering and help-seeking behavior. These layered complexities further constrained therapeutic capacity and contributed to fragmented engagement, compounding previously identified challenges, including low therapy dosage and high attrition.

Overall, the cohort's presentation underscores the need for integrated, whole-person care in high-acuity, low-resource rehabilitation settings. Without coordinated attention to physical health, somatic distress, and psychological needs, efforts to stabilize mental health symptoms or reduce substance use risk remain incomplete. The Second Cohort's experience thus illustrates that physical comorbidities and somatic expression are not secondary issues but central determinants of engagement, risk, and outcomes within trauma-informed residential care.

Discussion

Interpretation of Key Findings

Results from Lenegewa's second cohort provide encouraging evidence that a multidisciplinary, trauma-informed rehabilitation program can be successfully implemented in a low-income, culturally distinct setting. High retention (92%) among 413 severely traumatized women is itself a remarkable outcome, suggesting that the model's holistic design – combining shelter, livelihood opportunities, and a compassionate therapeutic community – created a strong holding environment that participants were reluctant to leave. This contrasts with typical attrition rates in similar contexts and underscores the importance of addressing basic needs alongside mental health to keep individuals engaged [10,21]. Many women cited the availability of vocational training and education as key motivators for staying, aligning with global mental health literature advocating socioeconomic integration in mental health programs [22].

Clinically, the program achieved meaningful reductions in depression and anxiety symptoms among a large subset of participants, validating the effectiveness of trauma-focused therapy and task-shifted counseling in this population. These improvements align with prior research on talk therapy delivered by lay workers in low-resource settings, which has shown significant symptom reduction compared to waitlist controls (e.g., 4- to 5-point greater drop in depression scores) [5,14]. Our findings add to this evidence base by showing that even women with complex, multi-type trauma can benefit from these interventions when adapted to context.

Notably, regular symptom monitoring (measurement-based care) was integral to the approach and likely contributed to positive outcomes by enabling timely treatment adjustments [14]. This aligns with emerging data indicating that such feedback systems improve the effectiveness of psychotherapy and reduce dropout. The ability to track symptom trajectories also enhances the program's accountability and learning capacity, addressing a common gap in humanitarian mental health programs, which often lack robust outcome monitoring [23].

At the same time, the mixed results in SUD treatment highlight known challenges of comorbidity. Integrated PTSD-SUD care is still relatively new in low-income settings, and our experience reflects both its necessity and difficulty. The data support the view that dual-focused treatment is essential – participants with unresolved SUD had poorer engagement and outcomes (as evidenced by relapse cases and dropouts). In contrast, those who achieved sobriety often concurrently showed improvement in PTSD. This corroborates studies in high-income settings indicating that treating PTSD and SUD simultaneously can improve overall recovery rates [24].

However, relapse rates were high, mirroring patterns observed elsewhere; SUD recovery often requires sustained support and multiple cycles of treatment [25]. The program's integrated approach likely prevented even higher attrition (some addiction-focused programs in similar contexts report >50% dropout [26]). Yet additional innovations (such as contingency management, long-term follow-up, or medication-assisted therapy, where feasible) will be needed to improve SUD outcomes. The difficulties faced by cases 4 and 5 emphasize how structural factors (e.g., family dysfunction, lack of community support, availability of substances) can override programmatic efforts; addressing these may require broader community and policy interventions beyond the program's scope.

A salient theme in our findings is the crucial role of cultural adaptation and community engagement. Recurrent atypical presentations, such as pseudoseizures, and the prevalence of spiritual explanations for distress confirm that trauma does not manifest in a cultural vacuum. Consistent with the cross-cultural psychiatry literature [27,28], participants often used locally salient idioms and belief systems to make sense of their symptoms. By integrating those beliefs into care rather than treating them as mere "misconceptions" to be corrected, the program likely improved trust and retention.

We demonstrated that partnering with traditional healers and validating patients' spiritual frameworks can coexist with evidence-based practice [8,29]. This is an essential insight for global mental health: culturally responsive approaches are not just about translation or surface changes but about fundamentally aligning treatment with patients' worldviews [14]. The positive outcomes and engagement at Lenegewa reinforce that culturally informed trauma care (e.g., acknowledging the evil eye concept, working with faith healers) can enhance acceptance of interventions that might otherwise be met with skepticism or stigma. It also highlights the need to train clinicians in cultural competence and to incorporate anthropological perspectives when designing interventions for local contexts [30].

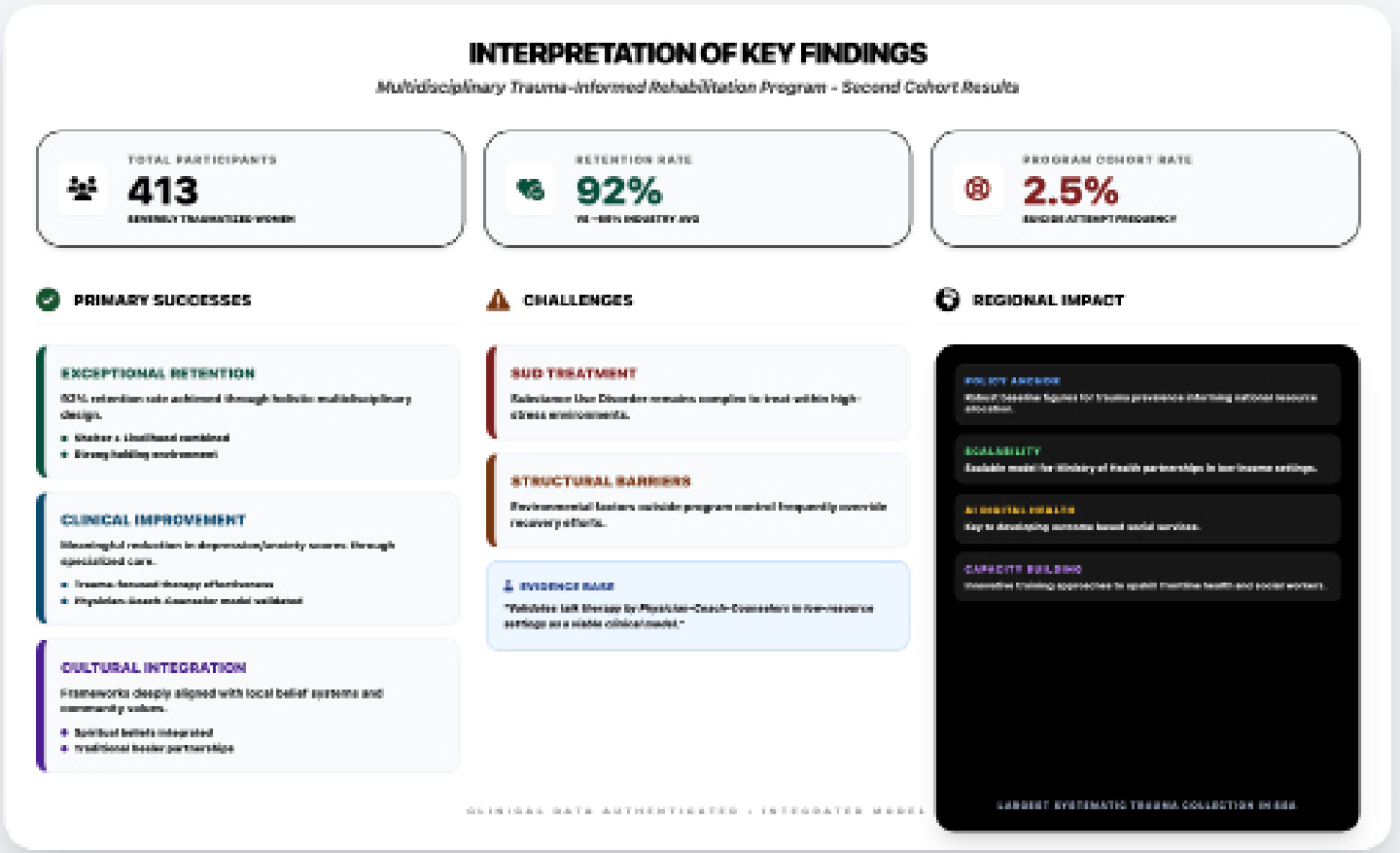

Figure 5: Interpretation of Key Findings.

Another key finding was a strong association between early engagement behaviors and later outcomes. The data showed that even missing sessions in the first month was a red flag for later dropout or relapse. This suggests that programs should treat the initial weeks as a critical window: intensive efforts to build rapport, troubleshoot barriers (transportation, childcare, etc.), and instill motivation early on may pay dividends in long-term retention. Our adoption of motivational interviewing and peer mentors addressed some of these needs, but we realized that more proactive action is possible. This aligns with common observations in therapy research that early therapeutic alliance and buy-in predict success [31]. By quantifying this in our context, we can now implement predictive tools to identify those slipping through the cracks. Indeed, our plan to flag those who miss multiple early sessions for special outreach is directly derived from this analysis.

From a health systems perspective, the Lenegewa model produced valuable data for the African mental health sector. Systematically collected outcomes (symptom scores, retention figures, SUD prevalence, suicide attempts, etc.) are exceedingly rare in sub-Saharan Africa for programs of this nature.

The cohort of 413 women and their associated dataset constitute one of the largest collections of rehabilitation outcomes for trauma-affected women in the region. This addresses a critical evidence gap identified by global health experts – the lack of context-specific data to guide policy and funding [23,32]. Our findings provide baseline figures that can inform both practice and policy: for example, knowing that a program like ours can achieve ~92% retention or that ~2.5% of high-trauma participants may attempt suicide over 6–8 months can help policymakers allocate resources and set realistic targets. Additionally, our experiences with technology (AI-enabled digital screening) could serve as a reference for other initiatives seeking to incorporate AI or mobile health in low-resource settings. In effect, Lenegewa is acting as a living laboratory for innovation in African mental health – generating data that will be shared with the Ministry of Health and partners to influence national scaling of trauma-informed services, possibly.

