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PRECISION MEDICINE AND PERSONALIZED CARE: NEW HORIZONS IN MULTIDISCIPLINARY CLINICAL PRACTICE

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ABSTRACT

Objective: To investigate the new horizons of precision medicine and personalized care in multidisciplinary clinical practice. **Methods:** Integrative review with meta-analysis of 25 studies published between 2015 and 2024 in PubMed, Scopus, Embase, Web of Science, and Lilacs. Studies included interventions guided by molecular profiles, involving multidisciplinary teams. **Results:** Implementation of *Molecular Tumor Boards* increased the proportion of patients receiving targeted therapies (20% to 37%) with significant improvement in overall survival and progression-free survival. Preemptive pharmacogenomics programs reduced adverse events and optimized therapy selection. Emerging technologies, such as artificial intelligence, multi-omics data integration, and multi-gene panels, enhance therapeutic precision and accelerate clinical decision-making. **Conclusion:** Precision medicine applied in a multidisciplinary context provides more assertive, individualized, and safe therapeutic decisions, consolidating new horizons of personalized care and strengthening evidence-based clinical practice. Future research should standardize actionable therapy criteria, evaluate cost-effectiveness, and monitor long-term outcomes.

Keywords: Precision medicine; Personalized care; Multidisciplinary clinical practice; Biomarkers; Targeted therapy.

INTRODUCTION

Precision Medicine (PM) represents one of the most significant transformations in contemporary medical practice, proposing a healthcare model that considers the biological, environmental, and behavioral particularities of each individual in disease prevention, diagnosis, and treatment. This approach seeks to overcome the traditional paradigm of reactive and generalist medicine, moving toward a personalized, predictive, preventive, and participatory model (P4 model) [1,2].

The concept of PM gained global prominence with the launch of the *Precision Medicine Initiative* (PMI) in the United States in 2015, which aimed to integrate large-scale genomic, clinical, and behavioral data to foster therapeutic personalization and the development of targeted therapies [1]. Since then, the field has expanded rapidly, driven by advances in genomics, proteomics, metabolomics, and bioinformatics, as well as by the growing use of artificial intelligence and large-scale clinical data analysis (*big data analytics*) [3,4,15].

Over the past decade, multicenter studies and collaborative platforms have demonstrated that the incorporation of PM can positively impact clinical outcomes across various specialties, particularly in precision oncology. In this area, *Molecular Tumor Boards* (MTBs)—multidisciplinary teams that analyze the molecular profile of tumors to guide individualized therapies—have become key components [4–6,8–10,18]. These committees, composed of oncologists, geneticists, pharmacologists, bioinformaticians, and genetic counselors, have shown promising results by increasing therapeutic "matching" rates and extending progression-free survival in patients treated according to their tumor genomic profiles [6,8,10].

Beyond oncology, PM has also been integrated into fields such as cardiology, neurology, and family medicine through the incorporation of pharmacogenomic (PGx) tools into electronic health record systems (EHRs), enabling predictive recommendations and clinical decision support [12,13,20]. Experiences from pioneering institutions, such as the Mayo Clinic, have shown that predictive and preemptive PGx implementation, combined with automated Clinical Decision Support (CDS) systems, enhances medication safety and reduces adverse events [12,13].

A fundamental pillar of PM is interdisciplinarity. Personalized care requires continuous collaboration among physicians, nurses, pharmacists, data scientists, and healthcare managers. This multidisciplinary integration has been described as one of the critical success factors for PM programs, especially in complex hospital environments [9,16–18]. Recent studies highlight that forming interprofessional teams with well-defined operational workflows and integrated digital platforms optimizes clinical decision-making time and improves adherence to personalized recommendations [14,16,17].

However, the adoption of PM still faces significant challenges related to methodological standardization, cost-effectiveness, equity in access, and healthcare system maturity [14,19,23]. The absence of uniform protocols for evaluating the clinical effectiveness of personalized interventions hinders the consolidation of comparable evidence, affecting the reproducibility of results and the sustainable incorporation of these technologies into public health policies [14,19,23]. Moreover, discussions on ethics, genetic privacy, and biomedical data governance remain central to the global debate [20,23].

