

GESTAR: An Integrated Telehealth Platform for Obstetric Risk Stratification, e-Learning, and Health Information Management

Rodrigo Lima¹, Tarcísio Lima Ferreira², Marcelo Costa Oliveira²,
Davy de Medeiros Baia², Pedro Pimentel³, Baldoino Fonseca², Marcio Ribeiro²

¹Universidade Federal de Pernambuco (UFPE) – Recife, PE – Brazil

²Universidade Federal de Alagoas (UFAL) – Maceió, AL – Brazil

³Universidade Federal Fluminense (UFF) – Niterói, RJ – Brazil

rsl@cin.ufpe.br, {tlf,oliveiramc,baldoino,marcio}@ic.ufal.br,

davy.baia@penedo.ufal.br, parp@easy.ufal.br

Abstract. *Maternal mortality remains a major challenge in Brazil's Northeast Region due to fragmented care pathways, socioeconomic constraints, and limited access to specialists. This paper presents GESTAR, a telehealth platform deployed in Alagoas. The system integrates: (i) obstetric risk stratification (SESAU/AL protocol NT15/2025; 73 factors), automatically generating the risk classification and a referral package ready to be routed through the state regulation workflow; (ii) telementoring and continuing education for healthcare professionals; and (iii) clinical decision support through automated, guideline-based care pathway recommendations. Built on a microservices architecture (Python/FastAPI, Next.js), the platform implements AES-256 encryption and automated report generation.*

Resumo. *A mortalidade materna continua sendo um desafio na região Nordeste do Brasil devido ao cuidado fragmentado, condições socioeconômicas e ao acesso limitado a especialistas. Este artigo apresenta o GESTAR, uma plataforma de tele saúde implementada em Alagoas. O sistema integra: (i) estratificação de risco obstétrico (protocolo SESAU/AL NT15/2025; 73 fatores), gerando automaticamente a classificação de risco e um encaminhamento pronto para a regulação estadual; (ii) teleducação para profissionais; e (iii) suporte à decisão clínica por meio de recomendações de linhas de cuidado automatizadas. Desenvolvido com arquitetura de microsserviços (Python/FastAPI, Next.js), conta com criptografia AES-256 e geração automatizada de relatórios.*

1. Introduction

Maternal and infant mortality remain critical public health concerns, especially in low- and middle-income settings. In Brazil, despite advances through the Unified Health System (SUS), regional disparities persist: the Northeast concentrates the highest maternal mortality ratios, reflecting structural inequalities in access to specialized obstetric care [Ministério da Saúde 2022]. In Alagoas, the Maternal Mortality Ratio reached 65.58 per 100,000 live births in 2022, exceeding both the national average of 53.3 and the UN Sustainable Development Goals target of 30 [DATASUS 2023]. Contributing factors include

the concentration of high-complexity services in the capital, limited availability of trained professionals in rural areas, fragmented health information systems, and deficiencies in continuing education of primary-care professionals—together producing inadequate risk screening, delayed referrals, and insufficient monitoring of high-risk pregnancies [Leal et al. 2021].

Telehealth bridges geographical barriers and strengthens healthcare delivery in underserved regions [Caetano et al. 2020], and recent advances in artificial intelligence and clinical decision support systems (CDSS) have shown significant potential to improve diagnosis, risk prediction, and clinical workflows [Esteva et al. 2019, Berner and La Lande 2016]. Yet prenatal care in many Brazilian municipalities still relies on paper-based risk-screening instruments, which limit data traceability, hinder timely referrals, and complicate epidemiological surveillance. Effective telehealth implementation thus requires integrated solutions addressing clinical decision support, professional education, and health information management together.

This paper presents GESTAR, an integrated telehealth platform designed around three complementary pillars: (i) a health information system for obstetric risk stratification, (ii) a telementoring and continuing education module for healthcare professional training, and (iii) clinical decision support through guideline-based care pathways and automated recommendations. The main contributions of this work include integrating these three dimensions into a unified platform and implementing a scoring-based risk stratification system derived from official clinical protocols. Accordingly, this work is framed as a technological development study with preliminary deployment evaluation, guided by the following research question: *how can an integrated telehealth platform support obstetric risk stratification, continuing education, and clinical decision support in municipalities with limited access to specialists?*

2. GESTAR Platform

The project was submitted to the UFAL Research Ethics Committee and is currently under final ethical review; deployment in the seven municipalities follows institutional service-evaluation guidelines.

Decision support improves adherence to evidence-based protocols and reduces variability [Berner and La Lande 2016], and structured e-learning yields measurable knowledge gains among professionals [Cook et al. 2008, George et al. 2014]. Brazilian maternal-health telehealth efforts typically operate as isolated services without integrating risk screening, referral, and education in one workflow [Harzheim et al. 2016, Marcolino et al. 2018, Oliveira et al. 2019]. GESTAR combines rule-based stratification, care pathways, and education within a single platform aligned with an officially endorsed state protocol.

