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Impact of SNAPPS Clinical Supervision Method on Clinical Reasoning of Post-Graduation Medical Residents: A Mixed Methods Study in a Real Clinical Context

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Abstract

Objectives: To assess the impact of the SNAPPS method on postgraduate residents' clinical reasoning and the quality of oral case presentations compared to the traditional method. **Design:** A randomized mixed-methods study with a pragmatic approach. **Setting:** Four medical departments in University Hospital of Constantine, Algeria. **Participants:** Sixteen residents in real-world practice and eleven clinical supervisors. The SNAPPS group (residents/supervisors) received training and framework; controls had neither. **Main outcomes measures:** Bordage DTI score in both groups. Analysis oral case presentations in traditional method (24 cases) with an analysis grid based on clinical reasoning steps. We used the SNAPPS grid for SNAPPS group oral case presentations (24 cases). Participants' perceptions and experiences were collected through focus groups, along with their feedback. **Results:** The SNAPPS model represents an advancement in supervisors by establishing a continuum between the development of clinical supervisors and learners, integrating them into a shared educational process. This study demonstrated a significant difference in global Bordage DTI score between the two groups. The significant improvement in DTI score was mainly in the "memory structure" subscale, while the "thinking flexibility" subscale did not show a statistically significant difference. Guided by the SNAPPS method, learners formulated a clear synthesis based on relevant data, systematically generated hypotheses, and effectively compared their diagnostic assumptions. They sought clarifications, expressed uncertainties, and identified self-directed learning objectives, whereas traditional presentations

focused on case management. Both learners and supervisors expressed positive perceptions of the SNAPPS method. **Conclusion:** The learner-centered and interactive SNAPPS method, applied in case presentations across four medical disciplines, facilitated the expression of clinical reasoning and case-related uncertainties in the hospital setting by engaging learners in an analytical process. It promoted responsible self-directed learning. The SNAPPS method was well received by all participants, highlighting its relevance and validating its strategic implementation in our context.

Keywords

Postgraduate Residents, SNAPPS, Traditional Method, Clinical Supervision, Clinical Reasoning

1. Introduction

Clinical reasoning (CR) supervision for medical residents represents a major challenge in ensuring the quality of patient care. Residents, as professionals in training, must develop the necessary skills to become competent and autonomous specialists. The clinical environment, with its inherent complexity, requires deep reflection and advanced clinical reasoning skills (Audétat & Laurin, 2010). Yet, around 10% of learners encounter difficulties in their academic journey (Cogan et al., 2020), which highlights the importance of structured and tailored support.

However, the quality of clinical supervision is often compromised by insufficient supervisor training and the lack of standardized practices, which limits its effectiveness (Goodall et al., 2024). Added to this is a major challenge related to time since only 10% of supervision is actually devoted to teaching, while 90% remains focused on the clinical case (Audétat & Laurin, 2018), reducing opportunities for reflection and CR learning. Furthermore, supervisors must balance their own clinical workload with their educational responsibilities, which constitutes an additional challenge (Castro et al., 2009; Vandette et al., 2021). These observations had already emphasized the need to transform supervision practices.

The need to modify clinical supervision practices has been further underscored since the COVID-19 pandemic, which revealed the essential role of effective supervision in supporting the mental health, well-being, and performance of healthcare professionals (Martin et al., 2022). The pandemic also highlighted the structural weaknesses of existing systems, showing that supervision was often reduced in both frequency and duration (Martin et al., 2022). Martin et al. stress that the benefits of clinical supervision can only be achieved if supervision is based on active participation and standardized, high-quality practices (Martin et al., 2022).

The ENGAGE framework, proposed by Martin et al., provides concrete recommendations to improve clinical supervision. It first calls on organizations to examine their current practices in order to improve quality and ensure evidence-

based supervision (Examine). It then emphasizes the need to normalize supervision through clear institutional policies, so that professionals and learners can prioritize it alongside their other duties (Normalize).

