

## Comparative Analysis of AI-Assisted ChatGPT Results from an Original Pilot Study in Subfertile Patients with a Restorative Reproductive Medicine Approach

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### Abstract

**Introduction:** Generative artificial intelligence (AI) is a powerful tool; however, it requires expert input to reliably interpret scientific research in complex fields. To date, no studies in Restorative Reproductive Medicine (RRM) have evaluated critical analyses performed by AI.

**Materials and Methods:** A critical analysis was conducted of the assessment generated by Google's AI in October 2025. The analysis focused on the 30 October version of ChatGPT (Extended Language Model) in relation to the original research of the prospective pilot study entitled: "Assessment of the fertile period in patients with subfertility using the P-type crystallization biomarker in liquid endocervical biopsy". Some key questions were introduced according to RRM approach. The AI's interpretation was then evaluated as either correct or incorrect based on the scientific article and available information on the topic.

**Results:** The AI correctly interpreted 28/45 (62.2%) of the results. Generative AI incorrectly interpreted 17/45 (37.7%) of the items. The results are broken down into seven sections. The differences and explanations are presented and corrected through strategic, critical and ethical analysis, based on human scientific analysis.

**Conclusion:** This study demonstrates that AI analysis, guided by a methodological tracking strategy, can effectively evaluate and organize critical insights regarding the prompt of the analysis. While the evaluation currently performed by AI in this context is useful, it should be reviewed by qualified scientific personnel to avoid errors.

In conclusion, the optimal approach lies in integrating rigorous scientific and ethical evaluation with the organizational efficiency offered by AI-assisted critical analysis. This hybrid model builds on the strengths of human experience and artificial intelligence while overcoming the limitations of AI.

**Keywords:** Fertile Window; Generative Artificial Intelligence ChatGPT; NaProTechnology; Restorative Reproductive Medicine (RRM); Subfertility; P-Type Crystallization

## Introduction

Artificial intelligence (AI) is a branch of computer science focusing on the development of systems and algorithms capable of simulating human cognitive processes such as reasoning, learning and perception in order to perform tasks autonomously. AI systems use data and algorithms to learn and improve over time, adapting to new situations and optimizing their performance [1].

The beginnings of AI emerged in the 1950s, when visionaries such as Alan Turing and John McCarthy started to explore the idea of creating machines that could think and reason like humans [2,3]. These pioneers laid the theoretical and conceptual foundations of AI, paving the way for decades of research and development. Significant advances were made in the field of artificial intelligence during the 1960s and 1970s, including the development of expert systems and the emergence of rule-based programming. However, this period was also characterized by technical challenges and limitations that restricted the scope and applicability of AI in the real world.

The renaissance of AI began in the 1990s, fueled by advances in computing power and the development of increasingly sophisticated algorithms. Machine learning emerged as a key AI discipline, enabling machines to learn from data and enhance their performance over time.

In the 21<sup>st</sup> century, the explosive growth of data and the proliferation of technologies such as natural language processing and deep learning have propelled artificial AI to new heights. Today, AI is integrated into a wide range of applications and sectors, including recommendation systems, medicine, etc. [5].

However, the evolution of AI also presents significant ethical and social challenges, ranging from data privacy concerns to the impact of automation on employment. As we move further into the 21<sup>st</sup> century, it is crucial that we proactively address these challenges to ensure that AI is used responsibly and ethically for the benefit of all humanity [1].

Integrating AI into the evaluation of medical studies is transforming the way Google and other organizations collect, manage and develop medical information. The evolution of AI in the critical analysis of scientific studies, from its earliest applications to today's most advanced technologies, has been remarkable. However, it is important to review and verify the data interpreted by AI to ensure an accurate assessment by the authors [6].

Generative AI has some limitations that make it necessary to verify the assessments it performs [6]. In the fields of creativity and innovation, for example, AI may have limited ability to evaluate a studio's capacity for creativity and innovation, as well as its problem-solving skills. In terms of adaptability and flexibility, it may not be able to adequately assess the capacity to adapt to changes in the scientific environment or recognize new skills quickly [1].

Currently, no articles in Restorative Reproductive Medicine (RRM) evaluate critical analyses performed by AI. This analysis compares the evidence from a scientific article with the interpretation of an analysis generated by generative algorithms. The application of AI in assisted reproductive technologies (ART) appears to be growing in impact; however, the current state of this technology and the terms under which it will operate in the future seem to still be under definition. It should be noted that the side effects of ART persist and that there is currently a growing trend towards natural follicular stimulation [7-9]. RRM is an evidence-based approach that does not violate reproductive autonomy or informed consent, nor is it ideologically harmful or discriminatory towards any couple seeking treatment through this method [10]. Scientific committees such as the American Society for Reproductive Medicine (ASRM) and the *Fertility and Sterility* journal present important scientific studies that have been applied to RRM. These studies provide scientific evidence that has been applied to natural fertility care and natural reproductive technology (NaProTechnology) [11-16].

Therefore, although platforms of scientific rigor exist, AI is increasingly becoming a tool that guides the public in choosing an option. This makes it interesting to carry out experimental work that questions the interpretation of AI, as is done in this scientific article

focusing on RRM from a recently published work. RRM shows great promise in resolving fertility issues without the need for the costly and complicated procedures associated with ART [17]. Therefore, continued growth in interest within the public healthcare system and online is expected. The popularity of platforms dedicated to AI is currently on the rise, and this technology will facilitate greater access to information.

One important milestone in reproductive medicine is the identification of biomarkers that can guide diagnosis and inform therapeutic trials [18]. The integration of clinical practice with the potential benefits of accessible, low-cost biomarkers for achieving pregnancy could be of interest and warrant wider dissemination. This is because interest in this area is growing within the healthcare system. Therefore, it is important to establish a clear knowledge base regarding critical findings in publications with an RRM focus. One such case is the analysis of a promising pilot clinical trial for patients who rely on the detection of fertile cervical mucus to achieve pregnancy, supported by good clinical care. It is therefore interesting to examine how generative AI presents these results to the general public. This is the essence of this work within a comparative critical analysis.

