GESTAR: A Telehealth Platform for High-Risk Pregnancy Triage and Longitudinal Follow-up

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Abstract. *Maternal mortality remains a challenge in Northeast Brazil due to fragmented care and limited access to specialists. This paper presents GESTAR, a telehealth platform deployed in Alagoas. The system integrates: (i) obstetric risk stratification based on an official state clinical protocol with 73 evidence-based factors; (ii) telementoring and continuing education for professionals; and (iii) clinical decision support via guideline-based care pathways and automated recommendations. Built on a microservices architecture (Python/FastAPI, Next.js), it features AES-256 encryption and automated PDF reports. Results from seven municipalities show 354 risk assessments, proving the platform's viability for prenatal care coordination in underserved regions.*

Resumo. *A mortalidade materna continua sendo um desafio no Nordeste do Brasil devido ao cuidado fragmentado e ao acesso limitado a especialistas. Este artigo apresenta o GESTAR, uma plataforma de telessaúde implementada em Alagoas. O sistema integra: (i) estratificação de risco obstétrico baseada em protocolo clínico estadual oficial com 73 fatores baseados em evidências; (ii) telementoria e educação continuada para profissionais; e (iii) suporte à decisão clínica por meio de linhas de cuidado e recomendações automatizadas. Desenvolvido com arquitetura de microsserviços (Python/FastAPI, Next.js), conta com criptografia AES-256 e geração automatizada de relatórios em PDF. Resultados de sete municípios mostram 354 avaliações de risco, comprovando a viabilidade da plataforma para a coordenação do cuidado pré-natal em regiões com menor acesso a serviços especializados.*

1. Introduction

Despite advances through the Brazilian Unified Health System (SUS), regional disparities persist: the Northeast concentrates the highest maternal mortality ratios [Ministério da Saúde 2022]. Alagoas reported a Maternal Mortality Ratio of 65.58 per 100,000 live births in 2022, exceeding the national average of 53.3 and the UN SDG target of 30 [DATASUS 2023]. Contributing factors include high-complexity service concentration in the capital and fragmented health information systems. Telehealth helps

bridge these gaps [Caetano et al. 2020], but effective implementation requires integrated solutions addressing clinical decision support, professional education, and health information management simultaneously.

This paper presents GESTAR[1][2], 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. Key stakeholders include state and municipal health managers, primary care physicians and nurses, and obstetric specialists. Its main contributions are the integration of these dimensions into a unified platform, the implementation of a scoring-based risk stratification derived from official clinical protocols, and preliminary real-world deployment results. 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. Background and Related Work

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

Brazil has expanded telehealth through the *Programa Telessaude Brasil Redes* [Harzheim et al. 2016], but maternal-health initiatives typically operate as isolated services without integrating risk stratification, referral, and education [Marcolino et al. 2018, Oliveira et al. 2019]. Risk stratification in prenatal care evaluates clinical, sociodemographic, and obstetric factors [Domingues et al. 2015]; in many municipalities it still relies on paper-based instruments, limiting auditability and aggregation for epidemiological surveillance. Digital solutions include rule-based clinical decision support [Berner and La Lande 2016] and e-learning yielding measurable knowledge gains for professionals [Cook et al. 2008, George et al. 2014]. Integrated platforms combining risk scoring, care recommendations, and education within a single clinical workflow remain scarce, motivating GESTAR's design.

3. Platform Architecture and Design

GESTAR adopts a client-server architecture with a layered, service-oriented backend and a single-page frontend, developed under the Scrum framework [Schwaber and Sutherland 2017], with requirements elicited through interviews and workshops with healthcare professionals and iterative prototyping validated by end users.

The backend uses Python 3.11 with FastAPI[3], PostgreSQL[4] with SQLAlchemy 2.0[5], and Alembic[6] for migrations. The RESTful API covers risk stratification, pati-

[1]Demo video: https://youtu.be/EE7ImAUlpn0

[2]For review purposes, the platform is available at https://homologacao.telessaude.easy.ufal.br/login (login: reviewer@easy.ufal.br / password: Telessaude123456!)