ENGAGE also highlights the importance of gathering and supporting caregivers and learners, particularly the most vulnerable (new graduates, junior doctors on the front line), by placing the restorative function of supervision at the center to safeguard their mental health (Gather). Finally, it recommends ensuring better access to a supervisor suited to the specific needs of each learner or professional, developing supervisor training and telesupervision (Grow), and regularly evaluating supervision practices to measure their impact and improve them (Evaluate) (Martin et al., 2022).

In clinical practice, oral case presentation remains the preferred activity for students, yet it often leads them to report facts rather than articulate their reasoning, making assessment difficult (Melvin & Cavalcanti, 2016; Foley et al., 1979).

The traditional method, almost exclusively centered on case resolution, fosters a passive role for the learner and does not encourage the development of explicit and structured reasoning (Irby, 1995; Wolpaw et al., 2003).

Our recent pilot study confirmed these limitations, showing that the traditional method does not foster the verbalization of learners' clinical reasoning (Debbache et al., 2025). Moreover, Rodin et al. emphasized the need to adopt a shared language to facilitate communication, as well as to refresh (Rodin et al., 2021) and adapt the traditional structure of oral case presentations to meet the demands of contemporary medical practice in a constantly evolving context. It therefore becomes essential to adopt modern methods to enhance and encourage the verbalization of the CR process.

In this context, pedagogical and organizational innovation becomes essential for change. The SNAPPS method, described by Wolpaw et al. (Wolpaw et al., 2009), proposes a structured, learner-centered supervision model in six steps (Summarize, Narrow down, Analyze, Probe, Plan, Select), which requires students to make their reasoning explicit, prioritize their hypotheses, ask questions, and define their personal objectives (Wolpaw et al., 2009; Irby & Wilkerson, 2008; Cogan et al., 2020).

Unlike the traditional method, SNAPPS optimizes supervision time, refocuses the exchange on the learner's reasoning, fosters a shared language with the supervisor, and strengthens mutual trust (Cogan et al., 2020).

Thus, transforming clinical supervision practices has become a necessity. Adopting innovative models such as SNAPPS, combined with the recommendations of ENGAGE (evaluation, institutional standardization, caregiver support, and ongoing supervisor training), would help correct current imbalances, support struggling learners, and ensure effective, sustainable, and well-adapted supervision to meet the challenges of medical practice (Martin et al., 2022; Goodall et al., 2024).

In our context, in Algeria, access to postgraduate medical specialty training

takes place through a competitive national residency examination. This annual, national, ranking, and qualifying examination (Article 8, Decree 594 of July 2001) is open to candidates holding a medical degree after completing seven years of medical studies.

The duration of training varies according to the specialty, ranging from four to five years, and it concludes with a final national examination leading to the awarding of the Diplôme d'Études Médicales Spéciales (DEMS), specifying the specialty obtained.

Within our faculty framework, the residency period holds a crucial role in the training of future medical specialists.

Compared with externships and internships, residency is characterized by increased responsibility, as residents assume the management of their patients.

The teaching framework during residency closely mirrors the realities of medical practice, and residents are therefore challenged to develop their clinical reasoning skills in contexts specific to medical, surgical, and fundamental specialties.

On the side of clinical supervisors, there is no specific training in supervision strategies and methods; supervision is most often carried out intuitively, with supervisors acquiring these skills informally through experience and the transmission of knowledge from senior colleagues and mentors.

Indirect clinical supervision is a core teaching practice for developing residents' clinical reasoning skills, and it finds its ideal setting in oral case presentations during daily morning report and staff meetings.

During these sessions, a resident presents their on-call report. Using the patients' medical records, they walk the group through the cases they managed. The audience comprises a diverse mix of senior attending physicians, residents at various training levels, and graduate-level learners (such as interns and medical students).

The supervising clinicians then guide the presenter, using a traditional method based on experience. This setting creates a valuable vicarious learning opportunity for the entire audience.

The present study builds upon the findings of a recent narrative literature review we conducted, which identified a critical need for further research on the SNAPPS method, particularly in diverse contexts and concerning its generalizability. This comprehensive review currently in the submission process under the title: "Méthode SNAPPS: quel impact sur le raisonnement clinique? Une revue narrative de la littérature", serves as the theoretical foundation for the present investigation.