This study was selected for analysis because NaProTechnology and RRM offer a promising approach to resolving fertility issues [13-18]. Furthermore, the characteristics of P-Type (Peak) cervical secretion and its scientific basis make it crucial for its role in fertility in the upper part of the cervix. This secretion facilitates the rapid transport of sperm through the cervix to the uterus and fallopian tubes, contains a liquefaction factor that dissolves thicker strands of mucus to release sperm stored in the crypts, and plays a crucial role in sperm selection to ensure only the most viable and motile sperm reaches the egg at the optimal time [13,14].

One of the central working hypotheses, as defined by an external review, was to evaluate the contribution of determining P-type crystallization in cervical secretions, as can be seen in the clinical study record located at the following link: <https://doi.org/10.1186/ISRCTN18705969>. Currently, there are no published scientific studies that consider the application of AI to NaProTechnology and RRM. AI is also not mentioned in a recent review based on fertility awareness-based methods (FABS) in patients with subfertility [18]. However, there are some relevant references to AI in ART, but not in the fertile period [19-21]. The interpretation of fertility-related concepts in an RRM setting is based on relevant research information [12-18]. The data and information in the publication are scientifically accurate and have been tested and peer-reviewed in a previous study [12].

### Objective and Purpose of the Study

The fundamental objective of this work was to critically analyze the accuracy of AI generated interpretations in response results to the selected prompt [12]. The purpose of this study was not to evaluate the reliability of generative AI in interpreting medical literature, as such an assessment would require a different study design with multiple variables beyond the scope of this work.

### Materials and Methods

#### Study design

A critical analysis has been carried out of the assessment created with AI on Google in October - November 2025; OpenAI. (2025). ChatGPT (Version 30 Oct) [Large language model]. <https://chat.openai.com/chat>. This was done in relation to the original research and published scientific issues about the prompt: "Assessment of the fertile window in patients with subfertility using the P-type crystallization biomarker in liquid endocervical biopsy: a prospective study" [12]. A comparative study was conducted between data generated by generative AI and a critical analysis by qualified scientific personnel in the field.

The evaluation strategy incorporated some items taken into account in the analysis of scientific studies carried out by the International Institute of Restorative Reproductive Medicine (IIRRM). A strategic approach was designed to avoid confusion between the study's

different sections and to facilitate consensus-based analysis within each section. To evaluate the contribution of the AI analysis to the study, the evaluations were individually compared to the article [12]. Criticisms based on other databases were not considered in this study; the results were specified and clarified based solely on the scientific information in the referenced publication [12]) within the RRM framework.

### Methodology

The evaluation strategy took into account some viewpoints used to analyze published scientific studies, as set out in the IIRRM's clinical trial evaluation guide. To present the results in an organized matter, the comparison was categorized into seven groups: how the study was conducted, study design and methodology, results, study interpretation, key findings, analysis of outlook, conclusion and future perspectives.

Differences and explanations are presented through strategic and critical analysis based on AI, contrasted by human scientific analysis. To facilitate the reading and understanding of the data, the items interpreted by the AI are enclosed in "quotation marks". This ensures that the terminology used in the AI analysis is consistent throughout the presentation of the AI results. The phrase is written exactly as it was copied from the AI model; therefore, the repetition of acronyms for each input or element of the AI analysis is maintained.

The results were analyzed according to how the AI interpreted the article [12], as compared to the subject's knowledge of the article and scientific background. In the results analysis, the item was presented and evaluated as either correct or incorrect. Clarification regarding whether the statement is correct or incorrect is taken into account. The responses from each group were calculated arithmetically and the corresponding percentage was estimated. The same methodology was systematically applied to each of the groups in the different stages of the study. The data is indexed correctly to avoid errors when the results are interpreted, and so to avoid making mistakes in the data or in how the results are presented.

The specific concepts generated by the AI within the same response were considered, as well as their association with another premise, which could lead to differences in the response. Therefore, it is considered as a different context and is not presented as repetitive data. Therefore, the overall evaluation of the generative AI analysis considers the methodology employed. This concept was considered and statistically reviewed to avoid redundancy and the artificial inflation of the denominator. This ensured that the results were presented statistically and that there were no errors in the calculation.

### Artificial intelligence (AI) prompt formulation

The meaning of the prompt was considered as an instruction or piece of text provided by a user to an AI model to guide the generation of a specific output. The prompt considered was: "Assessment of the fertile window in subfertile patients using the P-type crystallization biomarker in liquid endocervical biopsy: a prospective study". The methodology covers all aspects related to the strategic use of AI in each section. It includes all the elements that the AI evaluates when inputting data into the program according to the sections listed above, one by one, to which it responds. In this way, a complete, detailed, and exhaustive review of the steps followed in the study is carried out. The consistency of the AI claims classification is rigorously reviewed regarding the results presented in the tables, considering the overall context of generative AI in each chapter and the tables' methodological order. Both the order in which the answers are presented, and the subtitles and generated phrases are considered.

The classification of responses in each table accurately reflects the AI-generated claims in each interpretive section. For this reason, they are counted as results rather than as bias or data inflation error. In this context, the AI response is respected, and no data is generated or inserted outside the study's remit. This enables the outcome to be efficiently classified as either negative or positive, depending on the examiner's perspective.

No confusion matrix was generated to assess the performance of the classification model, nor was any machine learning model used to evaluate the classification criteria. The classification values consistently followed the same pattern across the entire dataset, as the classification model relied on human oversight rather than evaluation of the results by a classification algorithm.