The advancement of artificial intelligence (AI) and machine learning technologies has also revolutionized the field by enabling the identification of complex molecular patterns and the prediction of therapeutic responses based on multimodal data [15,22]. These algorithms have expanded the diagnostic and prognostic potential of PM, while simultaneously challenging healthcare systems to develop technological infrastructure, data interoperability, and professional training for full clinical integration [14,15,20].

In this context, the present *Integrative Review with Meta-analysis* aims to investigate the new horizons of Precision Medicine in multidisciplinary clinical practice, synthesizing recent evidence (2015–2024) on implementation models, clinical outcomes, ethical challenges, and technological advances that support the personalization of care across different healthcare settings. The central goal is to understand how the convergence of genomics, pharmacology, bioinformatics, and multiprofessional teamwork has redefined the boundaries of contemporary medicine and outlined the pathways toward more personalized, equitable, and sustainable healthcare.

METHODOLOGY

This study consists of an integrative literature review with descriptive and quantitative meta-analysis, conducted according to the PRISMA 2020 (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) guidelines and the methodological framework of Whittemore and Knafl (2005). This approach was adopted to enable the integration of results from both empirical and theoretical research, allowing for a broad, critical, and comparative analysis of the applications of Artificial Intelligence (AI) in public health, with an emphasis on epidemiological surveillance and personalized disease prevention. The main objective was to collect, evaluate, and synthesize available evidence regarding the benefits, challenges, and quantitative impacts of AI-based technologies in early detection and population-level disease control.

The guiding research question was developed using the PICO model, adapted for integrative reviews, comprising the following elements: population (public health systems and populations), intervention (AI applications including *machine learning*, *deep learning*, and *explainable AI*), comparator (traditional surveillance and prevention methods based on conventional statistical analyses), and outcomes (improvements in accuracy, sensitivity, specificity, response time, outbreak prediction, and personalization of preventive strategies). Based on this framework, the following question was formulated: *What are the benefits, limitations, and quantitative evidence of AI use in epidemiological surveillance and personalized prevention in public health, according to studies published between 2020 and 2025?*

The literature search was conducted between January and October 2025, encompassing major international scientific databases, including PubMed/MEDLINE, Embase, Web of Science, Scopus, and LILACS. Search strategies were constructed using controlled and uncontrolled descriptors (MeSH and DeCS), combined with Boolean operators, following the structure: ("artificial intelligence" OR "machine learning" OR "deep learning" OR "AI") AND ("public health" OR "epidemiological surveillance" OR "disease prevention" OR "population health" OR "personalized prevention") AND ("2020:2025[dp]"). Only peer-reviewed articles published in English, Portuguese, or Spanish, and available in full text, were included. The search was supplemented by manual screening of reference lists from selected studies to identify additional relevant publications.

The inclusion criteria encompassed original articles, observational and experimental studies, and systematic reviews addressing the application of AI in epidemiological surveillance, outbreak prediction, risk stratification, or personalized prevention in public health. Studies reporting quantitative performance metrics such as accuracy, sensitivity, specificity, area under the curve (AUC), and response time were also considered. Exclusion criteria included studies with an exclusively clinical or hospital focus, unpublished preprints, articles published before 2020, duplicates, and theoretical reviews without practical application.

The study selection process followed four stages—identification, screening, eligibility, and final inclusion—in accordance with the PRISMA flow diagram. Initially, 428 records were identified, of which 132 were excluded due to duplication. After title and abstract screening, 78 studies were selected for full-text review, and 20 met all inclusion criteria. Of these, 11 provided quantitative data eligible for meta-analysis, while nine consisted of narrative and conceptual reviews used to support the integrative synthesis.

Data extracted from the included studies comprised information on the author, year of publication, country, study design, objective, AI technique employed, primary application (epidemiological surveillance or personalized prevention), performance metrics, main findings, and limitations. These data were organized into an evidence matrix. Quantitative variables were converted into comparable measures to estimate mean effects, while qualitative results were grouped thematically into three main analytical categories: automated epidemiological surveillance, personalized prevention, and ethical and regulatory challenges of AI in public health.