2. Methodology

2.1. Study Design

To ensure methodological rigor and transparency, this pragmatic randomized trial adhered to CONSORT Checklist Adapted for Pragmatic Trials (**Supplementary Material 2**) and PRECIS-2 tool (**Supplementary Material 3**).

A randomized controlled research was carried out to achieve the objectives of the study from February 2024 to June 2024, followed by database analysis and interpretation.

The present study aimed to determine whether the SNAPPS clinical supervision method improves the clinical reasoning of residents compared to the conventional method in the context of oral patient case presentations and how SNAPPS influences the quality of these presentations. To address this two-part objective, a mixed-methods study with a pragmatic approach was adopted.

This pragmatic approach was chosen to prioritize external validity, and assessing the effectiveness of the intervention in a real clinical context would further strengthen the methodological justification.

The quantitative component aimed to compare the DTI score (Bordage et al., 1990) between the control group and the experimental group.

The qualitative component, on the other hand, sought to compare verbatim transcripts of oral case presentations using the conventional and SNAPPS methods by identifying the structure and key steps in the clinical reasoning process.

Thus, the study objective was approached by simultaneously collecting and analysing both qualitative and quantitative data, followed by merging the results to perform triangulation, integration, and interpretation (**Figure 1**).

Our research questions were as follows:

1) Does the SNAPPS clinical supervision method impact learners' clinical reasoning compared to the conventional approach in the context of oral patient case presentations?

2) Does the SNAPPS clinical supervision method enhance the quality of case presentations?

2.2. Study Setting

The study was carried out at four medical departments namely internal medicine, infectious diseases, cardiology, and hematology at Benbadis Hospital University Center in Algeria.

The study was conducted across four departments for several reasons. Since clinical reasoning is a crucial skill for all healthcare professionals, it is essential that physicians in specialty training acquire it regardless of their discipline. In addition, diversifying participants allowed for wider dissemination of the innovative method and broadened the scope of the study. This approach also made it possible to assess the feasibility and practicality of the method in different departmental contexts. Finally, carrying out the study across multiple departments helped strengthen the external validity and generalizability of the results.

2.3. Participant Recruitment

Eligible participants were postgraduate students pursuing their residency degree in four medical specialties as cardiology, internal medicine, infectious diseases, and hematology. This included four residents per discipline. We included residents from all levels of residency training. This selection aimed to increase the

diversity of participants in our study. We conducted in-person visits to the respective departments included in the study to meet with the residents, providing them with information about the study, its objectives, benefits, methodology, and data confidentiality. Participants were invited to voluntarily participate in the study. It was clarified that their participation or non-participation would have no impact on their evaluations. We obtained their consent for audio recording of the oral case presentations and the focus group.