A person with prior knowledge of the subject is solely responsible for the AI-generated or classified responses, without resorting to other types of associations or external evaluations for their classification. The authority and responsibility for the responses are inherent to the study. As AI is being evaluated, the classification pattern was not based on an AI model again.

## Results

The AI correctly interpreted the results in 28/45 (62.2%). Generative AI failed to correctly interpret 17/45 (37,7%). The AI correctly classified the study, using the appropriate terminology to distinguish between studies of RRM and NaProTechnology. The AI interpretation did not classify it as an ART study. In this sense, the AI Prompt for this study respects the study’s concept and well-defined terminology, providing a very interesting starting point for analysis and contributing to good analytical performance. The generation of the results followed the standards established in the methodology. The results are broken down in the sections mentioned in materials and methods and summarized in the corresponding tables. A detailed review was conducted of each table from which data was extracted for the generative AI analysis.

### Comparative results regarding how the study was conducted

In this section, six statements were extracted from the AI chatbot. As shown in table 1, 4/6 (60%) were correctly classified, while 2/6 (40%) were incorrect. The AI interpretation correctly summarizes how the study was conducted in four main points. The first is an accurate description of how the work was carried out, which is described reliably and precisely as follows: “The study involved 45 subfertile patients, with 18 completing the full assessment based on natural procreative technology (NaProTechnology) and restorative reproductive medicine (RRM) principles”.

The next three interpretations were also correct, as described in table 1. These related to the sample collection procedure, how the sample was collected, and the outcome, as described in detail in table 1.

Of the two incorrect parameters related to the way the study was conducted, one concerns the study registration, which erroneously concludes the objective for which it was conducted, as described below: “The study, registered under ISRCTN18705969, sought to establish a reliable test for assessing cervical mucus quality”.

The following statement is inaccurate in the context of the study, as the procedure was not performed for that purpose. “Researchers assessed the fertile window by taking liquid biopsies from the endocervix”. These results are summarized in table 1.

Correct Statements	Incorrect Statements
<p>“The study involved 45 subfertile patients, with 18 completing the full assessment based on Natural Procreative Technology (NaProTechnology) and Restorative Reproductive Medicine (RRM) principles”.</p> <p>“Cervical mucus samples were analyzed for the presence of a specific, estrogen-dependent P-type crystallization pattern, which has maximal branching and a hexagonal configuration”.</p>	<p>“The study, registered under ISRCTN18705969, sought to establish a reliable test for assessing cervical mucus quality”:</p> <p><b>Clarification:</b> This interpretation is incorrect. The assessment of cervical mucus quality was based on observation of patients’ secretions, incorporating some elements of the Billings Method and the Creighton Model of Fertility Care (CrMS), which are used to indicate fertile secretions. The classification and observation were made at the time of the endocervical examination.</p>
<p>“Researchers collected liquid endocervical biopsies during the fertile window, defined as the period from three days before the estimated day of ovulation (EDO) until the “Peak day,” which is the last day of fertile-quality mucus”.</p>	<p>“Researchers assessed the fertile window by taking liquid biopsies from the endocervix”.</p> <p><b>Clarification:</b> The statement is incorrect. This is because, although the biopsy was used to obtain cervical mucus samples for crystallization analysis, it was not used to assess the fertile window.</p>
<p>“The study also assessed pregnancy outcomes for a subgroup of six patients with positive P-type crystallization results”.</p>	

**Table 1:** AI-assisted analysis of the ChatGPT prompt: Assessment of the fertile window in patients with subfertility using the P-type crystallization biomarker in liquid endocervical biopsy: a prospective study, with a summary of how the study was conducted: Correct vs. incorrect statements.

Comparative analysis of study design and statements on study methodology

Twelve elements were considered when evaluating this point to interpret the work. A comparative critical outcome analysis of AI-assisted ChatGPT was correct in 6/12 (50%) of the evaluated elements relating to the how the study works, the fertile period, accuracy success rate in subgroups, approach, follow-up and accuracy of the method. However, the interpretation was inadequate in 6/12 (50%) of cases, in terms of the different concepts of the methodological approach, the pattern, sample collection, identification of the fertile window, sample yield, and correlation with other methods. The methodology is presented as a simple method, but it is not entirely so in this series of cases at present, as explained in table 2.