Treatment Engagement and Non-Compliance

Participant engagement in treatment varied widely and emerged as a crucial determinant of outcomes. While many women embraced the program, a minority showed resistance, limited insight, or irregular attendance, requiring the team to address these issues continuously:

Therapy Attendance: Over the course of the cohort, the program delivered more than 200 individual therapy sessions (excluding group sessions). However, not all assigned sessions were attended. At least 110 therapy appointments were missed by participants (as recorded in internal logs), representing missed opportunities for care [33,34]. These missed sessions were not concentrated in just a few individuals; instead, a substantial share of participants skipped one or more sessions. Patterns emerged – for instance,

those who eventually dropped out of the program typically began by missing several sessions in the first 4–6 weeks. Conversely, participants who rarely missed sessions tended to achieve better clinical improvements.

Religious, Cultural, and Neurobiological Reasons for Non-Compliance: The underlying causes of treatment noncompliance were both patient-related and systemic. A prevalent issue was low insight and denial of mental illness. Many women initially minimized the severity of their psychological problems or believed that time and prayer alone would heal them. Some, from backgrounds with limited mental health literacy, did not understand the purpose of counseling and viewed it as unnecessary or strange. Misconceptions about therapy – e.g., "talking about problems will make them worse" or equating psychotherapy with "madness" – led some to opt out of sessions. In several cases, participants prematurely declared themselves "cured" after a few weeks and stopped engaging, often attributing their perceived improvement to spiritual healing rather than therapy. Aggression and defiance secondary to complex trauma have also played a role in resisting treatment recommendations.

Culture and Religion as Defensive Coping Mechanisms in Trauma-Affected Populations

Consistent with Ethiopian cultural norms and broader patterns observed across the Global South, somatic expression of psychological distress emerged as a prominent avoidance mechanism among participants. Rather than articulating emotional pain directly, many women expressed distress as physical complaints—a phenomenon widely documented in Ethiopian and other low-resource contexts, where psychological suffering is more culturally acceptable when framed in bodily terms [28,33]. At Lenegewa, women frequently prioritized visits to the medical clinic for headaches, generalized body pain, gastrointestinal discomfort, or fatigue, while simultaneously missing or disengaging from scheduled counseling sessions [20]. This pattern reflects not malingering but a culturally mediated pathway for help-seeking in environments where mental illness remains highly stigmatized and psychological language is limited.

Clinical observations indicated that somatic preoccupation often served as an avoidance strategy, shielding participants from emotionally overwhelming experiences related to trauma, loss, and grief. For example, one participant repeatedly requested medical evaluations—including new eyeglasses and examinations for diffuse bodily aches—and expressed ongoing dissatisfaction with dormitory conditions. Retrospective clinical review suggested that these behaviors masked poorly regulated emotional distress rather than reflecting unmet medical need. Staff recognized that such presentations were frequently associated with low psychological insight, in which seeking care for physical ailments felt safer and more socially legitimate than engaging in trauma-focused psychotherapy. Similar patterns have been documented across trauma-affected populations in low- and middle-income countries, where somatic idioms of distress serve as culturally sanctioned expressions of suffering [20,28].

In parallel, a subset of women relied heavily on religious coping strategies to the exclusion of clinical treatment, creating additional challenges for engagement and continuity of care. In several instances, participants attended prayer meetings or traveled to holy water sites without authorization, asserting that these practices alone were affecting their recovery and therefore diminishing the perceived need for psychotherapy or clinical follow-up. While religious and spiritual practices were broadly respected and, in many cases, actively supported within the program—including the provision of designated spaces for prayer and religious observance—these practices occasionally shifted from complementary supports to substitutes for evidence-based care. When this occurred, religious coping ceased to function as a protective factor and instead became a competing explanatory and treatment framework, contributing to non-adherence and reduced therapeutic engagement.

Religion and spirituality play a complex and ambivalent role in mental health across the Global South. Extensive literature shows that faith can be a powerful source of meaning, resilience, and social support, particularly in contexts of poverty, displacement, and trauma [35]. However, religious belief systems can also serve as defensive mechanisms, enabling avoidance of psychological distress when symptoms are framed exclusively as spiritual problems requiring spiritual solutions [36]. In such cases, individuals may delay or disengage from mental health care, particularly when psychiatric symptoms are interpreted as moral weakness, spiritual failure, or supernatural affliction.

This dynamic is especially pronounced in low-resource, highly religious settings, where access to formal mental health services is limited and faith-based explanations are often more culturally salient, socially reinforced, and immediately accessible than biomedical models [37]. In Ethiopia and similar contexts, religious leaders often serve as de facto mental health providers, shaping explanatory models of illness and pathways to care. While these systems offer important community-based support, they may also inadvertently discourage engagement with clinical services, particularly when spiritual healing is presented as mutually exclusive from medical or psychological treatment.

Global mental health research indicates that overreliance on prayer, faith healing, or spiritual interpretations—while meaningful to individuals—can reduce engagement with evidence-based mental health interventions, even when symptoms are severe, recurrent, or functionally impairing [23,38]. Among trauma-affected populations, this pattern may perpetuate avoidance of trauma processing, reinforce externalization of responsibility for recovery, and delay symptom improvement. For individuals with complex trauma histories, reliance on spiritual explanations alone may also impede the development of emotional literacy and self-efficacy, both central to recovery.

In response to these challenges, clinical teams at Lenegewa adopted a balanced, trauma-informed approach that recognized the importance of faith while clearly reinforcing the need for

consistent clinical participation. Religious practices were reframed as supportive adjuncts rather than replacements for psychotherapy and psychiatric care. Ongoing psychoeducation emphasized that spiritual coping and psychological treatment need not be mutually exclusive and could coexist in ways that support healing without undermining therapeutic progress. This approach aligns with emerging best practices in global mental health, which advocate culturally responsive care models that respect local belief systems while maintaining ethical and clinical responsibility to provide evidence-based treatment [28,39].

Behavioral Disruptions, Resistance, and Neurobiological Dysregulation

A minority of participants exhibited behavioral disruptions and resistance to engagement that interfered with treatment continuity and campus functioning. These behaviors were most often observed among women with histories suggestive of complex posttraumatic stress disorder (C-PTSD) and, in some cases, comorbid personality pathology. Clinically, these participants demonstrated recurrent anger outbursts, impulsive rule violations, difficulty tolerating authority, and intense interpersonal conflicts with peers and staff. Such behaviors were not random or oppositional in nature but reflected trauma-related dysregulation rooted in neurobiological adaptations to prolonged abuse and threat exposure.

For example, *Case 6* involved an 18-year-old participant who struggled with chronic irritability, pervasive distrust, and pronounced sensitivity to perceived authority. She frequently clashed with peers and staff, refused to attend classes, and repeatedly requested transfers between vocational groups, citing conflicts with instructors. Her presentation was characterized by hypervigilance, rapid emotional escalation, and a low threshold for perceived rejection or control. These patterns are consistent with trauma survivors who have experienced prolonged interpersonal abuse, particularly during formative developmental periods, and who subsequently develop maladaptive relational templates marked by fear, mistrust, and defensive hostility.

From a neuroscience perspective, such behaviors are increasingly understood as manifestations of altered threat-processing and emotion-regulation systems. Trauma survivors with chronic exposure to violence often exhibit hyperactivation of the amygdala, the brain's primary threat-detection center, leading to exaggerated fear responses and heightened emotional reactivity [40,41]. At the same time, trauma-related impairments in the prefrontal cortex (PFC)—particularly regions involved in executive functioning, impulse control, and emotional regulation—reduce the individual's capacity to inhibit reactive responses, reflect on consequences, or modulate intense affect. This imbalance between a hyperresponsive limbic system and an under-regulating executive system contributes to poorly regulated anger, impulsivity, and interpersonal volatility.

Within this neurobiological framework, behaviors such as defiance, aggression, or rule-breaking can be understood not as willful misconduct but as state-dependent survival responses. Participants may rapidly perceive neutral or ambiguous interactions as threatening, interpret feedback as rejection or control, and respond with fight-or-flight behaviors—including verbal aggression, withdrawal, or boundary testing. This dynamic was observed at Lenegewa, where a small number of participants engaged in behaviors such as breaking curfew, using substances, or lashing out verbally at counselors when confronted about nonattendance or noncompliance [42,43]. In these moments, trauma-driven neurophysiological arousal appeared to override reflective processing, leading to impulsive actions that undermined treatment engagement.

Mood volatility and impaired impulse control occasionally escalated to temporary absconding from the program or explicit threats to terminate participation. Such behaviors align with evidence that individuals with complex trauma histories often struggle with emotional containment and relational rupture, particularly in structured environments that activate memories of past control or coercion [44]. Importantly, these disruptions were episodic rather than pervasive and were often followed by remorse or emotional withdrawal once arousal subsided, further supporting a trauma-based rather than characterological interpretation.

In response, staff at Lenegewa deliberately avoided punitive or exclusionary approaches, recognizing that coercive responses risk reinforcing trauma-related threat perceptions and escalating dysregulation. Instead, the team intensified trauma-informed engagement strategies, emphasizing safety, predictability, choice, and collaboration. Interventions included individualized behavior contracts, de-escalation techniques, and motivational interviewing (MI) to support autonomy and reduce resistance. When one participant angrily accused her coach, stating, *"You don't care about us!"* and subsequently skipped multiple sessions, the coach responded with empathic validation— *"It sounds like you're feeling uncared for; I want you to know your well-being matters to me"*—rather than reprimand or withdrawal of services [43,45].

This relational stance is supported by neuroscience-informed trauma care, which emphasizes that co-regulation precedes self-regulation. By maintaining calm, consistent, and emotionally attuned responses, staff helped downregulate participants' physiological arousal and gradually rebuild trust in interpersonal relationships. Over time, this approach reduced the frequency and intensity of defensive behaviors for most participants, enabling improved engagement and emotional stability. Nevertheless, a small subset of individuals ultimately terminated early, underscoring the limits of intervention within a time-limited residential model for those with severe neurodevelopmental trauma and entrenched dysregulation.

