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ARTÍCULO ORIGINAL

Pedagogical model for competency development in diagnosing cardiovascular hyperreactivity in pregnant women

Modelo pedagógico para la formación de competencias en el diagnóstico de hiperreactividad cardiovascular en gestantes

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ABSTRACT

Background: Cardiovascular hyperreactivity in pregnant women is significantly associated with an increased risk of complications.

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Objective: To design a pedagogical model for competency development in nursing for the diagnosis of cardiovascular hyperreactivity in pregnant women.
Methods: A quali-quantitative research study was conducted in the prenatal care, gynecology and obstetrics, family medicine, and obstetric intensive care services of the Ana Betancourt de Mora Gynecobstetric University Hospital in Camagüey province, between January and October 2025. Theoretical methods (analysis-synthesis, inductive-deductive, historical-logical); empirical methods (focus groups, survey, and Delphi method); and mathematical-statistical methods were used for data processing and analysis. The product was assessed by expert criteria.
Results: The diagnosis revealed that the most frequent gap was practical skill: 52 nurses (86.7%), which was significant ($p<0.001$). The Delphi method improved expert consensus regarding the dimensions. A model structured into four phases (40 hours) was validated: awareness (12.5%), theoretical-practical training (50.0%), guided application (25.0%), and evaluation (12.5%). The model's internal consistency was 0.88.
Conclusions: The designed pedagogical model represents a tool for strengthening diagnostic competencies in cardiovascular hyperreactivity in pregnant women for advanced practice nurses.
MeSH: nurse´s role; pregnancy; cardiovascular abnormalities; competency-based education; professional competence; education, medical

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RESUMEN

Fundamento: la hiperreactividad cardiovascular en gestantes se asocia de forma significativa con incremento del riesgo de complicaciones.
Objetivo: diseñar un modelo pedagógico para la formación de competencias en enfermería en el diagnóstico de hiperreactividad cardiovascular en gestantes.
Métodos: se realizó una investigación con enfoque cualicuantitativo en los servicios de atención prenatal, ginecología y obstetricia, medicina familiar y cuidados intensivos obstétricos del Hospital Universitario Ginecobstétrico Ana Betancourt de Mora, de la provincia Camagüey, entre enero-octubre 2025. Se emplearon métodos teóricos (análisis-síntesis, inductivo-deductivo e histórico-lógico); empíricos (grupos focales, encuesta y

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método Delphi); y matemático-estadísticos para el procesamiento y análisis de los datos. El producto fue valorado por criterios de expertos.

Resultados: el diagnóstico permitió constatar como la brecha más frecuente la habilidad práctica: 52 enfermeras, (86,7 %), lo cual resultó significativo (p< 0,001). El método Delphi permitió la mejora en el consenso de los expertos con respecto a las dimensiones. Se validó un modelo estructurado en cuatro fases (40 horas): sensibilización (12,5 %), formación teórico-práctica (50,0 %), aplicación guiada (25,0 %) y evaluación (12,5 %). La consistencia interna del modelo fue de 0,88.

Conclusiones: el modelo pedagógico diseñado representa una herramienta para el fortalecimiento de las competencias diagnósticas en hiperreactividad cardiovascular en gestantes para las enfermeras de práctica avanzada.

DeCS: rol de la enfermera; embarazo; anomalías cardiovasculares; educación basada en competencias; competencia profesional; educación médica

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INTRODUCTION

Cardiovascular hyperreactivity in pregnant women is a highly relevant clinical condition in maternal health; it is significantly associated with an increased risk of severe complications such as preeclampsia, preterm birth, and intrauterine growth restriction.[1,2] Its early and accurate detection represents a diagnostic challenge, where timely intervention makes substantial differences in perinatal outcomes.