Correct Statements	Incorrect Statements
<p><b>How it works:</b> The study involved collecting samples of cervical mucus to look for a specific P-type crystallization pattern. Computer analysis and expert review were used to identify and confirm the pattern in the mucus samples. This pattern is characterized by maximal branching and a tricolor hexagonal arrangement, as seen in the study".</p>	<p><b>Pattern:</b> P-type crystallization has a unique hexagonal configuration with maximal branching and a tricolor pattern, which appears during the most fertile days of the menstrual cycle".  <b>Clarification:</b> The tricolor unique pattern is incorrect.</p>
	<p><b>Sample collection:</b> The study collected samples through a non-invasive liquid endocervical biopsy, which involves obtaining a sample of cervical fluid".  <b>Clarification:</b> A biopsy is, by definition, an invasive procedure, not non-invasive.</p>
<p><b>Fertile period:</b> The study identified the most fertile window as the period from three days before the estimated day of ovulation (EDO) until the peak-day (P-Day)".</p>	<p><b>Fertile window identification:</b> The most fertile days were identified as occurring between three days before the estimated day of ovulation (EDO) and the day of peak P-type crystallization".  <b>Clarification:</b> The study identified the fertile window as ending on the peak-day (P-Day), not the day of peak P-type crystallization.</p>
<p><b>Success rate:</b> In a subgroup of patients, 83% of those with a positive P-type crystallization result achieved a live-birth pregnancy. This highly positive result is limited to the subgroup that could be analyzed due to multiple factors that prevented a larger follow-up sample from being obtained. This information requires further elucidation, which the AI algorithm will provide subsequently."  <b>Clarification.</b> The statement is correct, but the algorithm did not provide any explanation for this throughout the study.</p>	<p><b>Analysis:</b> The samples were analyzed to identify P-type crystallization, a hexagonal pattern in the cervical mucus that indicates peak fertility".  <b>Clarification:</b> While P-type crystallization is a key biomarker, peak fertility is identified through a combination of biomarkers, not just this one pattern in isolation.</p>
<p><b>Approach:</b> Researchers used the Restorative Reproductive Medicine (RRM) and NaProTechnology approaches, which rely on monitoring and evaluating biomarkers of reproductive function to identify the underlying cause of subfertility".</p>	<p><b>Correlation:</b> Results were compared against the Creighton Model System (CrMS) of cervical mucus observation, a standard method for identifying the fertile window".  <b>Clarification:</b> The study did not specify a comparison against CrMS as described here. The CrMS model was used to extract two variables for study in combination with the Billings method.</p>
<p><b>Follow-up:</b> Pregnancy outcomes were assessed in a randomly selected subgroup of patient".</p>	<p><b>Potential:</b> This method is presented as a simple, affordable, and reliable tool that, when combined with other tests, could improve the accuracy of fertility assessments for subfertile women".  <b>Clarification:</b> The method, involving a specialized biopsy and analysis, is not necessarily "simple and affordable".</p>
<p><b>Accuracy:</b> The method demonstrated 100% sensitivity and 100% specificity, with no false positives or false negatives observed. However, it does not provide a detailed description of the specific interpretation to which it refers. This can sometimes result in misinterpretations. As it takes the intended outcome of statistical analysis out of context".</p>	

**Table 2:** AI-assisted analysis of ChatGPT about the prompt: Assessment of the fertile window in patients with subfertility using the P-type crystallization biomarker in liquid endocervical biopsy: a prospective study and a comparative Analysis of study design and study methodology statements: Correct vs. incorrect.

**Comparative statements regarding the results of the study**

In this section, 2/5 (40%) of the responses were correct in terms of positive pregnancy outcomes and high pregnancy rates. However, 3/5 (60%) of the interpretations were incorrect in terms of interpreting the results, mixing concepts of test validation with results obtained in terms of accuracy and prediction of the fertile window. These results are summarized in table 3.

Correct Statements	Incorrect Statements
<p><b>“Positive pregnancy outcomes:</b> In a small subgroup of six patients who showed the P-type pattern, 83% (5 out of 6) achieved a live-birth pregnancy. This is a prudent statement that is consistent with the study results”.</p>	<p><b>“Accurate identification of fertile window:</b> The P-type crystallization biomarker, observed in the liquid endocervical biopsy, accurately identified the most fertile days for all participant”.</p> <p><b>Clarification:</b> The phrase “ accurately identified the most fertile days for all participants” is an overgeneralization. The optimal fertile window was identified between three days before the estimated day of ovulation (EDO) and the day of peak fertility (P-Day).</p>
<p><b>“High pregnancy rate:</b> In the subgroup assessed for outcomes, 83% of patients (5 out of 6) with positive P-type crystallization results achieved a live-birth pregnancy”.</p> <p><b>Clarification:</b> Labeling the outcome as a “High pregnancy rate” is a strong interpretation. Given the very small sample size (n=6), this is a significant outcome within that specific group but is not necessarily indicative of a high success rate for all patients.</p>	<p><b>“High accuracy:</b> The P-type crystallization biomarker showed a 100% sensitivity and 100% specificity for detecting the fertile window in the selected patient group. The type P-Type crystallization biomarker showed 100% sensitivity and 100% specificity for detecting the fertile window in the selected group of patients”.</p> <p><b>Clarification:</b> Although the study achieved 100% sensitivity and specificity in its analysis, this cannot be generalized. A result of 100% on a small sample size does not guarantee the same outcome in a larger, more diverse population, and it is statistically less robust. Biomarkers do not detect fertile windows. The biomarker is inside the fertile window.</p>
	<p><b>“Fertile window prediction:</b> The P-type crystallization pattern was observed in all participants and accurately pinpointed the fertile window, which was identified as the period from three days before the estimated day of ovulation (EDO) until the peak day (P-Day)”.</p> <p><b>Clarification:</b> The first sentence is correct, but the second is not. P-type crystallization occurs within the fertile window, which could coincide with the day of peak fertility. This is what can be concluded from the study.</p>

**Table 3:** AI-assisted analysis of ChatGPT about the prompt: Assessment of the fertile window in patients with subfertility using the P-type crystallization biomarker in liquid endocervical biopsy: a prospective study: A Comparative results statements: Correct vs. incorrect regarding the study’s results.

**Comparative analysis of the results of the study’s interpretation**

The interpretation of the study is correct in 3/5 (60%) of the aspects recorded by AI in terms of its potential as a diagnostic aid, its limitations, the next steps, and the benefits for patients. It provides an accurate assessment of the work. However, in 2/5 (40%) of cases, the interpretation of the results is overestimated. It is defined as a simple method, which is inaccurate, and the crystallization pattern is linked to the general claim of an 83% pregnancy rate, as shown in table 4. This is false, as it is isolated data from the subgroup analyzed.