In summary, these behavioral disruptions highlight the importance of interpreting resistance through a neurobiological and trauma-informed lens. Understanding anger, impulsivity, and rule violations as consequences of altered brain functioning—rather than intentional noncompliance—allowed the Lenegewa team to respond with interventions that promoted safety, preserved dignity,

and maximized the likelihood of re-engagement. This approach aligns with emerging global mental health frameworks that integrate neuroscience, trauma theory, and culturally responsive care to address complex behavioral presentations in low-resource, high-acuity settings.

Across the cohort, engagement challenges were shaped by the interaction of cultural coping styles, religious meaning-making, and trauma-related neurobiological dysregulation. Many participants expressed psychological distress through somatic symptoms, prioritizing medical complaints over counseling as a culturally acceptable means of help-seeking. This somatic focus often functioned as an avoidance strategy, masking unresolved trauma and limiting psychological insight. In parallel, some participants relied heavily on religious coping as a primary or exclusive pathway to healing. While faith practices frequently provided emotional support and meaning, overreliance on spiritual explanations occasionally displaced engagement with clinical care, contributing to non-adherence when religious practices were positioned as substitutes rather than complements to treatment.

Cultural, Neurological, and Psychological Context of Psychogenic Nonepileptic Seizures

A prominent and clinically significant feature of the cohort's presentation was trauma-related somatic and dissociative symptomatology, most notably psychogenic nonepileptic seizures (PNES). These episodes required careful psychological formulation and culturally informed interpretation to avoid misdiagnosis, inappropriate medical intervention, or reinforcement of maladaptive explanatory models. This was particularly important in a high-acuity, residential setting where seizure-like episodes can trigger urgent medical responses, elevate anxiety among peers, and rapidly shape community narratives about illness causation. PNES are characterized by seizure-like motor, sensory, or consciousness-altering events that occur without concurrent epileptiform activity on electroencephalography and are widely understood as manifestations of psychological distress rather than neurological pathology. In trauma-exposed populations, PNES are often conceptualized as expressions of dysregulated stress response systems, dissociation, and unresolved traumatic memory processing, frequently overlapping with posttraumatic stress disorder and functional neurological symptom disorder frameworks [34,41]. In practical terms, PNES represent a mind–body phenomenon where the nervous system expresses intolerable affect and threat appraisal through involuntary somatic states that can mimic epileptic seizures.

The empirical association between PNES and trauma is robust.

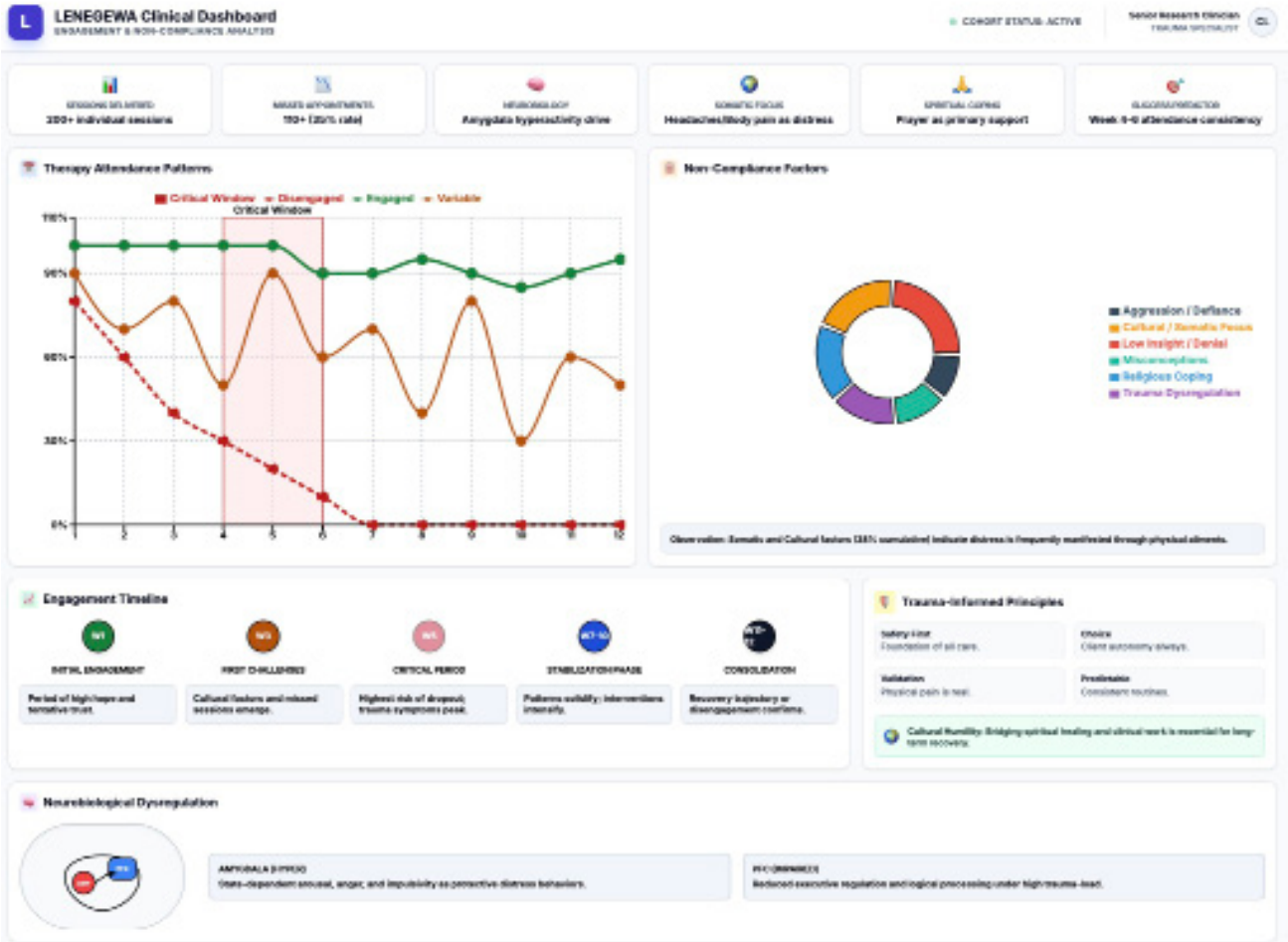

Figure 6: Clinical Engagement Dashboard.

Across clinical samples, 44% to 100% of individuals diagnosed with PNES report histories of significant trauma, with sexual abuse, chronic childhood maltreatment, and interpersonal violence consistently identified as salient antecedents [34]. Gender disparities are striking: women are approximately three times more likely than men to experience PNES, and extensive epidemiological and clinical studies indicate that individuals with PNES are up to fifteen times more likely to report a history of sexual assault than patients with epileptic seizures or other neurological conditions [46]. These findings support neurobiological models in which chronic trauma leads to hyperactivation of limbic threat circuitry and impaired top-down regulation, resulting in somatic discharge of unprocessed affect during emotional overwhelm. This relationship also helps explain why PNES frequently appear in populations with cumulative adversities, chronic relational threats, and limited access to early protective caregiving—conditions that shape stress neurobiology across development.

Psychogenic nonepileptic seizures (PNES) are best understood as functional neurological responses to overwhelming psychological stress, rather than disorders of abnormal cortical electrical activity seen in epilepsy. Neurobiological research increasingly conceptualizes PNES as disorders of brain network dysregulation, in which emotional processing systems override voluntary motor control and consciousness through maladaptive stress response pathways. This framework highlights that PNES are not "imagined" symptoms; rather, they are real, involuntary events produced by altered integration across neural systems that regulate threat detection, interoception, motor output, and conscious awareness.

Central to PNES is hyperactivation of limbic structures, particularly the amygdala, which plays a critical role in threat detection and emotional salience. Individuals with PNES—especially those with histories of early and chronic trauma—show exaggerated amygdala responses to emotional stimuli, reflecting a sensitized threat system [40,41]. When perceived threat exceeds the individual's capacity for emotional regulation, the brain may shift into a defensive, nonverbal mode of responding. Clinically, this can manifest as a rapid transition from distress to collapse, shaking, unresponsiveness, or trance-like states, particularly when the person is confronted with reminders of trauma, interpersonal conflict, shame, or a sense of being trapped—contexts that strongly activate survival circuitry.

At the same time, functional neuroimaging studies show reduced top-down regulatory control from the prefrontal cortex (PFC), particularly the medial and dorsolateral regions responsible for executive functioning, emotional inhibition, and conscious self-monitoring [47]. This impaired prefrontal modulation limits the individual's ability to cognitively process distress or regulate autonomic arousal, increasing reliance on reflexive, subcortical responses. In day-to-day functioning, reduced PFC regulation can appear as difficulty reflecting before reacting, impaired capacity to name emotions, low tolerance for affective intensity, and rapid escalation during relational stress—all of which set the stage for involuntary somatic discharge when the nervous system becomes overwhelmed.

PNES episodes are also associated with altered functioning of the anterior cingulate cortex (ACC) and insula, regions involved in emotional awareness, interoception, and the integration of bodily sensations with subjective experience [48]. Dysregulation in these regions disrupts the normal integration of emotional states and motor control, allowing intense affective arousal to be expressed somatically. As a result, psychological distress is "discharged" through seizure-like motor activity, loss of responsiveness, or dissociative states. This is clinically relevant in contexts like Lenegewa, where somatic idioms of distress are common and psychological language may be limited or stigmatized; interoceptive and affective disruptions can therefore become the dominant channel for communicating internal distress.

From a systems perspective, PNES can be conceptualized as a failure of neural integration between emotional, cognitive, and motor networks. During episodes, emotional circuits dominate, while networks governing voluntary movement and conscious awareness are functionally disengaged. Importantly, electroencephalography (EEG) during PNES episodes does not show epileptiform activity, confirming that the events are not generated by abnormal cortical discharges but rather by functional network disruption [49]. This distinction is critical for avoiding unnecessary anticonvulsant treatment, repeated medical workups that inadvertently reinforce the identity of symptoms as "neurological," and clinical interactions that increase fear rather than restore agency.