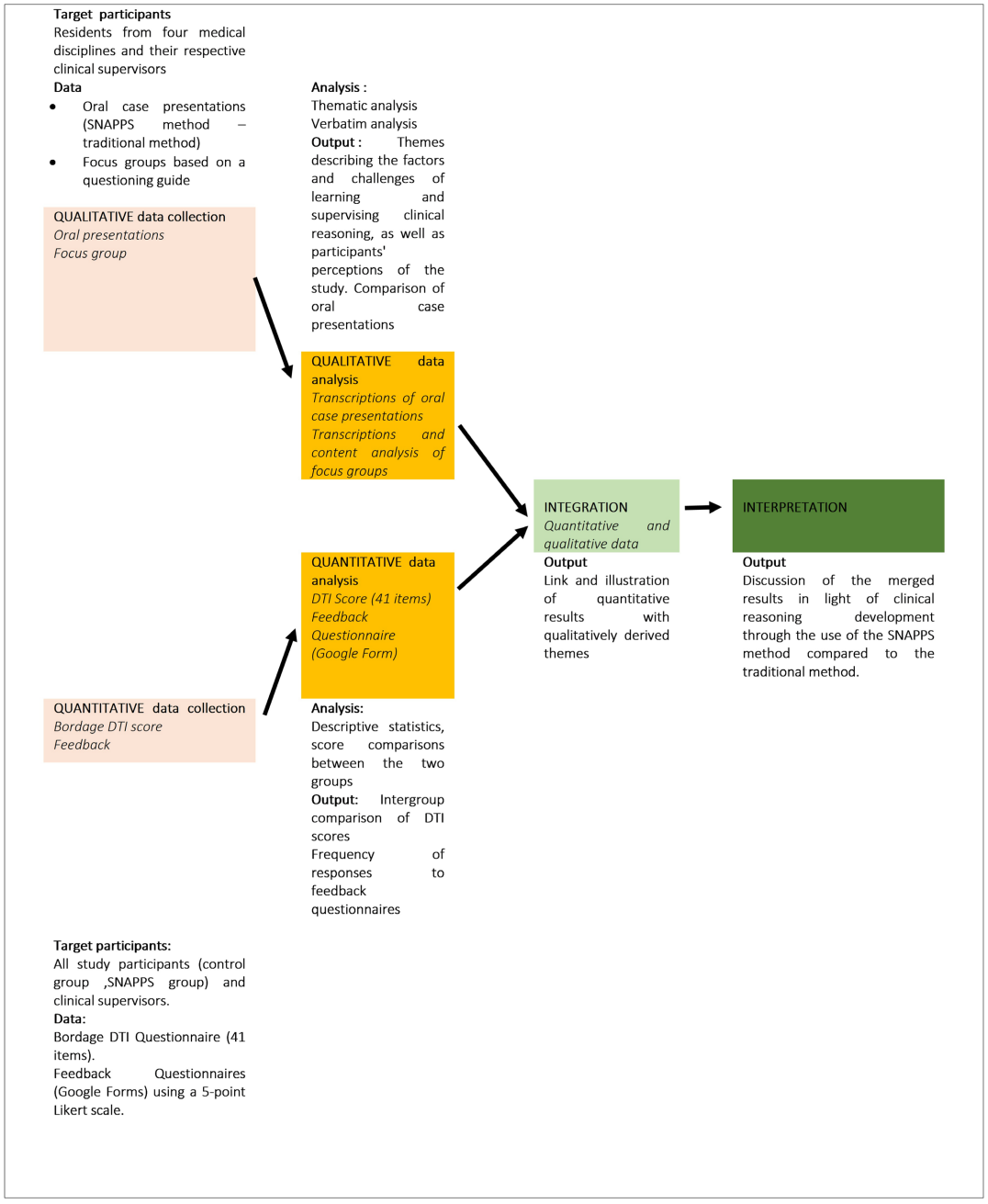

Figure 1. Mixed-methods research design with a pragmatic approach to gain an in-depth understanding of the impact of the SNAPPS method on residents' clinical reasoning and how it influences the quality of oral clinical case presentations.

The eligible clinical supervisors were from the same respective departments as the learners. This group included four assistant professors, three lecturers, and four professors.

2.4. Randomization

We conducted a randomized study with two groups using a pragmatic approach (Morandi, 2004) to address the specific needs and constraints of the study across four different clinical settings.

Randomization with pragmatic approach was a crucial methodological feature to balance the characteristics between groups, reduce selection bias, and improve their comparability.

Our methodological choice aimed to strike a balance between scientific rigor and practical applicability, ensuring that the results could be relevant to real-world clinical learning environments. Each specialty faced challenges related to participant availability, the limited number of participants (four per specialty), their daily responsibilities, and workload. Before starting data collection, and in line with the initial study protocol, we made practical adjustments specific to each specialty.

These adjustments focused solely on the level of training to ensure diversity and balance between the two groups in terms of specialty representation and years of study, without influencing participants' performance (**Table 1**).

Within each specialty, we assigned the four participants into two subgroups (control and experimental), considering the specific constraints of each discipline, following a block randomization approach. The subgroups were then merged to form the final study groups: the SNAPPS group (8 participants) and the control group (8 participants).