In this scenario, advanced practice nursing emerges as a strategic actor capable of expanding its role towards specialized clinical assessment and diagnosis in at-risk populations;[3] however, the effective incorporation of competencies into clinical practice is

limited by the absence of contextualized training models that go beyond mere transfer of theoretical knowledge and achieve the development of real performance capabilities in healthcare settings.[4]

In contexts such as the Cuban health system, characterized by strengths in universal coverage but with persistent challenges in the early detection of cardiovascular alterations during pregnancy, the development of robust pedagogical tools to strengthen the diagnostic competencies of nursing professionals is necessary. This need is not satisfied by generic training programs or adaptations of models designed for high-income contexts; rather, it demands educational proposals conceived from and for the local reality, with an intentional and validated pedagogical design.[5]

This paper addresses how to effectively and contextually prepare advanced practice nurses in the diagnosis of cardiovascular hyperreactivity in pregnant women, to contribute to the substantive improvement of the quality of prenatal care.

To answer this question, the study's central objective is to design a pedagogical model for competency development in nursing for the diagnosis of cardiovascular hyperreactivity in pregnant women.

The model aims to become a replicable methodological reference for the development of advanced clinical competencies in maternal health within health systems with similar characteristics and challenges.

METHODS

The research was developed under a quali-quantitative approach in the prenatal care, gynecology and obstetrics, family medicine, and obstetric intensive care services of the Ana Betancourt de Mora Gynecobstetric University Hospital in Camagüey province, between January and October 2025. The universe consisted of 129 health professionals.

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The sample was selected through non-probabilistic purposive sampling, consisting of three groups:

- Diagnosis group: 60 nurses with a minimum of five years of experience in maternal care and performance in medium- or high-risk obstetric services.
- Model development group: 30 multidisciplinary professionals (advanced practice nursing, educators, cardiologists, and obstetric intensivists).
- Expert group: 30 professionals selected using the expert competence coefficient ($K \geq 0.8$), from the University of Medical Sciences of Camagüey and primary health care, with more than 10 years of experience and relevant academic and scientific categories.

The following theoretical methods were used for information:

- Analysis-synthesis: in the documentary review and integration of results obtained at different stages, allowing the decomposition of training contents and their recomposition into the pedagogical model.
- Inductive-deductive: in interpreting qualitative and quantitative data to infer generalizations from specific cases (induction) and validate hypotheses from established theoretical principles (deduction).
- Historical-logical: used to analyze the evolution of the competency-based approach in health training and justify the relevance of the proposed model in the historical-training context.

Empirical methods:

- Focus group: four sessions were held with 15 participants each, using validated semi-structured guides to explore knowledge, skills, and attitudes related to the diagnosis of cardiovascular hyperreactivity in pregnant women.
- Structured diagnostic survey: applied to the 60 nurses in the diagnosis group, with a validated questionnaire (Cronbach's Alpha = 0.89) to quantifiably assess diagnostic competence.

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- Delphi method: used in two rounds with a panel of 30 experts to validate the pedagogical model, using a 5-point Likert scale and determining consensus using the median (Me), interquartile range (IQR), and global concordance index (GCI ≥ 0.85).
- Mathematical-statistical methods:
- SPSS version 25.0 was used for quantitative data processing, applying descriptive analysis (frequencies, measures of central tendency) and inferential analysis (Chi-square test, Kruskal-Wallis test).
- For qualitative data, thematic content analysis was performed using three-cycle coding (open, axial, selective) supported by word processors and spreadsheets until theoretical saturation was achieved.

Ethical considerations

The study adhered to the principles of the Declaration of Helsinki. All participants signed an informed consent form guaranteeing confidentiality, anonymous use of information, and the right to withdraw without consequences. The protocol was approved by the Ethics Committee of the Ana Betancourt de Mora Gynecobstetric University Hospital in Camagüey.

RESULTS AND DISCUSSION

The sample had a balanced age distribution, with predominance of the 35-44 year age group in 32 nurses (53.3 %), as shown in Table 1. The age range was between 25 and 54 years, mean 38.7 ± 6.2 years, and Median (Me) 39 years. Regarding professional experience, nurses with 11 to 15 years of work predominated, range 5 to 25 years, mean 12.4 ± 4.8 years.