Dissociation plays a key mediating role in this process. Trauma survivors frequently develop dissociative coping mechanisms as adaptive responses to inescapable threat, particularly during childhood. Over time, these mechanisms become automated neural responses, triggered by stressors that resemble prior traumatic experiences [41]. In PNES, dissociation may manifest as altered consciousness, depersonalization, or derealization, preceding or accompanying seizure-like activity, reflecting a neurobiological "shutdown" response when the fight-or-flight response is perceived as ineffective. This is remarkably consistent with complex trauma histories in which the individual's nervous system learned that neither escape nor defense was possible, and that disengagement or "going away" internally was the safest remaining strategy.

Autonomic nervous system dysregulation further contributes to PNES vulnerability. Individuals with PNES often exhibit heightened sympathetic arousal and reduced parasympathetic regulation, resulting in physiological instability under stress [50]. When combined with impaired cortical inhibition, this autonomic imbalance increases the likelihood of abrupt, involuntary motor and behavioral responses. Clinically, this may be observed as rapid physiological escalation—tachycardia, tremulousness, hyperventilation, freezing—followed by collapse or convulsive-like behaviors. The autonomic dimension also helps explain why grounding, paced breathing, and co-regulation are often effective immediate interventions once medical emergencies are ruled out.

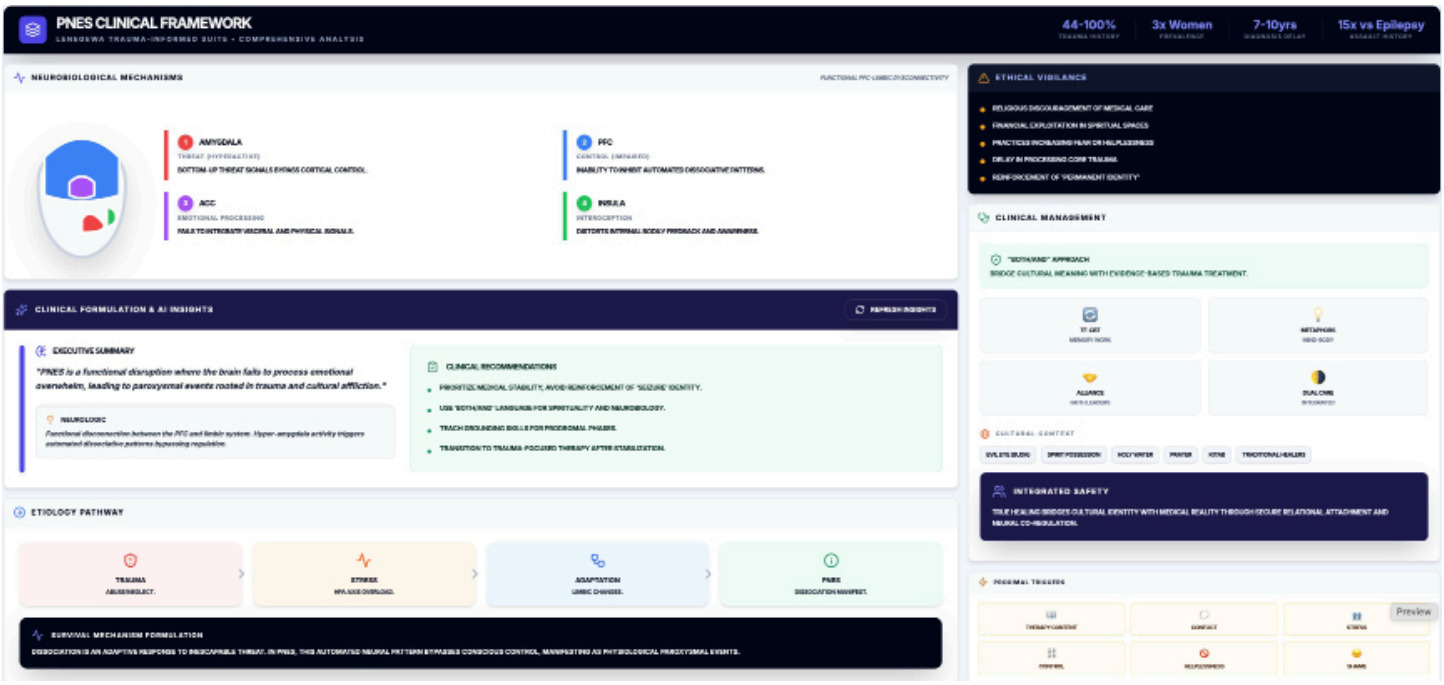

Figure 7: PNES Clinical Framework.

Taken together, PNES represent a neurobiologically mediated expression of psychological distress, arising from the interaction of heightened limbic reactivity, impaired executive control, disrupted interoceptive processing, and trauma-conditioned dissociative responses. These mechanisms explain why PNES are highly prevalent among individuals with histories of sexual abuse, chronic interpersonal trauma, and posttraumatic stress disorder, and why episodes are often triggered by emotionally salient or relational stressors rather than random physiological events. In a residential setting, these triggers can include group therapy content, interpersonal disputes, feelings of exclusion, reminders of coercion, or perceived loss of control—each of which activates threat networks and destabilizes regulation.

Understanding PNES through this neurobiological framework has important clinical implications. It reinforces that PNES are real, involuntary, and physiologically grounded phenomena, not malingering or conscious fabrication. This perspective supports trauma-informed treatment approaches that emphasize emotional regulation, grounding, psychotherapy targeting trauma processing, and restoration of prefrontal–limbic balance, rather than anticonvulsant medications or punitive responses. It also underscores the need for staff training so that the first-line response to PNES is calm containment and co-regulation, paired with appropriate medical screening, rather than escalation or stigmatizing interpretations.

Within the Lenegewa cohort, clinicians documented multiple episodes of stress-induced convulsions, fainting, or unresponsiveness among participants without prior epilepsy diagnoses. These events frequently occurred in emotionally charged interpersonal or therapeutic contexts, such as group therapy sessions addressing childhood abuse, discussions of sexual trauma, or acute relational conflicts with peers. The temporal association between emotional activation and symptom onset was consistent across cases, strengthening formulation as trauma-linked functional neurological events. In each instance, medical staff performed immediate evaluations to rule out acute medical or neurological etiologies, including epilepsy, syncope, or metabolic disturbances. The absence of postictal confusion, tongue biting, incontinence, or abnormal neurological findings further supported a psychogenic etiology. Once stabilized, participants were supported with grounding, containment, and trauma-informed de-escalation strategies. Importantly, the post-episode phase was treated as clinically meaningful, with staff tracking antecedents (emotional triggers, interpersonal stressors, therapy content) to reduce recurrence and improve participant insight without shame. Over the course of treatment, PNES episodes generally decreased in frequency and intensity as participants engaged in trauma-focused cognitive behavioral therapy, learned affect-regulation skills, and—when clinically indicated—received psychopharmacological interventions targeting anxiety, hyperarousal, and mood instability. In one illustrative case, a participant who initially experienced multiple PNES episodes per week achieved near-complete remission after consistent trauma therapy, focused processing of a core sexual assault memory, and structured anxiety-management interventions [51]. These clinical trajectories align with existing literature showing that PNES symptoms often remit when underlying trauma is addressed, and patients acquire alternative strategies for managing emotional distress. In addition, as relational safety increased within the program environment, participants appeared better able to tolerate emotional activation without needing somatic discharge, reinforcing the role of safe attachment-like conditions and consistent co-regulation in recovery.

However, clinical management was complicated by culturally embedded explanatory frameworks that differed markedly from biomedical interpretations. In Ethiopian contexts, sudden convulsions, trance-like states, or unexplained collapses are commonly interpreted through spiritual or supernatural lenses rather than psychological or neurological ones. A pervasive explanatory model attributes such phenomena to the "evil eye" (buda in Amharic) or to spirit possession. Importantly, these belief systems are not merely religious constructs but are rooted in indigenous cosmologies that predate the arrival of Christianity and Islam in Africa. They were later incorporated into Christian and Islamic practices rather than displaced by them [37,43]. Anthropological scholarship documents beliefs in the evil eye as among the oldest trans-cultural explanatory systems for illness and misfortune, historically serving as socially shared frameworks for understanding suffering, vulnerability, and interpersonal harm [52,53]. In this context, seizure-like events can be quickly interpreted as evidence of spiritual attack, shaping both family responses and peer reactions in ways that influence engagement with care.

Consistent with these cultural frameworks, many participants and their families initially interpreted PNES episodes as the result of curses, spirit attacks, or supernatural affliction rather than trauma-related psychophysiological responses. Before admission, many participants had sought care from religious or traditional healers, including holy water exorcism rituals, prolonged prayer, or protective amulets (kitab), which are commonly worn in Ethiopia to ward off the evil eye [54]. During residential treatment, when PNES episodes occurred, some participants requested immediate spiritual intervention—such as being taken to a church or holy water site—while others retrospectively attributed symptom improvement exclusively to concurrent spiritual practices. These responses reflected deeply ingrained meaning-making systems rather than resistance or denial per se. Clinically, this required careful communication that validated the person's worldview while preventing the episode from becoming socially reinforced as purely supernatural, which could intensify fear, avoidance, and dependency.

Nevertheless, not all symptoms or behaviors can be attributed solely to culture or religion without clinical consequences. While cultural and religious frameworks can provide comfort and coherence, uncritical or "blind" deference to these belief systems can delay access to necessary mental health treatment, particularly when symptoms are severe, recurrent, or functionally impairing [35,36]. In the context of trauma-related PNES, clinicians must navigate a complex ethical terrain: respecting patients' belief systems while recognizing that some interpretations may reinforce avoidance of trauma processing, externalize agency, or perpetuate fear and helplessness [41]. Respect for culture does not negate the clinician's responsibility to intervene when beliefs contribute to ongoing suffering or impairment. This balance is particularly delicate in residential care, where group narratives spread quickly and may shape whether the community treats PNES as a medical issue, a spiritual crisis, or a stigmatized identity.