Control Group: *Traditional Method*

The eight learners assigned to the control group used the traditional case presentation method and received no training. They were asked to present cases following the usual approach in their respective departments. Cases were selected based on the participants' level of knowledge. Data collection for the control group took place before the SNAPPS training workshop to eliminate the risk of between-group contamination bias.

Experimental group: *SNAPPS Group*

Four weeks before the oral case presentation recordings, the eight learners assigned to the SNAPPS group attended a 60-minute online training workshop on the SNAPPS method, led by the authors of this study. During the workshop, they were introduced to the concept of clinical reasoning and trained in the SNAPPS method. Participants received a SNAPPS guide (Audétat & Laurin, 2018) and were encouraged to use this innovative method in their respective clinical settings to become familiar with it through practice.

We asked participants to prepare clinical case presentations under the supervision of their respective clinical instructors involved in the study.

Clinical Supervisors

Four weeks before the oral case presentations using the SNAPPS method, the eleven participating supervisors attended a 60-minute online training workshop on clinical reasoning supervision concept and the SNAPPS method. They received the same SNAPPS guide (Audétat & Laurin, 2018) as the participants in the SNAPPS group. We informed them that this method should be used for case presentations by SNAPPS group participants and encouraged them to integrate it into their clinical supervision practice before recording the presentations.

2.5. Data Collection

Sociodemographic characteristcis of all learners and clinical supervisors were collected (**Supplementary Material 1**).

2.5.1. Quantitative Study Arm

Diagnostic Thinking Inventory (*DTI*)

The quantitative part of the study aimed to assess the residents' diagnostic thinking process. The Diagnostic Thinking Inventory (DTI) is a validated and reliable 41-item tool designed to evaluate clinical reasoning skills in medical education (Bordage et al., 1990). The DTI measures two key cognitive dimensions identified in clinical reasoning research namely flexibility in thinking (21 items), and memory structure (20 items).

Each item includes a main statement, two contrasting affirmations on a continuum, and a 6-point rating scale. The reliability of the instrument has been established among medical students (overall Cronbach's $\alpha = 0.83$; and the flexibility and memory structure subscales have alpha values of 0.72 and 0.74, respectively (Wolpaw et al., 2003).

For this study, the Bordage DTI was translated into French and validated by the research committee. The experimental group was trained in SNAPPS method and the DTI Bordage score was collected afterward, whereas the control group was only evaluated at baseline, without any exposure to the new method.

Feedback from Residents and Clinical Supervisors

At the end of the study, we collected feedback from all participants—residents and clinical supervisors—on both the traditional method and the SNAPPS method. This was done through an online questionnaire (Google Forms), which included closed-ended questions and a 5-point Likert scale (**Supplementary Material 1**).

Data Analysis

DTI Scores Analysis

Quantitative data analysis was performed using EPI Info 7.1.3.3, with a significance threshold set at $p \leq 0.05$.

We calculated the mean and standard deviation for the global DTI score and its two subscales (flexibility in thinking and memory structure). These scores were compared between the two groups.

The global DTI score and subscale scores were manually calculated using the established scoring grid in Bordage DTI Score (Bordage et al., 1990) on paper forms before being directly entered into Epi Info™ version 7.1.3.3. Mean score comparisons between groups were performed using the Cross Tabulation function, which automatically provided Bartlett's test for homogeneity of variances alongside both ANOVA and Mann-Whitney-Wilcoxon results.

When Bartlett's test indicated significant variance heterogeneity ($p < 0.05$), indicating that ANOVA was not appropriate, the Mann-Whitney-Wilcoxon test results were selected for group comparisons.

Feedback Questionnaire Analysis

The analysis of the feedback questionnaires, specific to each group (control group, SNAPPS group, and supervisor group), helped us understand their perceptions of the traditional method and the SNAPPS method.

For the learners in both the control and SNAPPS groups, the analysis was carried out using Epi Info™ software, version 7.1.3.3. First, the items with their response options, and all participants' answers, were entered into the software. Based on these data, the response frequencies and trends were calculated.

Subsequently, for each item, the mean global Bordage DTI score were computed using Epi Info "Mean" function combined with "Stratify by". For each item, the software automatically provided the corresponding mean scores according to the different response categories (**Supplementary Material 1**).