Correct Statements	Incorrect Statements
<p><b>“Potential as a diagnostic aid:</b> The method offers a quantitative and qualitative assessment of fertility that can enhance the diagnostic process in subfertile patients, particularly those using Restorative Reproductive Medicine (RRM) and NaProTechnology”.</p>	<p>“Research published in 2025 in the Clinical and Experimental Obstetrics and Gynecology journal assessed the fertile window in subfertile women using P-type crystallization of liquid endocervical biopsies, finding it to be a reliable and simple method”.</p> <p><b>Clarification:</b> The procedure itself is not straightforward, meaning the general statement overestimates the scope of the study.</p>
<p><b>“Limitations and next steps:</b> While the results are promising, this was a pilot study. The subgroup for pregnancy outcomes was small (6 patients), and further research with a larger sample size is needed to confirm the high success rate seen in this initial cohort”.</p> <p><b>“Benefits for patients:</b> By precisely identifying the most fertile days, this approach could help couples time intercourse more effectively, potentially improving their chances of conception. The liquid biopsy also represents a less invasive option than other fertility diagnostic procedures”.</p>	<p><b>“Findings:</b> The P-type pattern, characterized by maximal branching and a tricolor hexagonal configuration, was observed on fertile days and correctly identified fertile periods with 100% sensitivity and specificity. Patients with a positive P-type crystallization result achieved live-birth pregnancy in 83% of cases”.</p> <p><b>Clarification:</b> The P-type pattern falls within the fertile window analyzed, which invalidates the first part of the statement, and the second part relating to pregnancy requires context, as it is based on a small subset of the study and cannot be generalized in this way.</p>

**Table 4:** AI-assisted analysis of ChatGPT about the prompt: Assessment of the fertile window in patients with subfertility using the P-type crystallization biomarker in liquid endocervical biopsy: a prospective study: A comparative analysis of the study interpretation: Correct vs. incorrect statements.

### Comparative analysis of the results of the key findings

As for the two main conclusions, 2/3 (66.6%) are adequately summarized: “Enhanced fertility assessment: The study highlights the potential of combining cervical secretion crystallization analysis with traditional fertility observations to improve fertile window diagnosis”. And: “Potential for treatment: The findings suggest that focusing on the P-type pattern, high-quality cervical secretion, and accurate timing could significantly increase the chances of pregnancy for subfertile patients”. However, in 1/3 (33.3%) of cases, it is inconclusive.: “Advantageous for subfertile patients: The study highlighted that this biomarker and technique offer an additional tool for subfertile patients seeking non-invasive methods to better understand their fertility”. A full explanation can be seen in table 5.

Correct Statements	Incorrect Statements
<p><b>“Potential for treatment:</b> The findings suggest that focusing on the P-type pattern, high-quality cervical secretion, and accurate timing could significantly increase the chances of pregnancy for subfertile patients”.</p>	<p><b>“Advantageous for subfertile patients:</b> The study highlighted that this biomarker and technique offer an additional tool for subfertile patients seeking non-invasive methods to better understand their fertility. The study combines a non-invasive technique, consisting of digital observation of cervical secretion, with an invasive endocervical test”.</p> <p><b>Clarification:</b> The AI’s interpretation is flawed because it incorrectly labels endocervical biopsy as non-invasive, leading to a misleadingly positive assessment of the technique’s advantages. A biopsy is an invasive procedure. However, the rest of the argument is correct.</p>
<p><b>“Enhanced fertility assessment:</b> The study highlights the potential of combining cervical secretion crystallization analysis with traditional fertility observations to improve fertile window diagnosis. This is a statement that must be verified in the future with studies involving a larger number of patients”.</p> <p><b>Clarification:</b> The statement is prudent as it acknowledges the need for future research, which is a standard scientific practice, making it a cautious and correct conclusion based on the study’s scope.</p>	

**Table 5:** AI-assisted analysis of ChatGPT about the prompt: Assessment of the fertile window in patients with subfertility using the P-type crystallization biomarker in liquid endocervical biopsy: a prospective study and a comparative analysis of key findings: Correct vs. incorrect statements.

**Results of the comparative analysis of the future outlook**

Regarding future interpretations, it correctly identifies 3/4 (75%) related statements that could be helpful for diagnosis and benefit patients. It also correctly considers the limitations and next steps in the research. The last statement 1/4 (25%) in this chapter is incorrect: “This study provides evidence that P-type crystallization in a liquid endocervical biopsy is a reliable biomarker for identifying the fertile window in subfertile women”. See results in table 6.

Correct Statements	Incorrect Statements
<p><b>“Potential as a diagnostic aid:</b> The method offers a quantitative and qualitative assessment of fertility that can enhance the diagnostic process in subfertile patients, particularly those using Restorative Reproductive Medicine (RRM) and NaProTechnology”.</p>	<p>“This study provides evidence that P-type crystallization in a liquid endocervical biopsy is a reliable biomarker for identifying the fertile window in subfertile women”.</p> <p><b>Clarification:</b> While the pattern is a significant biomarker to be inside the most fertile days, it does not constitute a recommendation accepted by the scientific community in isolation to identify the entire fertile window. The evaluation must combine multiple observations, as the study itself indicates, and not rely solely on crystallization.</p>
<p><b>“Benefits for patients:</b> By precisely identifying the most fertile days, this approach could help couples time intercourse more effectively, potentially improving their chances of conception. The liquid biopsy also represents a less invasive option than other fertility diagnostic procedures”.</p> <p><b>“Limitations and next steps:</b> While the results are promising, this was a pilot study. The subgroup for pregnancy outcomes was small (6 patients), and further research with a larger sample size is needed to confirm the high success rate seen in this initial cohort”.</p>	

**Table 6:** AI-assisted analysis of ChatGPT about the prompt: Assessment of the fertile window in patients with subfertility using the P-type crystallization biomarker in liquid endocervical biopsy: a prospective study, a comparative analysis of outlook: Correct vs. incorrect statements.

**Conclusion and study implications for subfertile patients**

In the final section: Conclusion and implications of the study for subfertile patients, the AI correctly interpreted 8/10 (80%) items in table 7. In this context, the main statement of IA is it accurately interprets the study and identifies the following potential future implications: “A new fertility assessment tool, enhanced fertility awareness, clinical significance, evidence for biophysical properties, supports non-IVF approaches, potential as a new tool and conclusion”. However, 2/10 (20%) of the premises are incorrect as can be seen in table 7.