This challenge is further intensified by the proliferation of exploitative religious practices in some regions, where self-proclaimed prophets or spiritual leaders claim supernatural diagnostic abilities, assert exclusive access to divine insight, or promise healing and material prosperity in exchange for payment or sustained allegiance. Individuals with untreated mental health conditions—particularly those with trauma histories, depression, psychosis, or anxiety—are especially vulnerable to such exploitation because of impaired judgment, heightened suggestibility, and an intensified search for meaning or relief [37,41]. Global mental health research consistently shows that these practices disproportionately affect poor and marginalized populations in settings with limited access to formal mental health services, where spiritual leaders may function as de facto health authorities [35,38]. In such cases, religious authority can be used to discourage biomedical care, extract financial resources, or reinforce dependency, thereby exacerbating psychological harm and delaying recovery [23]. In the Lenegewa context, these realities heightened the importance of clinical vigilance, protective psychoeducation, and firm boundaries around harmful practices while maintaining respect for faith as a potential resilience factor.

From an ethical standpoint, trauma-informed practice requires heightened clinical vigilance. Cultural sensitivity does not imply neutrality in the face of harm. Instead, clinicians are obligated to identify when belief systems are applied coercively or exploitatively and to protect patients from practices that undermine autonomy, safety, or access to evidence-based care [39]. This includes providing careful psychoeducation, setting boundaries, and, when appropriate, engaging ethical community and faith leaders who support integrative approaches to healing. Such engagement can reduce adversarial dynamics and create culturally legitimate pathways for participants to accept clinical care without experiencing it as betrayal of faith.

At Lenegewa, clinicians adopted a both/and framework that honored cultural and spiritual meaning while consistently promoting evidence-based trauma treatment. Participants were educated that intense emotional stress can produce genuine physical symptoms—including seizures or paralysis—even in the absence of neurological disease, and that these experiences reflect the body's expression of psychological pain rather than evidence of possession or moral failure [55,56]. At the same time, clinicians did not dismiss spiritual worldviews. Therapy sessions provided space to discuss beliefs about curses or spirit disturbance, and positive faith practices—such as prayer or the use of blessed holy water—were reframed as complementary supports rather than substitutes for treatment [7]. Metaphors linking cultural concepts to therapeutic processes—for example, explaining that "the evil eye loses its power as the mind heals from trauma"—proved particularly effective in bridging explanatory models without reinforcing avoidance of care [44]. Staff also emphasized that spiritual practices could accompany treatment, while consistent participation in therapy remained essential for skill-building and recovery.

In select cases, with explicit patient consent, collaboration with local faith leaders further enhanced engagement. For example, an Orthodox priest was invited to pray with a participant experiencing PNES while she continued trauma-focused counseling. Such partnerships reflect broader Ethiopian models that integrate religious and biomedical care. Studies indicate that most patients are comfortable receiving both simultaneously and often maintain dual explanatory models for illness without perceiving contradiction [7,9]. Over time, many participants began to reinterpret their symptoms, acknowledging trauma and stress as triggers without abandoning their faith, illustrating that culturally responsive psychoeducation can expand understanding rather than generate conflict. This shift in meaning-making appeared to reduce fear, improve treatment adherence, and decrease the social reinforcement of PNES episodes as supernatural crises.

In summary, the cohort's presentation of PNES and related psychosomatic symptoms underscores the need for an integrated psychological, somatic, neurobiological, and cultural framework for trauma care. The program's response—combining rigorous clinical intervention with cultural validation and ethical vigilance—reduced stigma, improved symptom understanding, and prevented participants from being relegated solely to non-clinical remedies. This balanced approach exemplifies trauma-informed care attuned to the local context, acknowledging that healing occurs at the intersection of psyche, body, neurobiology, culture, and meaning [57]. It also demonstrates that effective PNES management in low-resource settings requires not only clinical competence, but also culturally skilled communication, careful boundary-setting, and systems-level strategies to prevent misinterpretation and ensure sustained engagement in evidence-based care.

Digital Platform and Predictive Analytics

The introduction of the ClarityConnect AI-enabled digital platform was a significant innovation for this cohort, transforming how data was collected and used in clinical decision-making. Its implementation demonstrated the feasibility of using technology for mental health care in a low-resource, low-literacy setting and produced several noteworthy outcomes:

Screening Coverage and Acceptance: Of 413 participants, 375 women (91%) completed at least one AI-enabled digital self-assessment via ClarityConnect during the program [31,58]. The remaining 9% completed paper assessments due to initial technical or literacy barriers, but later attempted the AI-enabled digital format with assistance. This high coverage suggests that, with appropriate support, even populations with limited prior exposure to technology can engage with AI-enabled digital mental health tools. Basic training and one-on-one guidance were provided initially. A few participants were unfamiliar with tablets, so staff or peer "AI-enabled digital mentors" helped them enter responses. Within a few weeks, nearly all participants were comfortable with the platform, and many expressed enthusiasm upon seeing their scores and progress visualized on the screen. No major connectivity issues occurred, aside from minor outages quickly resolved through offline data caching. Overall, there was broad acceptance of the AI-enabled digital approach, dispelling initial concerns that it might be too cumbersome or culturally incongruent.

Risk Stratification and Alerts: ClarityConnect's real-time analytics proved invaluable for risk monitoring. The system was configured to flag high-risk responses automatically. For example, if a participant scored in the severe range on the PHQ-9 (≥20) or endorsed any suicidal ideation item, an alert was generated for the clinical team. Similarly, high scores on the GAD-7, an ACE

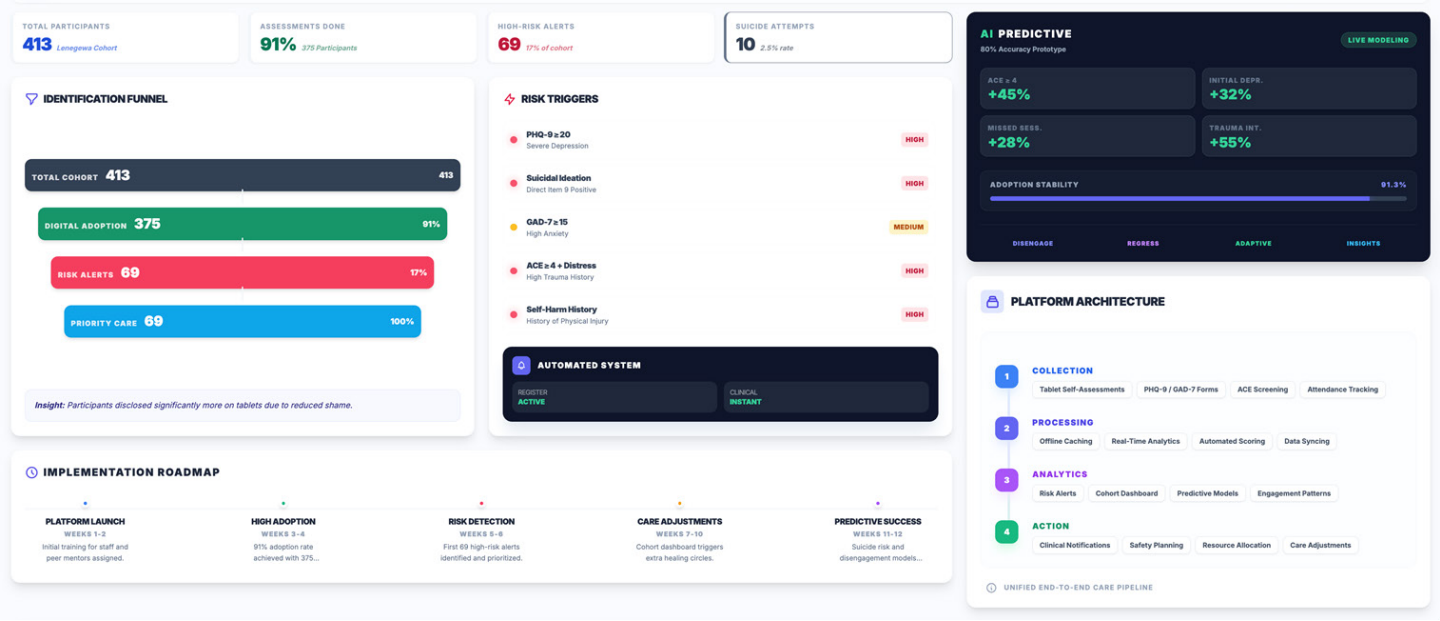

Figure 8: ClarityConnect Platform Implementation.

score above a threshold (e.g., ≥4) combined with current distress, or any positive response on the suicide/self-harm item triggered notifications. Through these automated alerts, the team identified 69 women who required priority follow-up – a figure that aligned with the 17% of urgent cases they anticipated. Notably, some alerts caught issues that might have been missed in routine care. After a partial rollout of ClarityConnect, staff realized that a few participants had underreported symptoms in face-to-face interviews (due to shame or stigma) but had disclosed them on tablet assessments. Thus, the AI-enabled digital tool "cast a wider net," ensuring that critical cases did not fall through the cracks. It enabled a dynamic risk register: nurses and counselors would receive daily lists of any new high scores or concerning changes and could respond promptly (sometimes on the same day with a safety plan or extra session.

Data-Driven Care Adjustments: Beyond individual alerts, the platform aggregated data into a cohort dashboard. This allowed program leadership to observe trends such as the distribution of depression severity across the community, average changes over time, and the most prevalent symptoms. These population-level insights informed resource allocation. For instance, midway through the program, the dashboard showed a spike in grief and depression indicators in the weeks following a group trauma-processing workshop (likely as women were unpacking painful memories). In response, the team scheduled additional self-care and stabilization activities – an extra mindfulness session and a weekend healing circle – to support participants through this challenging period. In another case, data revealed that anxiety scores were particularly high among a subgroup of women who had recently been reunited with their children (living on campus for a visit). Recognizing the stress of parenting challenges, staff arranged a special parenting support group that week. These examples illustrate how real-time monitoring enabled nimble adjustments to meet participants' needs better.