Statistically significant differences were identified in the distribution by area of performance: 40% in primary health care ($p=0.030$) and by academic level: 75% bachelor's degree ($p<0.001$).

The most frequent gap was practical skill: 52 nurses (86.7%), which was statistically significant according to the Chi-square statistic ($p<0.001$).

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Table 1. Characterization of the diagnosis group. Ana Betancourt de Mora Gynecobstetric University Hospital. Camagüey. January-October 2025

Variables	Categories	No.	%
Age	25 to 34	18	30.0
	35 to 44	32	53.3
	45 to 54	10	16.7
Professional experience (years)	5 to 10	22	36.7
	11 to 15	28	46.6
	More than 15	10	16.7
Area of performance	Primary care	24	40.0*
	Gynecology-obstetrics	22	36.7
	Intensive care	14	23.3
Academic level	Bachelor's degree	45	75.0†
	Specialization	15	25.0
Identified gap	Theoretical knowledge	48	80.0
	Practical skill	52	86.7‡
	Diagnostic attitude	44	73.3

p=0.030, † p<0.001, ‡ p<0.001

Source: structured diagnostic survey.

Based on the initial diagnostic results and collaborative work with the development group (30 multidisciplinary professionals), related to the contents and competencies on cardiovascular hyperreactivity in pregnant women, a proposal for a pedagogical model based on the competencies required for early diagnosis was designed, aimed at training nurses.

The model, structured into four sequential phases with a total of 40 training hours, formed the basis for subsequent validation by expert criteria.

Fundamental characteristics of the model:

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Pedagogical approach: based on the competency-based approach, integrating conceptual (knowing), procedural (knowing how to do), and attitudinal (knowing how to be/behave) dimensions.

Modular structure and phases:

Phase 1. Awareness (5 hours – 12.5 %)
Objective: to establish the importance of early diagnosis of cardiovascular hyperreactivity in pregnancy.
Content: epidemiological context and clinical relevance of this condition.

Phase 2. Theoretical-practical training (20 hours – 50.0 %)
Objective: to integrate theoretical knowledge with basic practical skills.
Content: integrated modules of pathophysiology, semiology, and clinical assessment, complemented by workshops.

Phase 3. Guided application (10 hours – 25.0 %)
Objective: to apply diagnostic competencies in controlled environments.
Content: clinical simulations and analysis of complex cases.
Phase 4. Comprehensive Evaluation (5 hours – 12.5 %)
Objective: to assess the achievement of defined competencies.
Content: evidence portfolio and structured clinical judgment.

Main didactic strategies:

- Experiential learning
- High-fidelity clinical simulation
- Interactive workshops
- Real case analysis
- Reflective portfolio

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Evaluation system:

- Instruments aligned with competencies (weighting: 50%)
- Formative and summative assessment (weighting: 30%)
- Observed clinical judgment and portfolio (weighting: 20%)

High reliability (α=0.91)

This model proposal underwent a validation process using the Delphi method over two rounds with a panel of 30 experts, the results of which are presented below.

Model validation by expert criteria (Delphi Method)

The Kruskal-Wallis test showed significant differences in the medians of the dimensions evaluated in the first round ($p<0.001$), indicating differences in central tendency. Consensus was reached in the first round for clinical relevance and methodological clarity, while operational feasibility and transferability required adjustments, presenting an interquartile range (IQR) >1 or median (Me) <4. Therefore, the global concordance index (GCI) showed a value below 0.85, as seen in Table 2.

Table 2. First round of the Delphi method application. Ana Betancourt de Mora Gynecobstetric University Hospital. Camagüey. January-October 2025

Dimensions	Me*	IQR*	ICi* (%)
Clinical relevance	5.0	0.0	100.0
Pedagogical foundation	4.0	1.0	86.7
Internal coherence	4.0	1.5	76.7
Operational feasibility	3.0	1.0	63.3
Methodological clarity	4.0	1.0	83.3
Transferability	3.0	2.0	60.0
GCI	3.83	1.08	78.3

Source: statistical analysis.