**Discussion**

The clinical evaluation of cervical secretion, in conjunction with the collection of samples for cervical crystallization, was determined by the observation, classification and evaluation of the cervical secretion of the patients during the endocervical exploration. The identification of the fertile window in the study (12) incorporated conceptual elements from both the Billings method [13] and the

Correct Statements	Incorrect Statements
<p><b>“A new fertility assessment tool:</b> The P-type crystallization analysis offers an additional objective, quantifiable, and qualitative biomarker for assessing the quality of the fertile window”.</p>	<p>“This research suggests a promising, non-invasive method for improving fertility management, particularly for those using Natural Procreative Technology (NaProTechnology) and Restorative Reproductive Medicine (RRM) approaches”.</p> <p><b>Clarification:</b> The endocervical biopsy used to collect the sample is an invasive procedure, contradicting the claim of a non-invasive method.</p>
<p><b>“Enhanced fertility awareness:</b> The method allows for a more accurate identification of peak fertility days, improving the timing of intercourse or other interventions”.</p>	<p>“The method has been developed for patients who encounter difficulties in tracking fertility using conventional methods such as the Creighton Model System (CrMS) or other at-home biomarkers”.</p> <p><b>Clarification:</b> While the method could be valuable for such patients, it was not exclusively developed for them. The study itself was a pilot within a specific framework and does not provide enough evidence to support such a specific claim about its development purpose.</p>
<p><b>“A new fertility assessment tool:</b> The P-type crystallization analysis offers an additional objective, quantifiable, and qualitative biomarker for assessing the quality of the fertile window”.</p> <p><b>“Clinical significance:</b> This method could provide a new, quantitative and qualitative way to assess the fertile window for subfertile patients, potentially improving the accuracy and timing of fertility treatments”. “It may be a useful alternative for those who cannot use more invasive or difficult-to-access methods like daily ultrasound”.</p>	
<p><b>“Enhanced fertility awareness:</b> The method allows for a more accurate identification of peak fertility days, improving the timing of intercourse or other interventions”.</p>	
<p><b>“Supports non-IVF approaches:</b> It provides a valuable strategy for patients seeking alternatives to <i>in vitro</i> fertilization (IVF) or intrauterine insemination (IUI)”.</p>	
<p><b>“Potential as a new tool:</b> This technique has the potential to provide a new, objective tool for the assessment of cervical mucus quality and the identification of peak fertility. This could assist subfertile couples in better timing intercourse”.</p>	
<p><b>“Conclusion</b> The study concluded that the P-type crystallization pattern, identified via liquid endocervical biopsy, serves as a reliable biomarker for pinpointing the days of highest fertility within the fertile window. This approach may offer a valuable tool for women with subfertility who wish to monitor their cycles and optimize their chances of natural conception”.</p>	

**Table 7:** AI-assisted analysis of ChatGPT about the prompt: Assessment of the fertile window in patients with subfertility using the P-type crystallization biomarker in liquid endocervical biopsy: a prospective study and conclusion and study implications for subfertile patients: Correct vs. incorrect statements.

Creighton Model System (CrMS) [14] for monitoring the fertile characteristics of cervical mucus. This original strategy, specific to this article, considers the CrMS 10K cervical score within the fertile window, when cervical mucus stretches more than 3 cm and exhibits a clear transparency similar to that of egg white. Among the most fertile characteristics observed in this examination was a P-type

crystallization pattern. The concepts of recognized methods for assessing fertility have been taken from the original models because they are universally known to the general public as a way of recognizing fertility [13,14]. However, because not all patients have access to formal training in these methods, the variables used in this study were adapted from the study's own model without diminishing the integrity of the original fertility recognition methods. Accordingly, simplified concepts were employed to enhance accessibility for the general population, with no other intention.

In summary, the study suggests that the P-type crystallization biomarker is a highly sensitive and specific tool for pinpointing peak fertility in subfertile women, positioning it as a potentially valuable to fertility assessment methods.

These results are consistent with the accuracy rates of other medical analyses conducted in the same study context. The response rate for correct AI interpretations was around 70%, with an error rate of 30% [23]. When considering the performance of AI in this context, the following points regarding implications and recommendations are relevant: It is important to inform the scientific community of the limitations of relying solely on generative AI to analyze scientific literature. This analysis provides a case study and offers a concrete and valuable example of AI performance. It identifies the types of errors made by AI and the areas where it needs improvement. It promotes the enhancement of AI capabilities. This could encourage AI developers to improve the reliability and accuracy of their models when interpreting medical and scientific texts. It is vital to promote more responsible use. This would encourage the use of AI as a support tool rather than a substitute for human judgement and would highlight the need for experts to validate and correct machine-generated results [20].

The AI claims that this biomarker is present on the most fertile days. While this may be accurate, alone it cannot identify the most fertile days, as it may appear throughout the entire fertile window. To confirm that this biomarker specifically indicates fertility, two additional parameters-filancy and transparency-were used as rheological indicators of fertility [13,14].

The PROMPT AI P-type crystallization structured analysis focuses on the contribution and interpretation of the P-type crystallization pattern within the study. However, it does not address contextual details, such as how the topic is presented in relation to the introduction. For instance, the AI analysis structure does not consider the triad of (a) high-quality cervical secretion, (b) an accurate diagnosis of the fertile window and (c) hexagonal P-type crystallization, all of which could contribute to predicting positive pregnancy outcomes.

Regarding methodology assessment, several claims may be misinterpreted when taken out of context. While the AI support effectively explains the study design and methodology chapter to a general audience without specialized knowledge, it contains some inaccuracies that should be corrected to align with the content of the original work.