Predictive Analytics and Suicide Risk: The rich cohort dataset also enabled the team to prototype predictive analyses for critical outcomes. A key focus was suicide risk, given that 10 suicide attempts occurred in the cohort (a 2.5% attempt rate) [12,13]. Using data on who attempted suicide, the team identified risk factors: nearly all attempters had ACE scores ≥4, high initial depression scores, and multiple missed therapy sessions in the month before the attempt. They extrapolated that in a future cohort of 800 (double the size), one might expect ~20 attempts if no changes were made, with perhaps 1–3 potentially fatal outcomes (using an estimated 5–15% lethality rate for attempts [28,59]). This sobering projection led AYA to strengthen its Risk Management Plan even before scaling up. Enhanced measures included: conducting weekly suicide risk screenings (instead of monthly) for those flagged as high-risk; establishing an on-call crisis counselor system so help was available 24/7; and training all staff – even non-clinical staff such as vocational trainers – to recognize warning signs of suicidality (withdrawal, giving away possessions, etc.) [4,60]. By increasing monitoring frequency and broadening the safety net, the program aimed to detect signs of crisis earlier. This example underscores how data was used not only descriptively but also predictively to preempt adverse outcomes.

Identifying Disengagement Patterns: Preliminary analysis of engagement data identified specific behavioral predictors of dropout or relapse. For example, participants who missed more than two sessions in their first month were far more likely to drop out or have a poor treatment response. Those who relapsed in substance use often showed sporadic session attendance and lower initial motivation scores (as rated by counselors). Recognizing these patterns, AYA's data team began developing simple predictive models (e.g., logistic regression) to flag new admissions at risk of disengagement. The plan is to eventually integrate an AI-driven module that learns from each cohort's data to improve these predictions. Although still in the early stages, the second cohort's data provided proof of concept: it is feasible to use routine program data to stratify clients by risk of noncompliance or deterioration. In the future, a "risk score" could be generated for each new participant, prompting targeted engagement efforts (such as assigning the most skilled counselors to those predicted to be at high risk or conducting additional motivational interviews up front) [25,61].

Overall, the use of AI-enabled digital tools and analytics significantly enhanced the program's ability to deliver personalized, proactive care. It brought a level of precision to a setting that traditionally relies on sparse data. Despite the Lenegewa team's ambivalence about fully transitioning to AI-enabled digital service delivery, which is expected when moving from one model to another, the successful adoption of ClarityConnect will dispel myths that high-tech approaches cannot work in rural Africa. On the contrary, it empowered local staff with information and gave participants a novel way to voice their progress and needs. As a result, Lenegewa now has one of the most data-rich cohorts of trauma survivors in the region, positioning the center to contribute unique insights to research and continuously improve its services.

Lessons Learned and Implementation Challenges

The journey of this cohort also revealed essential challenges and areas for improvement, many of which translate into actionable lessons:

Trauma-Informed Training for All Staff: One insight was that everyone in contact with participants, not just clinicians, needs grounding in trauma-informed principles; 80% of the Lenegewa staff are trained in trauma-informed care. Lenegewa is becoming a trauma-informed organization. Several incidents, if framed from a trauma perspective, could have different outcomes. For example, we observed a few instances early on in which support staff (e.g., vocational instructors, security personnel) responded to problematic behaviors in punitive ways, inadvertently reinforcing participants' mistrust. After additional training and weekly debriefings, these incidents decreased. Going forward, wider training is planned so that the entire organizational culture consistently embodies understanding, patience, and non-violence – essential elements for trauma survivors who are often hypervigilant to perceived threats [62].

Team-Based Coordination: Communication gaps among the medical, counseling, and social work units sometimes delay interventions (e.g., a therapist not immediately aware that a patient missed a psychiatric appointment, or a social worker unaware of a client's new medication side effects). As a result, ClarityConnect developed a centralized portal for referral management to address these communication gaps. To scale up, Lenegewa needs to minimize friction between departments and leverage AI-enabled digital tools to reduce care costs and improve outcomes. A unified case management platform like ours should also enhance continuity of care and ensure that high-risk cases receive more concerted attention. It reflects models of collaborative care that have been successful in other global mental health contexts [57].

Early Psychiatric Intervention and Adherence: High-risk patients taught us that the timing of interventions matters. In Cohort 2, some of the most unstable participants (especially those with psychosis or severe depression) decompensated, in part due to delays in initiating medication or irregular intake (due to stock-outs or refusal). By starting psychotropic medications within the first 48 hours when indicated and using direct observation during the initial weeks, we aim to prevent avoidable crises [63]. This proactive stance acknowledges that while therapy is crucial, certain severe cases require biomedical stabilization in parallel to even participate in therapy effectively.

Managing Mid-Treatment "Dips": We observed a pattern in which many participants experienced a surge of distress during weeks 4–6 of the program, likely as trauma processing intensifies and the initial novelty wears off. This manifested as heightened anxiety, anger, and irritability, grief outpourings, or, in a few cases, consideration of dropout. In light of this, we are adapting the curriculum to add extra support during this critical period – for example, scheduling a resilience workshop and a coping skills refresher in week 5, normalizing the difficulty as a known phase of healing, and perhaps bringing in graduates to encourage perseverance [2,24]. The aim is to ride through the turbulence rather than lose participants when the work gets hardest. This adjustment is a direct result of analyzing symptom trajectory data, underscoring the value of feedback-informed program design.

Aftercare and Follow-Up: Some outcomes (such as relapse) underscore that recovery is fragile without ongoing support. Although not originally part of the model, it became clear that a continuum of care post-discharge is needed. Many women expressed anxiety about "what comes after" graduation. In response, ClarityConnect can collect post-discharge data. Additional follow-up mechanisms are underway, including telehealth and community-based support. This aligns with global calls to extend mental health care beyond acute episodes, especially for chronic trauma-related conditions [39], and to explore ways to maintain contact even after women leave campus, which could mitigate regression and enable early intervention if problems recur [23].

Infrastructure and Scalability: Successes with ClarityConnect have strengthened plans to digitize all Lenegewa services by February 2026. For scaling, we recognized the importance of robust data systems – both for clinical tracking and for demonstrating impact to funders. The implementation of ClarityConnect, which also covers the social work team, vocational training progress, post-discharge outcomes tracking, and medical services, provides a 360-degree view of each participant's journey [64]. Scaling up will test whether the intensive, tailored approach can be maintained – our strategy is to rely on technology for efficiency where possible (e.g., dashboards that alert staff to who needs attention most, mobile apps for participants to report mood in real time) and to invest heavily in staff training and supervision to preserve quality. We have already seen that weekly supervision by a psychiatrist was invaluable; with more coaches, we might implement a cascading supervision model (training senior coaches as supervisors) to uphold care standards [65].

Full rollout of ClarityConnect across the center is underway. During cohort 5 admissions (early February 2026), ClarityConnect is planned to automate and coordinate all medical, rehabilitation, and vocational services, including intake workflows, screening administration, clinical documentation, referral routing, scheduling, and follow-up tracking. As part of AYA's human-centered design approach, AYA worked closely with the Lenegewa team to co-design the platform so that automation supports—not disrupts—care delivery and staff workflows.

Implications for Global Mental Health and Policy

The outcomes of the Lenegewa program have several broader implications:

First, they underscore the need for comprehensive, contextually adapted models to address complex trauma in low- and middle-income countries (LMICs). Traditional siloed approaches (treating mental health in isolation from socioeconomic needs or focusing on one disorder at a time) are likely insufficient for populations like ours. Improvements in participants' mental health, along with gains in skills and hope for the future, suggest a synergistic effect – healing was facilitated by the prospect of a better life (jobs, community acceptance), and vice versa. This supports calls by the Lancet Commission and others for integrated approaches that address social determinants alongside clinical care [23]. For policymakers, investing in multi-component programs may yield cross-cutting benefits (mental health, economic empowerment, reduced violence) that justify the complexity and cost relative to single-focus interventions.

Second, our experience demonstrates the feasibility of AI-enabled digital tools, including large language models (LLMs), in resource-limited mental health settings. Skepticism about high-tech interventions in African contexts is common, but our successful deployment of a tablet-based screening and data system counters that narrative. It shows that with cultural adaptation and user training, AI-enabled digital platforms can augment human resources and improve care delivery, even where literacy is limited. This is particularly resonant given Africa's huge mental health treatment gap, few specialists, and the need for scalable solutions [39].

The Lenegewa model offers a blueprint for how AI-driven decision support might function: stratifying risk, enabling AI-powered digital coordination of a multidisciplinary team, focusing scarce clinical attention where it's most needed, and continuously learning from outcomes. While our predictive analytics are nascent, they illustrate how local data can inform proactive strategies (such as intensifying suicide prevention ahead of a scale-up). Notably, this aligns with a broader global health trend toward precision public health using data. Our initiative could inspire similar programs to incorporate monitoring and simple algorithms to boost effectiveness without waiting for large trials – essentially a practice-based evidence paradigm (vs. evidence-based practice) in which programs iteratively improve by analyzing their own data [66]. Of course, integrating AI needs to be done cautiously; algorithms must be free of bias, respect privacy, and be co-designed with community input [61]. If done right, such technology could dramatically increase the reach and sustainability of mental health services in low-resource areas.