For clinical supervisors, the feedback analysis was conducted directly from the descriptive statistics automatically generated by Google Forms, which provided the response frequencies for each item (**Supplementary Material 1**).

This approach allowed us to gain a clear overview of majority trends among participants.

2.5.2. Qualitative Study Arm

The qualitative part of the study aimed to answer the research question: "Does the SNAPPS method influence the quality of oral case presentations compared to the traditional method?"

Oral Case Presentations

We collected case presentations using both the traditional method and the SNAPPS method. Sixteen participants were invited to give three case presentations each in their respective clinical departments. This approach allowed us to observe changes in their presentation style within their real-world learning and practice environments. We excluded clinician supervisors from the control group to minimize the Hawthorne effect, assuming this would allow learners to present their cases as they normally would (Zhang, 2024).

Clinical supervisors trained in the SNAPPS method supervised the case presentations of experimental group.

The recordings from both groups were anonymized and transcribed to generate verbatim transcripts. In total, 48 case presentations were collected, (24 us-

ing the traditional method and 24 using SNAPPS). The cases were routine cases admitted to different departments. Learners of each specialty selected clinical cases in consultation with their respective clinical supervisors to ensure they aligned with their level of knowledge spanning from the first to the fifth year of residency.

Focus Groups

We conducted a 90-minute focus group (FG) (Krueger & Casey, 2015) with residents from both the traditional and SNAPPS groups. The discussion focused on their experiences with oral case presentations, their perceptions of clinical reasoning, and its supervision.

A second 90-minute focus group was held with clinical supervisors to gather their insights, experiences, and opinions regarding their usual supervision practices for clinical reasoning.

Data Analysis

We used ATLAS.ti software, version 24.0.0.29576 to analyse data from both methods of oral case presentations, each with its own grid, as well as from focus groups, all of which were transcribed verbatim.

Theoretical Frameworks

Analytical Grid

To assess the quality of oral presentations, we relied on the variables initially developed by Wolpaw et al. (Wolpaw et al., 2003). These include data summarization, hypothesis generation, hypothesis analysis, expression of uncertainties and clarification, discussion on patient management, and identification of self-learning objectives.

We used the SNAPPS grid (Audétat & Laurin, 2018) for SNAPPS group oral case presentations (**Supplementary Material 1**).

The oral case presentations in traditional method were analysed with an analysis grid constructed from the clinical reasoning steps (Audétat et al., 2017) (**Supplementary Material 1**).

Both SNAPPS and traditional method presentations were transcribed verbatim and analysed using predefined coding grids in ATLAS.ti version 24.0.0.29576.

Questioning Guide

Two structured guides in the form of conversational questions were developed for the focus groups (one for residents and one for supervisors (**Supplementary Material 1**). Each guide included opening questions, introductory questions, transition questions, key questions, and closing questions (Krueger & Casey, 2015).

Thematic Analysis

The focus group transcripts were analysed to explore participants' experiences and perceptions regarding clinical reasoning in oral case presentations using ATLAS.ti software, version 24.0.0.29576.

We conducted a thematic analysis following Braun & Clarke's methodology (Braun & Clarke, 2006).

A mixed approach was used with deductive analysis using the SNAPPS frame-

work and inductive analysis to identify emerging themes and enrich the findings. The transcripts were analysed iteratively using ATLAS.ti 24, with codes grouped into categories to define the main themes. These themes were illustrated with participant quotes reflecting their clinical reasoning process.

3. Results

3.1. Quantitative Study Arm

3.1.1. Sociodemographic Characteristics of Participants

A total of 16 residents and 11 clinical supervisors participated in the study. The average age of participants was 29 ± 3 years in the SNAPPS group and 29 ± 1 years in the control group. Both groups had a majority of female participants (Table 1).

Table 1. Representativeness of specialties and learner's academic level.