GESTAR is developed through a collaboration of clinical expertise, academic research, and public health management. Key stakeholders span three groups: executing agencies (NTS-AL as lead developer; MS and SESAU/AL as governance/funding), healthcare providers (a technical core of ~32 developers and high-risk obstetricians, plus professionals and managers in UBS across seven municipalities), and target beneficiaries (pregnant women, postpartum patients, and infants in the neonatal and first-year periods).

The GESTAR platform was developed using an agile Scrum-based approach

[Schwaber and Sutherland 2017], with requirements elicited through interviews and workflow observations involving health professionals to ensure clinical relevance. Functionally, the tool enables risk stratification based on standardized protocols, tele-triage via specialized forms, and continuous telemonitoring for obstetric care. It supports professional collaboration through tele-consultations and provides managers with interactive dashboards for decision-making. Non-functional priorities include strict Brazilian General Data Protection Law (LGPD) compliance for data privacy, a responsive web/mobile interface for accessibility, and high availability to support real-time communication between primary care and specialized teams.

2.1. Architecture

The platform follows a client-server architecture with clear separation between the backend services and the frontend application. Figure 1 shows the complete architecture of the platform.

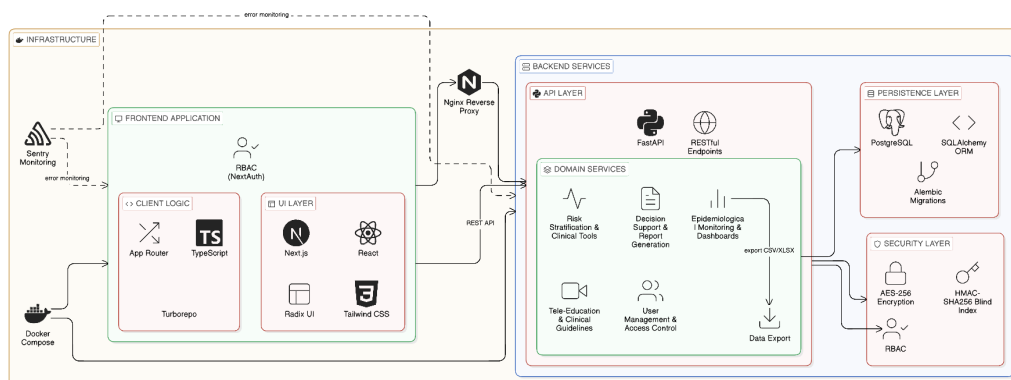


Figure 1. System architecture of the GESTAR platform

The system's backend is powered by Python 3.11 with FastAPI and PostgreSQL, utilizing SQLAlchemy and Alembic for robust data persistence and migrations. Its modular RESTful architecture prioritizes security through AES-256 encryption and HMAC-SHA256 blind indexes for LGPD-compliant data handling. On the client side, a TypeScript 5.8 monorepo integrates Next.js 15, React 19, and Tailwind CSS, featuring a five-level RBAC model via NextAuth for granular access control. The entire infrastructure is containerized with Docker, using Nginx and Sentry for orchestration and monitoring. This stack enables a high-performance clinical workflow, integrating risk classification algorithms and standardized reporting directly into the healthcare environment.

2.2. Main Features

Obstetric Risk Stratification and Clinical Tools: An automated stratification system based on SESAU/AL NT15/2025 implements 73 risk factors across five categories (socio-environmental, nutritional, obstetric history, pre-existing conditions, current pregnancy). Each factor is weighted 1–10 points; a three-tier classification follows:

- **Habitual Risk (0–4 points):** Standard primary care follow-up.
- **Intermediate Risk (5–9 points):** Primary care with multidisciplinary support.
- **High Risk (≥ 10 points):** Immediate referral to specialized services.

A gestational-age calculator (Robinson & Fleming [de la Fuente-Diez et al. 2021]) and pre-eclampsia screening complement the stratification, ensuring evidence-based, standardized assessment across municipalities. Figure 2 shows the risk-assessment form interface with dynamic factor selection.

Figure 2. Risk stratification form interface showing patient data fields and dynamic risk factor selection organized by clinical categories.

The stratification is rule-based: factor weights, score thresholds, and care-pathway recommendations are deterministic mappings from NT15/2025 rather than learned from data, favoring interpretability and auditability; data-driven AI components are discussed as future work. The rules and recommendations were validated for clinical consistency by a senior obstetrician specialized in high-risk pregnancy care (≥ 15 years of experience), through iterative cross-checking against NT15/2025.