Third, the data from this cohort provide advocacy leverage for mental health funding and policy change. In many LMICs, mental health programs struggle to gain priority and resources due to limited local evidence of impact [67]. By documenting concrete outcomes – e.g., X% symptom reduction, Y women vocationally employed post-program, Z% decrease in suicidal behavior – we arm stakeholders with evidence to justify expanding trauma-informed care initiatives. Presentations of our findings to the regional health bureau have already generated interest in replicating elements of the model (such as the physician–coach task-sharing and AI-enabled digital screening) in other parts of Ethiopia. The quantitative results meet donors' demands for measurable impact, potentially attracting more investment. Additionally, qualitative successes, such as personal transformation stories, humanize the data and can rally political will by illustrating the human potential unlocked by such programs. In short, Lenegewa's experience can serve as a demonstration project for integrating mental health into broader poverty alleviation and women's empowerment efforts – themes that align with the Sustainable Development Goals (e.g., SDG 3 on health, SDG 5 on gender equality, SDG 1 on poverty).

Future Directions: Sustainability and the Role of Agentic AI

Looking ahead, a critical question is how to sustain and scale models like Lenegewa's in a financially and operationally feasible way. Traditional donor-dependent programs often falter when funding cycles end, and rigid program designs may not adapt well to complex local challenges [68]. Our initial success, while heartening, must withstand the test of long-term viability and expansion into more communities. Here, agentic artificial intelligence (AI) systems present an intriguing opportunity to enhance sustainability. By "agentic," we refer to AI systems that autonomously support decision-making and optimize resources in real time, acting as intelligent agents within the program's operations [65].

One avenue is using AI to improve resource allocation efficiency. For instance, predictive algorithms (trained on our growing dataset) could forecast which participants are most likely to benefit from specific interventions (vocational training vs. extended therapy) and allocate resources accordingly. If the AI model predicts that a particular woman is at high risk of dropping out of vocational classes, it could signal staff to provide targeted support or adjust her training plan – potentially preventing dropout and saving the sunk costs of a lost training spot [69]. In poverty alleviation contexts, such personalization can enhance outcomes while reducing waste. Our data already suggest that retention might improve by up to 30% with early intervention for those flagged as high-risk non-compliers, a figure in line with improvements seen in AI-augmented maternal health programs in Rwanda [62,70]. This level of optimization can make a program more cost-effective and appealing to funders seeking maximum impact per dollar.

Another domain is automated impact tracking and reporting. Over 70% of NGOs in Africa reportedly lack robust systems to track long-term outcomes [67]. This undermines donor confidence and often leads to funding shortfalls. We envision AI tools that automatically compile outcome data (e.g., symptom changes, job placements, income improvements among alumnae) and even generate narrative reports for stakeholders. For example, natural language processing could scan participant surveys or testimonies and produce composite stories of change, while blockchain technology could transparently link expenditures to outcomes for accountability [18]. A prototype could be a real-time "impact dashboard" that program managers and funders can view. This would drastically reduce the labor required for manual M&E (monitoring and evaluation) and ensure continuous transparency. In Lenegewa's case, as we scale to thousands of data points, such automation will be indispensable for maintaining clarity on performance. It could also help break the cycle of donor dependence by demonstrating effectiveness and enabling outcome-based financing models [66].

However, the integration of AI must be done ethically and collaboratively. We must guard against algorithmic biases – for instance, if the AI's training data reflects biases (gender, ethnic, or other), it might distribute resources unequally or misidentify risk in specific subgroups [61]. To mitigate this, we plan to involve local stakeholders (staff and participants) in designing and fine-tuning the AI systems, effectively "teaching" the AI in a culturally informed manner. Moreover, any AI recommendations will be interpreted by human supervisors rather than blindly followed, preserving a human-in-the-loop model for crucial decisions. In essence, the vision is not AI replacing human judgment but augmenting our team's capabilities so that, as numbers grow, the quality of individualized care does not diminish.

The pursuit of sustainable scaling at Lenegewa aligns with broader development and global mental health agendas. By integrating AI and data-driven approaches, we strive to balance scalability with personalization – a known tension in public health programs. This approach also advances multiple Sustainable Development Goals: ending poverty (SDG 1) through the economic empowerment of women, ensuring healthy lives and well-being (SDG 3) by

addressing mental health, and fostering innovation and partnerships (SDG 17) through technology integration and collaboration with diverse stakeholders [71]. If successful, AYA and the Trauma Innovation Center can serve as a model for how future programs in Africa might be designed – not as replicas of Western models, but as contextually built systems that leverage the best of local practice and cutting-edge technology.

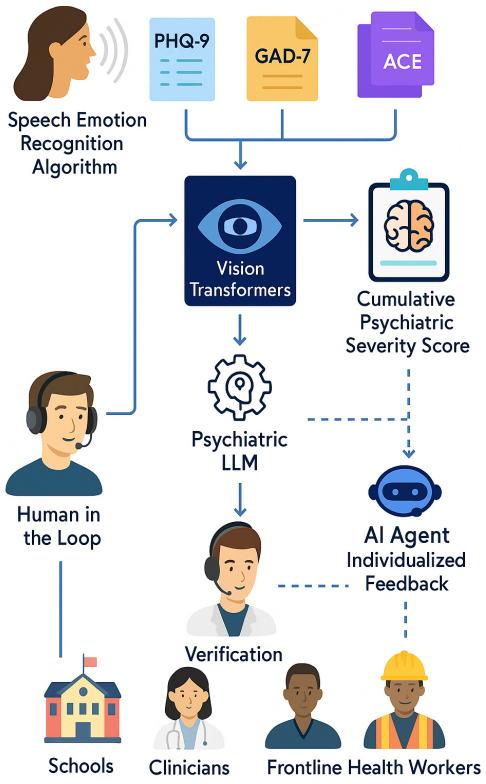

Figure 9: AYA Agentic AI Model.

Conclusion

The second cohort at Lenegewa offers a compelling and nuanced case study of delivering trauma-informed mental health and rehabilitation services to a highly vulnerable population in sub-Saharan Africa. Operating in a context marked by profound trauma exposure, structural marginalization, and severe resource constraints, the program demonstrates both the promise and the complexity of implementing comprehensive mental health care in low-resource settings. The Lenegewa experience illustrates that thoughtfully integrated systems—rather than isolated interventions—are required to address the intertwined psychological, social, and economic consequences of trauma.

At its core, the Lenegewa model is an innovative synthesis of AI-enabled digital tools, task-shared clinical care, embedded psychiatric oversight, social work integration, and vocational empowerment. ClarityConnect, used for standardized screening, automated risk stratification, and measurement-based monitoring, enabled early identification of high-risk participants and more strategic allocation of scarce clinical resources. The physician–coach model, operating under psychiatric supervision, extended the reach of mental health services in a setting with critically limited specialist availability. Together, these components formed a coherent "Intelligent Rehabilitation System" capable of responding dynamically to participant needs while maintaining clinical rigor.

The study findings indicate that sustained engagement was associated with meaningful improvements in depressive symptoms, anxiety, trauma-related distress, and early indicators of substance use recovery. These outcomes are particularly noteworthy given the cohort's high burden of adverse childhood experiences, ongoing psychosocial instability, and limited prior access to mental health care. The observed improvements underscore the potential of contextually tailored, trauma-informed interventions to promote recovery even among populations facing extreme adversity.

At the same time, the cohort's experiences highlight critical challenges that demand ongoing vigilance. Treatment resistance and inconsistent engagement—shaped by cultural stigma, somatic expression of distress, religious coping practices, neurobiological dysregulation, and behavioral volatility—tempered outcomes for a subset of participants. Cultural explanatory models, including beliefs about the evil eye or spiritual affliction, significantly influenced how distress was expressed and initially managed. Rather than treating these dynamics as barriers to be eliminated, the program treated them as realities requiring thoughtful clinical navigation, cultural humility, and adaptive care strategies.

Importantly, these challenges directly informed iterative refinements to the program for subsequent cohorts. Planned modifications include stronger early psychoeducation on trauma and mental health, deeper and more structured integration of culturally meaningful healing practices, enhanced interdisciplinary coordination among clinical, social work, and vocational teams, and more robust crisis management and escalation protocols. These adaptations reflect a learning health system approach in which data, clinical experience, and cultural insight continuously inform program evolution.

The Lenegewa experience underscores a central principle in global mental health: effective care emerges at the intersection of scientific rigor and cultural humility. The model's success did not lie in importing a one-size-fits-all intervention but in co-creating and refining an approach that resonates with local realities—acknowledging spiritual traditions, leveraging community strengths, and applying advanced digital tools to address context-specific challenges. This philosophy aligns with broader movements in global mental health that advocate for interventions designed, tested, and adapted within the settings where they are deployed, rather than transferred wholesale from high-income contexts [30].

As the program prepares to scale to larger cohorts—potentially serving thousands of women—the challenge will be to maintain quality, personalization, and ethical care at scale. Planned

investments in enhanced training, AI-enabled digital innovations, predictive analytics, and strengthened community partnerships are intended to meet this challenge. If these strategies prove effective, the Lenegewa model could serve as a blueprint for expanding trauma-informed mental health and rehabilitation services across similar low-resource settings, where the burden of trauma is high and specialist care is scarce.

By contributing to the growing evidence base on integrated, culturally responsive mental health care in the Global South, this programmatic outcomes and implementation study reinforces a critical conclusion: comprehensive trauma-informed care is not only feasible in low-resource settings—it is essential. The journey of the 413 women in this cohort shows that recovery remains possible even after profound adversity. With sustained support, respectful engagement, and innovative use of technology, survivors can rebuild their lives, reclaim dignity, and chart pathways toward stability, purpose, and hope.

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Author Contributions statement

Alemu conceptualized the study, led the overall research design, and directed manuscript preparation. Ohiomoba contributed to the development of data systems, AI methodology, data analysis, and digital platform integration. Asfaha and Teklemariam served as direct clinical service providers and contributed to manuscript preparation, including developing clinical vignettes and interpreting frontline clinical observations. Amare led the initial initiative to establish and coordinate mental health services at Lenegewa and provided targeted training to physicians in trauma-informed mental health and psychosocial care. Negussie provided psychiatric oversight and clinical supervision, contributing to diagnostic formulation and interpretation of clinical outcomes. Neger and Fekadu contributed through a critical review of the manuscript and by providing key intellectual and clinical feedback that strengthened the final submission. Balatel contributed to the development of ClarityConnect's backend architecture and led enhancements to the platform's data management and analytics systems. Degefu, Abdi, and Ibrahim contributed to data collection and direct services. Kaleb served as the lead project manager for the AYA team at Lenegewa. All authors reviewed and approved the final manuscript and agree to be accountable for all aspects of the work.