[3]FastAPI: `https://fastapi.tiangolo.com/`

[4]PostgreSQL: `https://www.postgresql.org/docs/`

[5]SQLAlchemy: `https://docs.sqlalchemy.org/`

[6]Alembic: `https://alembic.sqlalchemy.org/`

ent management, statistics, user management, course/video management, and care lines. Sensitive data is protected with AES-256 encryption and HMAC-SHA256 blind indexes, ensuring LGPD compliance [República Federativa do Brasil 2018]. The frontend is a Next.js 15[7]/React 19[8] monorepo (TypeScript 5.8, Radix UI, Tailwind CSS) implementing RBAC via NextAuth with five roles (ADMIN, ADMIN_PREFEITURA, ADMIN_MEDICO, MEDICO, USER). Key functional requirements: risk assessment with automated scoring, PDF report generation, role-based dashboards, and video course management; non-functional: AES-256, sub-second response, WCAG accessibility.

The platform is containerized with Docker Compose[9] (Nginx, Uvicorn, PostgreSQL) with health checks and persistent volumes; error monitoring uses Sentry[10]. Figure 1 shows the overall architecture.

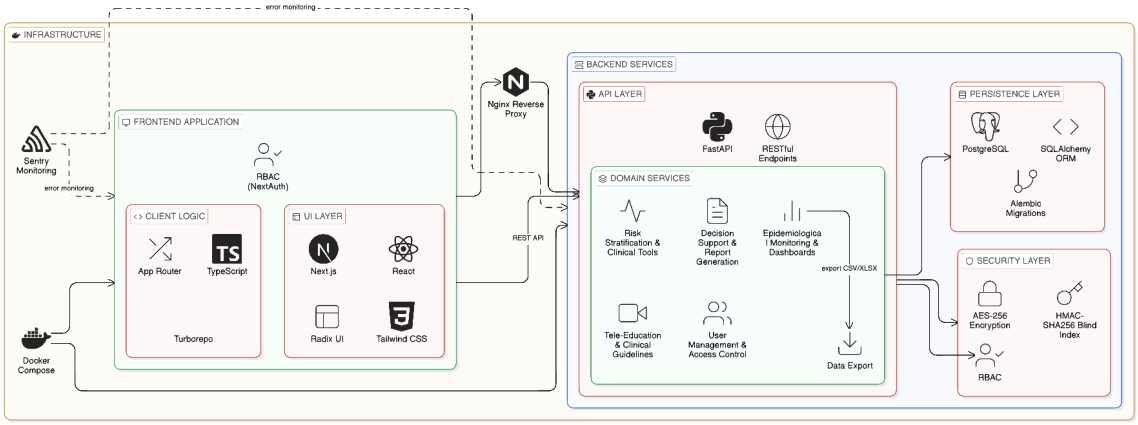

Figura 1. GESTAR platform architecture showing frontend, backend services, persistence and security layers, and infrastructure.

4. Obstetric Risk Stratification

The core clinical functionality implements obstetric risk stratification based on the Secretaria de Estado da Saúde de Alagoas (SESAU/AL) Technical Note 15/2025 (NT15/2025) [Secretaria de Estado da Saúde de Alagoas – SESAU/AL 2025].

4.1. Risk Factor Model and Classification

The system implements 73 risk factors across five categories (Table 1), each weighted 1–10 points by clinical severity (e.g., maternal age extremes, morbid obesity, stillbirth, cardiopathy, gestational hypertension, fetal malformations: 10 pts each).

Risk classification follows a three-tier model: **Habitual Risk** (0–4 pts) for standard primary care follow-up; **Intermediate Risk** (5–9 pts) for enhanced monitoring with multidisciplinary support; and **High Risk** ($\geq$10 pts) for immediate referral to specialized prenatal care. The healthcare professional registers patient data, collects clinical and biometric information, records laboratory results (e.g., hemoglobin, glucose, serology), selects applicable risk factors, and the system computes the score and generates

[7]Next.js: `https://nextjs.org/docs`
[8]React: `https://react.dev/`
[9]Docker: `https://docs.docker.com/`
[10]Sentry: `https://docs.sentry.io/`

Tabela 1. Risk factor categories and scoring ranges based on SESAU/AL NT15/2025.

Category	Factors	Points Range
Socio-environmental factors	4	1–10
Nutritional assessment	4	2–10
Obstetric history	16	2–10
Pre-existing clinical conditions	15	5–10
Current pregnancy risk factors	17	5–10
Total	**56**	–

care recommendations automatically[11]. The classification component is rule-based and deterministic: factor weights, score thresholds, and care-pathway recommendations are mapped directly from NT15/2025 rather than learned from data, favoring interpretability and auditability for managers and front-line professionals. The implemented rules and recommendations were reviewed and validated for clinical consistency by a senior obstetrician specialized in high-risk pregnancy care ($\geq$15 years of experience) through iterative cross-checking of factors, weights, thresholds, and generated recommendations against the source protocol; data-driven AI components are discussed as future work.