Decision Support and Report Generation: After assessment, the system generates care recommendations and links each patient to clinical guidelines. PDF reports include color-coded risk levels, emergency referral guidelines (e.g., magnesium sulfate dosing for eclampsia), and pre-filled referral forms for high-risk cases. Each consultation receives a UUID and QR code for secure sharing without disclosing identifiable data.

e-Learning and Care Lines: The integrated e-Learning Module delivers context-sensitive video training (gestational anemia, diabetes, hypertensive diseases) directly inside the clinical workflow, complemented by Structured Care Lines—dynamic guidelines bridging risk identification and standardized conduct.

Epidemiological Monitoring and Management: For public health governance, GESTAR provides role-specific interactive dashboards that deliver real-time statistics on registered patients, risk distribution, and geographical trends across municipalities. Figure 3 shows the dashboard view from the administrator’s perspective.

The system supports data-driven management, identifying high-risk concentrations and monitoring professional performance. Data export (CSV/XLSX) enables further

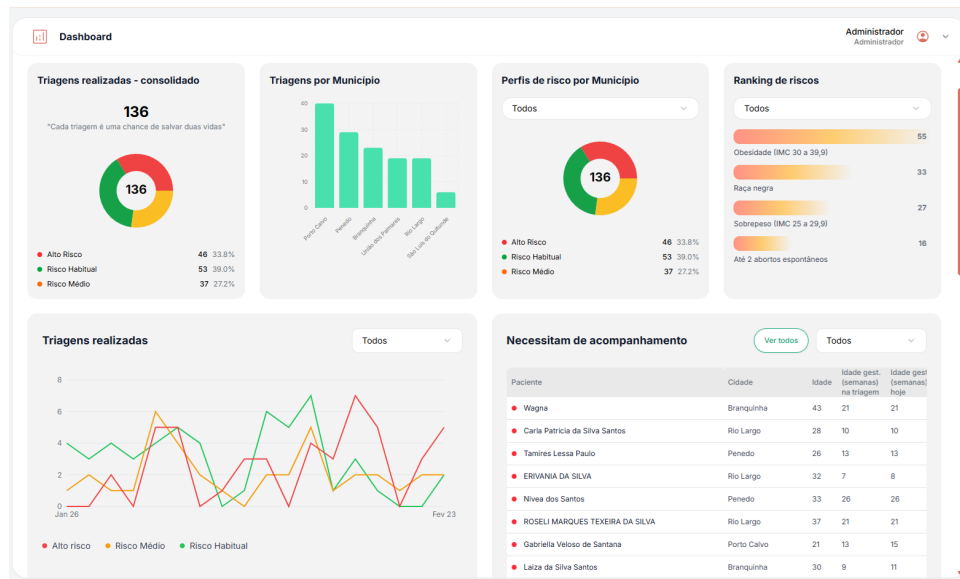


Figure 3. Administrator dashboard showing consolidated statistics, risk distribution by classification level, and geographical analysis across municipalities.

analysis under strict LGPD compliance (AES-256 encryption, RBAC scoped to health units).

Tests and Demonstration: A comprehensive suite (Pytest/Jest unit + integration tests) validates the risk algorithm, data logic, and RESTful-PostgreSQL interactions. Demonstration videos¹ cover patient registration, risk stratification, recommendation generation, and tele-education.

3. Preliminary Results

These preliminary results reflect GESTAR’s early prenatal triage scope: only pregnancies registered by 13 weeks and 6 days of gestation are eligible; cases identified after this cutoff follow routine municipal workflows.

GESTAR has been deployed across seven municipalities in Alagoas: Branquinha, Colônia Leopoldina, Penedo, Porto Calvo, Rio Largo, União dos Palmares, and São Luís do Quitunde. Between October 2025 and February 2026, the system recorded 354 risk-stratification consultations: 120 High Risk (33.9%), 91 Medium Risk (25.7%), and 143 Usual Risk (40.4%). The nearly 60% prevalence of High and Medium Risk cases highlights the platform’s role in standardizing stratification, enabling early identification of high-risk pregnancies that might otherwise go undetected, and supporting prioritized interventions and rigorous follow-up.

4. Conclusion and Future Works

GESTAR integrates standardized risk stratification, e-Learning, and health management for maternal care in Alagoas, offering traceable dashboard-level visibility over risk distribution and referral status compared with prior paper-based screening. Future work targets (i) RNDS/e-SUS AB/SISPRENATAL integration; (ii) outcome metrics (referral lead

¹<https://youtu.be/EE7ImAUlpn0>

time, time-to-specialist, late high-risk identification) for before/after comparison; and (iii) machine-learning components on top of the rule-based core, preserving auditability. The authors gratefully acknowledge DESD/SEIDIGI/MS for the financial support provided to this project.

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