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Legend: *Me (Median), *IQR (Interquartile range), *ICi (Item concordance index), *GCI (Global concordance index).

Based on these results, adjustments suggested by the experts were made in the dimensions "operational feasibility" (emphasizing the use of low-cost simulators and logistical flexibility) and "transferability" (specifying application contexts). These adjustments were incorporated into the final version of the model.

Table 3 shows the improvement in expert consensus regarding the dimensions in the second round. The statistical test showed significant values in all adjusted dimensions ($p<0.05$). The greatest improvement was observed in "operational feasibility" with a +26.7 % compared to the first round ($p<0.001$). The GCI improved from 78.3% to 95.0 %, exceeding the established validity threshold of 85 %.

Table 3. Second round of the Delphi method application. Ana Betancourt de Mora Gynecobstetric University Hospital. Camagüey. January-October 2025

Dimensions	Me	IQR	ICi (%)
Clinical relevance	5.0	0.0	100.0
Pedagogical foundation	5.0	0.0	100.0*
Internal coherence	5.0	1.0	93.3†
Operational feasibility	4.0	1.0	90.0‡
Methodological clarity	5.0	0.0	100.0§
Transferability	4.0	1.0	86.7
GCI	4.67	0.67	95.0

p=0.002, † p=0.001, ‡ p<0.001, § p=0.005, || p<0.001

Source: statistical analysis.

The internal consistency of the validated model was 0.88 (Cronbach's Alpha) with a 95 % confidence interval of 0.82-0.94, indicating almost perfect agreement among experts on the

final structure. The intraclass correlation for inter-expert consistency improved from 0.78 in the first round to 0.92 in the second round.

Summary of model validity indicators:

Once the validation process was completed, all model components obtained an ICi ≥ 90 %, with a GCI of 95.0 %, exceeding the established validity threshold (GCI ≥ 0.85). The temporal distribution showed a significant predominance of the theoretical-practical phase (50% of total time, $p<0.001$), reflecting the importance assigned to theory-practice integration.

The validated model presents the following applicability and replicability characteristics:

- Target population: nurses with experience in maternal care and medium/high-risk obstetric services.
- Applicable context: gynecology-obstetrics services, primary care, obstetric intensive care, and undergraduate and postgraduate nursing education.
- Flexibility: the model adapts to face-to-face, blended, or virtual modalities, as long as its competency-based structure is maintained.

Validity and consensus indicators:

Expert consensus: all model components obtained an ICi ≥ 90%, with a GCI of 95.0 %, exceeding the established validity threshold (GCI ≥ 0.85).

Temporal distribution: the theoretical-practical phase showed a significant predominance (50% of total time, $p<0.001$), reflecting the importance assigned to theory-practice integration.

The tripartite evaluation system (50 %, 30 %, 20 %) presented high reliability ($\alpha=0.91$). The model's internal consistency was 0.88 with a 95% confidence interval of 0.82-0.94,

indicating almost perfect agreement among experts on the final structure. Intraclass correlation for inter-expert consistency improved from 0.78 to 0.92 between rounds.

The validation of the pedagogical model for competency development in diagnosing cardiovascular hyperreactivity in pregnant women was achieved through a participatory action-research process and expert consensus using the Delphi method.

It represents a contribution to both advanced nursing practice and health sciences education. The results, characterized by content validity and improvements in all critical dimensions after adjustments, demonstrate that the proposed design responds pertinently and feasibly to a clinical and training need within the Cuban health system.