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Appendices

Appendix A. ClarityConnect AI-Enabled Digital Workflow and Data Capture

ClarityConnect is an AI-enabled, end-to-end digital platform that supports intake, screening, risk stratification, clinical documentation, referral routing, scheduling, follow-up, and outcomes monitoring throughout the three-month residential rehabilitation and job training program. During screening, the platform captures standardized symptom measures (PHQ-9, GAD-7, CAGE-AID, SDS, ACE) and a brief 30-second voice sample to develop and validate voice-based AI models. Once fully validated and integrated into the workflow, the platform's voice AI and LLM capabilities are intended to estimate psychiatric severity in real time and provide decision support (e.g., alerts, triage, suggested follow-up actions) for Physician-Coaches and the multidisciplinary care team.

A.1 Intake-to-Discharge Workflow (High-Level)

- Intake and consent → identity registration, baseline demographics, referral source, and safety screening.
- Baseline screening (minimum required at least twice per stay) → PHQ-9, GAD-7, ACE, CAGE-AID, SDS; 30-second voice sample.
- Automated risk stratification → low/moderate/high risk; ACE ≥ 4 flagged as high risk; suicide ideation triggers immediate review.
- Clinical routing → psychiatry referral, medical center referral, SUD/detox referral, social work case management assignment.
- Care plan generation → individualized treatment plan and vocational track plan; scheduled follow-ups.
- Service delivery tracking → attendance for individual therapy, group therapy, medical visits, social work sessions, vocational training.
- Mid-program re-screening → repeated measures and updated risk score for high-risk patients, escalation protocol if worsening symptoms.
- Discharge planning → re-administration of screening tools, relapse prevention, safety plan, reintegration plan, employment/skills pathway, follow-up scheduling.
- Aftercare follow-up (yet to be implemented) → periodic check-ins, symptom monitoring, linkage to community resources.

A.2 Core Data Elements (Minimum Dataset)

Domain	Example Variables	Primary Uses
Identity & Enrollment	Participant ID; cohort; admission date; discharge date	Cohort tracking; retention; service planning
Screening & Risk	PHQ-9; GAD-7; ACE; CAGE-AID; SDS; suicide ideation item	Triage; escalation; monitoring
Voice & AI (R&D)	30-second voice sample metadata; consent flags; model version (2025 to 2026)	AI development; quality control; governance
Clinical Services	Individual therapy sessions; group therapy attendance; psychiatry visits; meds	Measurement-based care; utilization; outcomes
SUD Services	Detox episodes; relapse events; toxicology screens (if used)	Risk management; relapse prevention
Social Work	Case management sessions; reintegration plan; legal/social referrals	Continuity; stability; discharge success
Vocational	Track assigned; attendance; skill milestones; job placement readiness	Economic empowerment outcomes
Safety Events	Suicide attempts; self-harm; violence; hospitalization	Quality/safety improvement; IRB reporting

Appendix B. Measurement-Based Care Schedule and Thresholds

Screening occurs at intake and at least once mid-program (at least twice during a three-month stay). Additional screening is triggered by clinical concern, relapse, or safety events. An ACE score of 4 or higher is considered high risk. Symptom thresholds guide immediate follow-up, enhanced monitoring, and referral routing.

Measure	When Administered	Example Thresholds	Action
PHQ-9	Intake at admission and end of the program	Moderate–severe score; ideation item endorsement	Same-day review; safety plan; psychiatry referral
GAD-7	Intake at admission and end of the program	Moderate–severe score	Skills group; therapy intensity increase; meds review
ACE	Intake at admission and end of the program	ACE ≥ 4 high risk	Prioritize trauma-focused therapy; social work plan
CAGE-AID/SDS	Intake at admission and end of the program	Positive screens; severe dependence indicators	Detox routing; relapse plan; SUD group
Voice sample (30 sec)	Intake (and optional repeat)	Quality checks (noise, duration)	AI training set inclusion: re-collection if needed

Appendix C. Cultural, Ethical, and Clinical Considerations in the Management of Psychogenic Nonepileptic Seizures (PNES)

Domain	Key Considerations	Application in the Lenegewa Program
Clinical Identification	PNES differentiated from epilepsy through medical evaluation, absence of epileptiform activity, lack of postictal confusion, and emotional or interpersonal triggers	All seizure-like episodes were medically assessed prior to clinical formulation; psychogenic etiology guided trauma-informed intervention
Trauma Mechanisms	PNES conceptualized as somatic expression of unresolved trauma, dissociation, and dysregulated stress response	Treatment emphasized stabilization, affect regulation, and trauma-focused psychotherapy rather than symptom suppression
Cultural Explanatory Models	Symptoms often interpreted through beliefs in the evil eye (*buda*) or spirit possession, rooted in pre-Abrahamic indigenous cosmologies	Cultural meanings were acknowledged to support engagement and therapeutic alliance
Ethical Boundaries	Cultural sensitivity balanced with clinical responsibility; harmful or avoidant interpretations not uncritically reinforced	Providers intervened when beliefs delayed care, increased risk, or contributed to functional impairment
Religious Practices	Faith-based practices may serve as coping mechanisms but can also delay evidence-based treatment	Spiritual practices (e.g., prayer, holy water) were reframed as complementary, not substitutes, for clinical care
Risk of Exploitation	Individuals with trauma and mental illness are vulnerable to coercive or exploitative religious practices	Social work and clinical teams monitored for coercion, financial exploitation, and treatment avoidance
Clinical Response Protocol	Immediate medical assessment followed by grounding, psychoeducation, and trauma processing	Standardized response reduced stigma and prevented unnecessary medicalization or spiritualization
Integrated Care Approach	Effective PNES management requires mind–body–culture integration	Combined clinical treatment, cultural validation, psychoeducation, and ethical vigilance
Clinical Outcome	Improved insight and symptom reduction over time	Many participants reinterpreted symptoms as trauma-related while retaining spiritual identity

Appendix D. Group Therapy Model

Group therapy is delivered as a structured component of the treatment model, complementing individual therapy and supporting the residential milieu through peer support and skill-building.

Module	Example Content
Stabilization & Safety	Grounding skills; emotion regulation; sleep; crisis planning; coping strategies
Trauma Psychoeducation	Understanding trauma responses; normalization; triggers; body–mind connections
Relapse Prevention	Craving management; refusal skills; high-risk situations; recovery supports
Interpersonal Skills	Boundaries; communication; conflict resolution; healthy relationships
Empowerment & Future Planning	Self-efficacy; vocational identity; values clarification; reintegration planning

Appendix E. Individual Therapy Framework

Domain	Description	Implementation at Lenegewa
Therapeutic Modality	Trauma-focused, evidence-based individual psychotherapy	Primarily Trauma-Focused Cognitive Behavioral Therapy (TF-CBT), with supportive and skills-based interventions as indicated
Target Population	Women with histories of complex trauma, PTSD symptoms, dissociation, mood disorders, and comorbid substance use	All participants receive individual therapy; intensity adjusted based on risk stratification
Provider Type	Physician-Coaches under psychiatric supervision	Therapy delivered by trained Physician-Coaches with regular case review and supervision by psychiatrists
Session Frequency	Regular, scheduled sessions across the 3-month residential program	Typically weekly or more frequently for high-risk participants
Core Treatment Targets	Emotional regulation, trauma processing, cognitive restructuring, safety, and stabilization	Focus on reducing PTSD symptoms, depression, anxiety, dissociation, and behavioral dysregulation
Integration With Screening	Measurement-based care using standardized tools	PHQ-9, GAD-7, ACE, CAGE-AID, SDS, and repeat screening to guide treatment adjustments
Crisis Management	Immediate response to high-risk presentations	Acute escalation to psychiatry for suicidality, severe dissociation, or decompensation
Cultural Responsiveness	Respect for cultural and spiritual meaning-making	Cultural beliefs acknowledged; therapy reframed to coexist with faith-based coping when appropriate
Coordination With Social Work	Integrated case management and psychosocial support	Social workers address housing, family systems, legal issues, and reintegration barriers
Outcome Monitoring	Symptom change and engagement tracked over time	Reduction in symptom severity and improved emotional regulation observed in engaged participants

Appendix F. Social Work Integration Framework

Social work is essential to rehabilitation success, supporting stabilization, continuity, and reintegration. Social workers coordinate case management, safety planning, family engagement as appropriate, community linkages, legal and social service navigation, and discharge readiness.

Key social work functions include:

- Case management and psychosocial needs assessment at intake.
- Individualized reintegration plan: housing, safety, family/community supports.
- Linkage to legal aid, protection services, and social welfare benefits where available.
- Coordination with vocational trainers to address barriers to participation (e.g., childcare, health issues).
- Discharge planning and follow-up coordination to reduce relapse and re-trafficking risk.

Appendix G. AI Development, Governance, and Safety (Implementation Summary)

ClarityConnect's AI roadmap includes (a) voice-based severity estimation from brief voice samples and (b) LLM-enabled workflow support for providers. AI outputs are intended to support—rather than replace—clinical judgment. The center's leadership and the SPHMMC IRB oversee ethical implementation, data governance, and safety monitoring.

Domain	Planned Safeguards	Operationalization
Consent & Privacy	Explicit consent for voice capture; de-identification; role-based access	Consent workflow embedded in intake; audit logs
Model Validation	Holdout testing; bias checks; error monitoring	Prospective validation before clinical decision support
Human-in-the-Loop	Provider review before action; override capability	Alerts require clinician acknowledgment
Safety Events	Escalation protocols; adverse event reporting	Integrated incident workflow; quality review meetings
Cultural Fit	Human-centered design; language and context tailoring	Iterative feedback cycles with Lenegewa team