4.2. Report Generation

The system generates a PDF report aligned with state health standards: color-coded risk levels, emergency referral guidelines, and pre-filled referral forms for high-risk cases. Each consultation generates a UUID for secure sharing via QR codes[12]. GESTAR also includes a gestational-age calculator and pre-eclampsia screening; the prenatal triage scope covers pregnancies registered by 13 weeks 6 days, with later cases following routine municipal workflows.

5. e-Learning Module

The e-Learning module provides structured video-based content integrated within the clinical platform, organized hierarchically (courses $\rightarrow$ modules $\rightarrow$ videos) and aligned with risk categories[13]. Structured care lines link dynamically to risk results: upon classification, the system surfaces relevant care lines, bridging assessment and evidence-based guidelines.

6. Health Information Management

Role-specific dashboards[14] display statistics, geographical analysis, temporal trends, and performance metrics. CSV/XLSX export supports filters by municipality, date range, and risk level under LGPD compliance (AES-256, HMAC-SHA256 blind indexes, municipality-scoped RBAC).

[11] Risk form screenshot: https://drive.google.com/file/d/1ANhI4ttGnfO-LEy-J7sTdW2K6Y4JeqUj/view

[12] Result screen screenshot: https://drive.google.com/file/d/1nje62GH5RFQ0U4Xvwb2GjoqZWIws8NSW/view

[13] Courses interface screenshot: https://drive.google.com/file/d/104lYqeY6h-sk_gb9achGFGjmJRiLnc85/view

[14] Dashboard screenshot: https://drive.google.com/file/d/1AimahVpZ75JTde3ePu0tnZHO44oeMtV6/view

7. Preliminary Results

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, 354 risk-stratification consultations were recorded: 120 High Risk (33.9%), 91 Medium Risk (25.7%), and 143 Usual Risk (40.4%). High-risk patients are enrolled in longitudinal telemonitoring, where specialized obstetricians follow them from triage through the postpartum period—ensuring early identification translates into sustained care. The nearly 60% prevalence of High and Medium Risk cases underscores the platform's role in detecting pregnancies that might otherwise go unmonitored, enabling prioritized interventions and streamlined referrals.

8. Discussion, Lessons Learned, and Limitations

GESTAR addresses a gap in maternal-care telehealth by integrating clinical decision support, e-Learning, and health information management within one obstetric workflow [Berner and La Lande 2016, Cook et al. 2008]. Compared with the prior paper-based screening in the participating municipalities (hard to audit and aggregate), the scoring-based stratification standardizes assessment, and role-based dashboards add previously absent epidemiological visibility. Implementation quality is supported by automated tests covering $\sim$70% of backend modules (Pytest) and $\sim$60% of frontend components (Jest)—exercising the stratification algorithm, RBAC checks, and main API endpoints—monitored continuously in CI.

Lessons learned. (i) Early involvement of front-line professionals in elicitation and prototyping was essential to align clinical workflows with usable interfaces and surface forms-design issues before deployment. (ii) Adopting an officially endorsed state protocol (NT15/2025) facilitated institutional buy-in and reduced friction in negotiating the rule base, since validation referenced an existing normative document. (iii) Rural deployment exposed intermittent-connectivity scenarios, motivating offline-capable PDF reports and conservative use of network-bound features.

Limitations. Evaluation is preliminary: it reports usage volume and risk distribution but does not yet quantify clinical outcomes or formal usability metrics. The platform does not yet integrate with national systems (e-SUS AB, SISPRENATAL, RNDS), constraining interoperability. Classification is rule-based without ML, favoring auditability but potentially limiting sensitivity. Generalization beyond the seven Alagoas municipalities is not claimed, since protocol and context are state-specific.

9. Conclusion and Future Works

GESTAR integrates risk stratification, e-Learning, and health management for maternal care in Alagoas; SESAU/AL protocol automation reduces assessment subjectivity and provides decision support at the point of care, with preliminary deployment across seven municipalities (354 consultations) demonstrating viability for prenatal coordination in underserved regions. Future work targets (i) RNDS/e-SUS AB/SISPRENATAL integration; (ii) outcome metrics (referral lead time, time-to-specialist, late high-risk identification) for before/after comparison; (iii) usability and adoption studies (e.g., Semiotic Inspection Method, User Engagement Scale); and (iv) machine-learning 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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