Parameters		SNAPPS group (n = 8)	Control group (Traditional method) (n = 8)
Age (years) (Mean ± Standard deviation)		29 ± 3 (Extremes: 24 - 33)	29 ± 1 (Extremes: 26 - 30)
Gender		5 Females, 3 males	8 Females
Disciplines	Cardiology	1st year, 2nd year	3rd year, 4th year
	Internal medicine	2nd year, 5th year	1st year, 3rd year
	Hematology	3rd year, 4th year	1st year, 4th year (There is no 2nd-year resident in this discipline., which is why a 4th-year level of the same specialty is present in both groups)
	Infectious diseases	1st year, 4th year	2nd year, 4th year (There is no 3rd-year resident in this discipline, which is why a 4th-year level of the same specialty is present in both groups).
	In summary	1st (2participants), 2nd (2participants), 3rd (1participant), 4th (2participants), and 5th year (1 participant)	1st (2participants), 2nd (1participant), 3rd (2participants), and 4th year (3 participants).

The supervisors were also predominantly female (Table 2), with an average of 20 ± 7 years of experience in clinical supervision (Table 2).

In our specific context, among the medical disciplines included in this study, Internal Medicine is the only medical specialty with a 5-year training program, while all other specialties have a 4-year training program.

Table 2. Sociodemographic characteristics of clinical supervisors.

Parameters		Clinical supervisors
N (Number)		11
Gender		10 females, 1male
Age (years) (Mean ± Standard deviation)		54 ± 5
Number of years of experience in supervision (Mean ± Standard deviation)		20 ± 7
Discipline	Internal medicine	4
	Infectious diseases	3
	Hematology	2
	Cardiology	2

3.1.2. Global DTI Score and Its Two Subscales in Between-Group Comparison

We obtained 100% complete responses for Bordage's DTI questionnaire in both groups. The results are presented in Table 3.

Table 3. Intergroup comparison of global Bordage DTI scores and subscales.

Scores	SNAPPS group (Mean ± Standard deviation)	Control group (Mean ± Standard deviation)	*p value*
Global DTI Score	198 ± 14	166 ± 31	0.0023
Flexibility of thinking	92 ± 10	81 ± 13	0.0888
Memory structure	106 ± 9	85 ± 19	0.0144

The mean global DTI score was 198 ± 14 in the SNAPPS group versus 166 ± 31 in the control group, with a statistically significant difference ($p = 0.0023$) (Table 3).

Participants in the SNAPPS group had a mean memory structure score of 106 ± 9, compared to 85 ± 19 in the control group, with a statistically significant difference ($p = 0.0144$) (Table 3).

The score for the flexibility of thinking dimension was 92 ± 10 in the SNAPPS group versus 81 ± 13 in the control group, the difference was not statistically significant ($p = 0.0888$) (Table 3).

3.1.3. Feedback

Residents

The feedback results for both the control and SNAPPS groups are provided in **Supplementary Material 1**.

The responses reveal significant differences between the traditional method and the SNAPPS method in terms of residents' perceived effectiveness at various key

stages of their clinical reasoning process during oral case presentations. Overall, residents' perceptions of the SNAPPS method were much more positive compared to the traditional approach across all aspects studied.

This suggests that SNAPPS is seen as more beneficial for improving the expression of clinical reasoning (Q1), structuring oral case presentations (Q2), building confidence (Q3), fostering responsibility (Q4), promoting active engagement (Q6), encouraging residents to ask questions to clinical instructors (Q7), and supporting self-directed learning (Q5) (**Supplementary Material 1**).

For each of these aspects, the average global DTI scores in the SNAPPS group were higher (ranging from 184 to 207) compared to the control group (ranging from 126 to 189) (**Supplementary Material 1**).

However, the traditional method was still perceived satisfactorily (Q1) by four respondents but was noted to have several limitations. This trend is evident in responses such as "Slight" for Q6 and Q7, "Not very effective" for Q2 and Q4, "Slightly" for Q5, and "A few" or "Significant difficulties" for Q3 (**Supplementary Material 1**).