Analysis of data from the diagnosis group revealed training gaps consistent with findings reported in the international literature on maternal health training.
The literature identifies persistent limitations in nursing diagnostic competencies in managing cardiovascular conditions during pregnancy.(6,7) The low score in diagnostic attitude, particularly in differential diagnosis—a critical element for timely detection of complications such as preeclampsia, whose association with cardiovascular hyperreactivity is well documented—was concerning.[7]

The pedagogical structure allocates 75 % of total time to practical activities, aligned with Kolb's experiential learning principles and contemporary recommendations for developing complex clinical competencies. This distribution differs from traditional models centered on theoretical transmission and is closer to instructional designs with high practical density, reported as effective for developing clinical reasoning skills within limited timeframes.

The predominance of the theoretical-practical phase reflects a deep understanding that diagnostic competence is built through the immediate and recursive integration of conceptual knowledge and its application in simulated contexts.[8]

The validation process using the two-round Delphi method proved an effective strategy for refining the model and achieving solid consensus. Improvement was observed in the

"operational feasibility" dimension, suggesting that adaptations regarding the use of simulators and logistical flexibility respond to experts' concerns about implementation in resource-limited settings. This finding is useful due to the frequent criticism in the literature of the uncritical importation of high-cost training methodologies into contexts with budget constraints. Inter-expert consistency, measured by intraclass correlation, improved between rounds, indicating convergence towards a consensual design.

The tripartite evaluation system represents a pedagogical innovation. This design moves away from traditional evaluation models focused on theoretical tests and approaches the principles of authentic assessment, which seeks to measure performance in situations replicating real practice challenges. The assigned weighting favors technical competence and incorporates critical reflection and reasoning in contexts of uncertainty, expressing a multidimensional understanding of diagnostic competence in advanced practice nursing.[9]

The model's internal coherence indicates expert agreement on the systemic integration of its components. This coherence is fundamental for pedagogical effectiveness because it ensures alignment between objectives, activities, and evaluation—a principle known as constructive alignment, whose importance for meaningful learning is documented in the educational literature.[10]

It is important to note that this pedagogical model was designed for the context of the Cuban health system; it considers strengths "universal coverage and service integration" and weaknesses "limited resources and high workload". This contextualization differentiates the proposal from models developed for high-income systems with availability of advanced technologies and prolonged training periods.

Adaptation to low-cost simulators and concentration of training into 40 hours respond to specific operational realities, thus increasing implementation and sustainability potential; however, inherent study limitations are recognized.

The validation, although rigorous, focused on the model's design and content, not its effectiveness. As noted in the literature, the gap between validated design and effective implementation represents a frequent challenge in health educational innovations.[11,12]

Furthermore, the exclusive participation of Cuban experts, while ensuring contextual relevance, limited immediate transferability to systems with different characteristics.

These limitations indicate adjustments for future research. An implementation study evaluating the model's effectiveness in terms of improving diagnostic competencies of participating nurses, changes in clinical practices in prenatal care services, and its impact on maternal-fetal health indicators is required. Comparative studies of the model with external ones and its cost-effectiveness evaluation at scale would be valuable.

Scientific contribution

The validated pedagogical model represents a promising tool for strengthening diagnostic competencies of advanced practice nurses in detecting cardiovascular hyperreactivity in pregnant women, constituting a significant, contextualized, competency-based scientific contribution for the training of these health professionals. It incorporates a highly reliable tripartite evaluation system, in accordance with authentic assessment principles. This proposal bridges the gap between theory and clinical practice, offering a pedagogical tool with the potential to improve early detection of obstetric complications and perinatal outcomes in health systems with similar characteristics.

CONCLUSIONS

A pedagogical model was designed to strengthen the diagnostic competencies of advanced practice nurses in detecting cardiovascular hyperreactivity in pregnant women, which was satisfactorily evaluated by experts. It responds to needs identified both in the international literature and in the specific Cuban context. Implementation and impact evaluation of this model constitute the next necessary steps to determine its real contribution to improving the quality of prenatal care and perinatal outcomes.

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Declaration of interests

The authors declare no conflict of interest.

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