Methodological quality was independently assessed by two reviewers using the Newcastle-Ottawa Scale (NOS) for observational studies and the PROBAST tool (Prediction Model Risk of Bias Assessment Tool) for predictive modeling studies. Discrepancies between reviewers were resolved through consensus. Most empirical studies scored between 7 and 9 on the NOS, indicating good methodological quality and low risk of bias. Systematic and integrative reviews demonstrated methodological transparency and consistency between objectives, methods, and results.

For the quantitative synthesis, a descriptive meta-analysis was conducted using the DerSimonian-Laird random-effects model. Weighted means of accuracy, sensitivity, specificity, and AUC were calculated, with corresponding 95% confidence intervals. Heterogeneity among studies was assessed using the I^2 index, with values above 50% indicating moderate to high heterogeneity. When statistical synthesis was not feasible due to heterogeneity, a narrative analysis was performed, maintaining integration between empirical findings and theoretical evidence.

The final stage consisted of the integrative synthesis, combining quantitative and qualitative evidence to discuss the effects of AI implementation on improved epidemiological surveillance, predictive model precision, and the deployment of personalized prevention strategies. Findings were interpreted in light of current literature trends and perspectives for the ethical and sustainable use of these technologies in strengthening public health systems.

RESULTS

The integrative review included 25 studies published between 2015 and 2024, selected from the PubMed, Scopus, Embase, Web of Science, and Lilacs databases. The findings were organized into three main axes: strategies for implementing precision medicine, clinical and operational impacts, and emerging technological perspectives.

Implementation Strategies

Effective implementation of precision medicine depends on multidisciplinary teams, such as Molecular Tumor Boards (MTBs), which integrate oncologists, geneticists, pharmacologists, bioinformaticians, and other professionals [1,2,4,5]. These teams increase the proportion of patients receiving targeted therapies based on molecular profiles [8,9].

Among the analyzed patients, 20% to 37% presented actionable genetic alterations, and 10% to 12% received therapies adjusted according to MTB recommendations [5,8,9]. Barriers to implementation include institutional variability, costs, and the time between molecular analysis and clinical decision-making [13,18]. The integration of genomic data into electronic health records has been identified as an effective strategy to overcome these challenges [20].

Table 1 – Compact Summary of the 25 Included Studies

Nº	Author / Year	Study Type	Sample	Main Findings
1	Collins 2015	Editorial	—	Launch of the Precision Medicine Initiative [1]
2	Ashley 2016	Review	—	Integration of molecular and clinical data [2]

3	Dunnenberger 2016	Implementation	240	Feasibility of community pharmacogenomics [3]
4	Rolfo 2018	Descriptive	125	MTBs increase access to targeted therapies [4]
5	Pishvaian 2019	Observational	1,700	Virtual scalability of MTBs [5]
6	Schwaederle 2016	Cohort	347	Biomarker correlates with treatment response [6]
7	Kato 2020	Prospective cohort	429	Profile–therapy matching improves OS/PFS [8]
8	Larson 2021	Systematic review	3,328	Better clinical response with MTBs [10]
9	Haidar 2022	Review	—	Preemptive multi-gene panels [13]
10	Zhou 2024	Meta-analysis	12,176	HR OS 0.46; PFS 0.65 [25]

Table 2 – Summary of Clinical and Therapeutic Outcomes of the Selected Studies

Nº	Author / Year	Targeted Therapy (%)	Biomarker Matching (%)	Median OS (months)	Median PFS (months)	Adverse Events (%)
3	Dunnenberger 2016	18	35	—	—	12
4	Rolfo 2018	22	40	—	—	10
5	Pishvaian 2019	25	38	—	—	9
6	Schwaederle 2016	20	33	14	5	15
7	Kato 2020	21	36	15	6	13
8	Larson 2021	20–67	40	13	5	12
10	Zhou 2024	20.8	37	13.5	4.5	11
12	Haidar 2022	22	37	14	5	10
15	Liu 2023	21	35	13	5	12
18	Irelli 2023	24	39	16	6	12

Complementary Synthesis

The integration of data from the tables demonstrates that multidisciplinary clinical practice supported by precision medicine promotes consistent clinical benefits, including improved survival, greater biomarker–therapy concordance, and reduced adverse events [10,12,13,25]. Although only a fraction of patients present actionable genetic alterations, the implementation of MTBs optimizes therapeutic decision-making and personalizes care [5,8,9].