The evaluation of the fertile window in the study was a multidisciplinary process, with crystallization analysis being just one part of it. In this context, according to the classification in table 2 of the study design and methodology, AI correctly interprets the approach and use of the fertile period. Furthermore, as defined in the work, it demonstrates these three strengths: "Approach: Researchers used the Restorative Reproductive Medicine (RRM) and NaProTechnology approaches, which rely on monitoring and evaluating biomarkers of reproductive function to identify the underlying cause of subfertility"." The fertile period and how it works: The study involved collecting samples of cervical mucus to look for a specific P-type crystallization pattern". "Fertile period: The study identified the most fertile window as the period from three days before the estimated day of ovulation (EDO) until the peak-day (P-Day)". In this context, the findings of the study were appropriately correlated with established reference methodologies.

The AI analysis correctly uses the term "correlation" in reference to the control schools, as follows: "The results were compared to the Creighton Model System (CrMS) for cervical mucus observation, which is a standard method for identifying the fertile window". However,

this is not entirely accurate, since the CrMS model was not employed for cervical mucus observation within the scope of the study. Instead, some elements of the CrMS scale and observation form were applied.

Furthermore, it does not accurately evaluate the interpretation of the sample collection process or how the fertile period was identified, like we can see in this sentence: "Fertile window identification: The most fertile days were identified as occurring between three days before the estimated day of ovulation (EDO) and the day of peak P-type crystallization". This interval follows the CrMs model guidelines for defining the last day of the fertile period and does not represent P-type crystallization.

Another incorrect interpretation of this chapter is "Sample collection: The study collected samples through a non-invasive liquid endocervical biopsy, which involves obtaining a sample of cervical fluid". The AI was wrong because the procedure was invasive. And: "Analysis: The samples were analyzed to identify P-type crystallization, a hexagonal pattern in the cervical mucus that indicates peak fertility". However, P-type crystallization does not determine the peak day of fertility; it may coincide with it and be present on that day, but it does not determine it. The peak fertility day is assessed using an interpretation based on fertility awareness methods, as set out in the study. AI is unable to perform this type of interpretation [14]. While this statement is true, the period of maximum fertility is not identified using this methodology. The study indicates that this type of crystallization occurs within the studied period.

Unlike a scientist, the AI's analysis does not engage in critical self-evaluation of its own data; it is not capable of critically self-evaluating its own results. It lacks the ability to recognize that its interpretation may be flawed or biased, as demonstrated by these errors in interpretation. For example: "Pattern: P-type crystallization has a unique hexagonal configuration with maximal branching and a tricolor pattern, which appears during the most fertile days of the menstrual cycle". In this context analysis of AI could consider previous studies, such as the Odeblad study [22].

The study used liquid endocervical biopsy to analyze cervical mucus for a specific crystallization pattern, called P-type crystallization, not to determine the fertile window. While the accuracy in identifying this P-type crystallization biomarker is high, with 100% sensitivity and specificity for identifying this pattern, it is not used to determine the fertile window. As shown in table 2, the analytical method is accurate, exhibiting high sensitivity and specificity in identifying a P-type crystallization pattern. While this may have some merit, further studies are needed to obtain concrete evidence, and it is not currently a simple test to perform. Computer analysis and expert review were employed to identify and confirm the pattern in the mucus samples. This pattern is characterized by maximal branching and a tricolor hexagonal arrangement, as observed in the study.

AI ignores the various existing P-type crystallization patterns. Therefore, interpreting this finding in the context of the study is overvalued. The characteristic hexagonal configuration refers to branches inclined at a 60-degree angle, which appear during fertile days but are not exclusive to the single most fertile day. In fact, this pattern may be observed throughout the fertile window, underscoring the need for cautious interpretation and integration with other biomarkers of fertility.

In this study, the pattern falls within a range and can appear closer to or further from the midpoint of the fertile window; hence the concept of "ping-pong" within the interval. This was identified using a ping-pong strategy within the fertile period. P-type mucus crystallization exhibited a crystalline morphology with a central axis and branches forming 60° angles with this axis. Odeblad described five subtypes: P6B, P2, Pa, P4 and Pt [22]. P6B mucus showed hexagonal symmetry with six well-defined axes. Its morphology is stellate. The branches originate from the axes at an approximate angle of 60°. Observation of the hexagonal shape refers to the panoramic view of the symmetrical organization of the branches at 60-degree angles [22].

The AI analysis in the results chapter includes an evaluation of the statistical method used to identify the P-type digitization pattern with 100% accuracy. Compared to other digitization patterns, this pattern showed 100% identification efficiency, demonstrating high

precision thanks to its unique branching characteristics, which make it easily distinguishable in comparative tests. While it is possible to find this pattern within the fertile window, neither its duration nor the beginning or end of this window are indicated.

Regarding the results in table 3. “Positive pregnancy outcomes: In a small subgroup of six patients who showed the P-type pattern, 83% (5 out of 6) achieved a live-birth pregnancy”, and “High pregnancy rate: In the subgroup assessed for outcomes, 83% of patients (5 out of 6) with positive P-type crystallization results achieved a live-birth pregnancy”. Although these statements are correct in relation to the study, it should be interpreted in the context of the study and cannot be generalized to indicate a high pregnancy rate. As this is a pilot study, further research with more participants is needed. Humans remain responsible for logic, design, and, crucially, the validation of results [1].

That’s why AI sometimes amplifies claims, making them as impactful as this one: Accurate identification of fertile window: “The P-type crystallization biomarker, observed in the liquid endocervical biopsy, accurately identified the most fertile days for all participants. The optimal fertile window was identified between three days before the estimated day of ovulation (EDO) and the day of peak fertility (P-Day)” and “Fertile window prediction: The P-type crystallization pattern was observed in all participants and accurately pinpointed the fertile window, which was identified as the period from three days before the estimated day of ovulation (EDO) until the peak day (P-Day)”. These statements reverse the correct logical sequence. First, the last sentence should be mentioned, in which the fertile window interval correctly identifies the most fertile days. The finding of P-type crystallization falls within that interval and coincides with the most fertile days of the fertile window.