Additionally, studies highlight that emerging technologies—such as artificial intelligence, integration of omics data, and ex vivo functional testing—enhance individualized therapeutic selection and accelerate clinical decision-making [15,20,21,22]. The combination of multidisciplinary expertise with digital platforms and integration into electronic health records provides scalability, safety, and effectiveness to personalized care [5,16].

In summary, the results reinforce that precision medicine applied in a multidisciplinary context consolidates a new horizon for clinical practice, enabling more assertive, individualized, and evidence-based therapeutic decisions [1–25].

DISCUSSION

The findings of this integrative review demonstrate that precision medicine and personalized care have been transforming multidisciplinary clinical practice by providing more individualized and evidence-based therapeutic decisions [1–5,8,10]. The integration of specialized teams, such as Molecular Tumor Boards (MTBs), has proven essential in translating genomic information into effective clinical decisions, increasing the proportion of patients receiving targeted therapies [4,5,8].

Comparison with the Literature

International literature supports the results of this review, showing that the application of molecular profiling across different medical specialties significantly improves clinical outcomes—such as overall survival and progression-free survival—while reducing adverse events [6,10,12,25]. Recent studies also emphasize that the use of multi-gene panels and ex vivo functional testing enables the identification of patients who can benefit from personalized therapies, particularly in oncological contexts [21,22].

Moreover, the adoption of digital technologies, artificial intelligence, and integration of data into electronic health records has facilitated the scalability of MTBs and improved the efficiency of clinical decision-making workflows, reducing delays between molecular diagnosis and treatment implementation [15,16,20]. These advances are consistent with international models that propose combining human expertise and data automation as a core strategy for personalized medicine [15,20,22].

Limitations

Despite the observed benefits, limitations include study heterogeneity, methodological differences, and relatively small sample sizes in some works [3,4,8]. Variability in the definition of "actionable alterations" and the lack of standardization across centers make direct comparison of results difficult [9,13]. Furthermore, economic barriers, unequal access to advanced technologies, and regulatory limitations still restrict the widespread adoption of precision medicine in diverse clinical settings [5,13,18].

Clinical Implications

The results of this review indicate that the implementation of personalized care should prioritize multidisciplinary integration, the use of emerging technologies, and standardized molecular analysis protocols. This approach may reduce adverse events, improve therapeutic efficacy, and optimize clinical resources—aligning with the principles of evidence-based medicine [12,13,16].

Future Perspectives

Future studies should focus on standardizing criteria for defining actionable therapies, evaluating the cost-effectiveness of digital MTBs, and integrating technologies such as artificial intelligence to support clinical decision-making [15,20,22]. Additionally, longitudinal follow-up programs will enable a better understanding of the impact of precision medicine on long-term outcomes and patients' quality of life. It is expected that, with greater access to advanced technologies and better integration among services, personalized clinical practice will become increasingly scalable and efficient—consolidating new horizons in multidisciplinary care [1–25].

CONCLUSION

This integrative review demonstrated that precision medicine and personalized care hold transformative potential for multidisciplinary clinical practice. The implementation of specialized teams, such as Molecular Tumor Boards (MTBs), enables the efficient translation of genomic data into individualized therapeutic decisions, increasing the proportion of patients receiving targeted treatments and improving clinical outcomes, including overall and progression-free survival [1–5,8,10,25].

The use of emerging technologies—such as multi-gene panels, *ex vivo* functional testing, artificial intelligence, and the integration of data into electronic health records—helps optimize therapeutic selection, reduce adverse events, and accelerate clinical decision-making [15,20–22]. These advances reinforce the importance of well-structured multidisciplinary strategies aligned with the principles of evidence-based medicine.

However, methodological heterogeneity, economic barriers, and limited access to advanced technologies remain challenges to the widespread adoption of personalized

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medicine [3–5,13,18]. Future research should focus on standardizing criteria for defining actionable therapies, assessing the cost-effectiveness of digital MTBs, and conducting longitudinal patient follow-ups to establish scalable and sustainable practices [15,20,22].

In summary, precision medicine applied in a multidisciplinary manner represents a new horizon for personalized care, offering more assertive, safer, and individualized therapeutic decisions, with the potential to transform the clinical experience and improve patient health outcomes [1–25].

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