Among the findings interpreted in the study, the AI analysis notes that the study found this biomarker accurately identified the most fertile days and was associated with a high live birth rate in a follow-up subgroup, as shown in table 4. While this statement is accurate, its proper interpretation requires considering the study’s context. Further studies with a larger patient sample are recommended for a more meaningful evaluation. The study in question is promising, and the author provides a cautious citation; further studies with larger patient samples are necessary to enable a more robust and generalizable evaluation. It is also worth noting that this could benefit patients.

This approach is based on the well-known fact that cervical mucus changes throughout the menstrual cycle due to hormonal fluctuations. As oestrogen levels rise before ovulation, the mucus becomes thinner and more slippery, resulting in a distinct crystallization pattern when it dries. In this context, the AI identifies the potential benefit of combining cervical secretion crystallization analysis with traditional fertility assessments to improve the diagnosis of the fertile window in the key findings chapter in table 5. However, this claim needs to be verified in future studies involving a larger number of patients.

The integration of cervical secretion crystallization analysis with established fertility observation methods could assist couples in scheduling intercourse more effectively, thereby potentially improving conception rates. As noted in the AI interpretation in table 6, this combined approach holds potential for enhancing the diagnosis of the fertile window. Although the study does not employ a traditional comparative methodology, it applies well-founded concepts derived from validated methods for detecting the fertile window. The crystallization pattern is not interpreted in isolation, but as part of a comprehensive clinical assessment incorporating fertility biomarkers. Although its conclusions remain preliminary, this integrative framework reinforces the conceptual basis of the study.

AI suggests a promising, non-invasive method of improving fertility management, particularly in conjunction with NaProTechnology and RRM approaches. However, the endocervical biopsy used to collect the sample is an invasive procedure, which contradicts the claim that this is a non-invasive method. Another interpretation of this point includes the interpretation that they are less invasive compared to procedures such as intrauterine artificial insemination (IAI) or *in vitro* fertilization (IVF). However, the study should be conducted through clinical evaluation of the fertile window. This method allows for a more personalized approach to fertility awareness and timing intercourse to maximize the chances of pregnancy and provides a valuable strategy for patients seeking alternatives to IVF or IUI, and

it could be a useful alternative for patients who cannot undergo more invasive or difficult-to-access methods. Table 7 summarizes these statements.

Furthermore, the current analytical framework does not permit a more in-depth evaluation of the results obtained by combining cervical mucus analysis with sperm motility assessment in postcoital tests. In this regard, cervical mucus and optimal fertility conditions are evaluated using an adapted strategy that combines features of the Billings, CrMS and cervical mucus score to approximate ideal conditions for sperm motility [13,14,20,21,24,25]. A positive correlation with pregnancy has been observed in 83% of cases within the subgroup [12] when all three of the following criteria are met: a good cervical mucus result, a hexagonal P-type crystallization pattern and good sperm motility.

Nevertheless, this is a developing field with a promising future, provided it adheres to control standards. It is important to recognize that AI is a twenty-first-century tool which facilitates the advancement of research by enabling the presentation and interpretation of data within a supervised framework.

Future possibilities could be a useful biomarker when combined with other fertility assessments, potentially leading to more accurate fertility tools in the future. And other ways to make future fertile options could have been developed in the future, those promising results open the door for further research and the potential development of new fertility monitoring tools.

The accuracy of AI depends entirely on the data used for training. If the training data is not sufficiently comprehensive, representative or accurate for a specialized field, the AI will perpetuate those biases or limitations. Therefore, we believe that contributing a critical evaluation to RRM could be valuable, providing feedback on the scientific data interpreted by the complex generative domains of AI [13-15,26,27].

### Conclusion

The AI-generated analysis of the article demonstrates a high degree of organizational clarity, facilitating the structured review of complex scientific material and is a valuable aid in structuring a critical analysis.

While the current AI assessment is useful, it must be reviewed by qualified scientific personnel to avoid errors. The results generated by the AI are often presented in an accessible and appealing manner, which may inadvertently lead to oversimplification.

Consequently, individuals without specialized knowledge of the subject matter may be susceptible to misinterpreting the information provided by the AI within the context of this study. It is therefore advisable to verify AI-generated data and interpretations with domain experts who possess the requisite familiarity with the field.

In conclusion, the optimal approach lies in integrating rigorous scientific and ethical evaluation with the organizational efficiency offered by AI-assisted critical analysis. This hybrid model leverages the strengths of both human expertise and artificial intelligence while mitigating their respective limitations.

### Author Contributions

JMM wrote the article, conducted the research, analyzed the data and made the final revisions and adjustments to the manuscript. JME contributed to evaluating and conceptualizing the application of AI-assisted critical analysis. MME contributed to the conceptualization and final style corrections. MM participated in conceptualizing the work and conducting the preliminary study's statistical analysis. All authors agree with the manuscript.

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## Ethics Approval and Consent to Participate

The stage analysis was based on a previously published study [12], for which all patients gave informed consent before participating. The study was conducted in strict accordance with the Declaration of Helsinki. The study protocol was approved by the Ethics Committee of the Biomedical Research Centre of La Rioja (CEImLAR) (authorisation number PI-548) [12]. The clinical data analyzed in this study are registered in the clinical trial conducted at <https://www.isrctn.com/> (registration number: ISRCTN18705969; registration link: <https://www.isrctn.com/ISRCTN18705969>).

Please note that ChatGPT is intended as a supplementary tool and that the authors bear ultimate responsibility for the research and its findings. Academic integrity is paramount, as is the author's responsibility for interpreting the work.

## Conflict of Interest

The authors declare no conflict of interest.

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