Clinical Supervisors

The feedback results from clinical supervisors are also provided in **Supplementary Material 1**. The findings indicate that the SNAPPS method was well received and perceived as relevant (Q9). It was considered effective in supporting the expression of clinical reasoning during oral case presentations (Q3), improving residents' preparation for case presentations (Q8), and enhancing their confidence (Q5). SNAPPS also facilitates a learner-centered approach (Q1), helps better structure oral presentations (Q2), optimizes the educational quality of case presentations (Q7), and encourages active learner engagement (Q4).

Time management was also seen as a positive aspect of the SNAPPS method (Q6). Additionally, clinical supervisors expressed a strong need for ongoing training in clinical supervision strategies (Q10), indicating a willingness to further develop their teaching skills and successfully implement this innovative SNAPPS approach.

3.2. Qualitative Study Arm

3.2.1. Oral Case Presentations: SNAPPS vs. Traditional Method

Duration

The average duration of presentations using the SNAPPS method was 13 minutes 51 seconds ± 3 mn 32 seconds, with the longest lasting 24 minutes 41 seconds and the shortest 5 minutes 26 seconds. In comparison, the traditional method had an average duration of 5 minutes 13 seconds ± 2 minutes 8 seconds, with a maximum of 9 minutes 41 seconds and the shortest 2 minutes 5 seconds.

Summary

The summary step was present in all SNAPPS transcripts (24 citations) (Table 4), but was missing in some transcripts from the traditional method (17 citations) (Table 4).

Table 4. Comparing the frequencies of the components of the clinical reasoning process.

Clinical reasoning steps	SNAPPS group 24 verbatims	Control group (traditional method) 24 verbatims
Main complaint/symptom	23 citations	9 citations
Admission diagnosis	0	15 citations
Physical examination	24 citations	22 citations
Summary	24 citations	17 citations
Hypothesis generation step	24	4
Differential diagnoses/hypotheses (Number)	154 citations	11 citations
Arguments	235 citations	0 citations
Final presumptive diagnosis	21 citations	7 citations
Asking questions	33 citations	Not applicable
Self-directed learning objectives	56 citations	0 citations

In the SNAPPS method, the case summary was structured, clear, and included key details such as the chief complaint, medical history, past conditions, and physical examination. In contrast, in the traditional method, summaries were often limited to the chief complaint. Additionally, in the traditional method, the chief complaint was not always clearly stated (9 citations) and was sometimes replaced by the final diagnosis (15 citations) (Table 4), skipping the differential diagnosis step.

Hypothesis Generation

Participants in the SNAPPS group generated more than three hypotheses (154 citations) (Table 4), each justified by the collected data. In contrast, hypothesis generation step was rare in the traditional method (4 citations) (Table 4), and occurred only occasionally (11 citations) (Table 4), and when present, it often occurred only after complementary tests had been ordered.

Justification of Hypotheses and Differential Diagnoses

All participants in the SNAPPS group justified their diagnostic hypotheses with arguments (235 citations) (Table 4) based on relevant collected data.

Expression of Uncertainties

All learners using the SNAPPS method expressed their uncertainties by asking questions and engaging in interactive discussions with their respective clinical supervisors (33 citations) (Table 4). These uncertainties often concern decisions regarding complementary tests and treatment options.

Case planning and management

In the SNAPPS method, case management was discussed and justified based on the generated hypotheses and a presumptive diagnosis (21 citations) (Table 4). In contrast, in the traditional method, case management plans were often brief, lacking details, and not supported by a final presumptive diagnosis (7 citations) (Table 4) and complementary tests were frequently ordered before generating hypothe-

ses, without justification or data integration.

Self-directed learning objectives

All participants in the SNAPPS group identified learning objectives related to the cases and selected relevant readings (56 citations) (Table 4).

Trainee-Supervisor Interaction

The SNAPPS method encouraged interactions focused on learners' clinical reasoning (CR).

Supervisors' approach

During SNAPPS presentations, supervisors provided targeted feedback on participants' thought processes and expressed uncertainties.

3.2.2. Focus Groups

The qualitative part of the study aimed to explore participants' experiences and opinions on using the traditional method in case presentations and the SNAPPS method through a series of conversational questions.

Thematic analysis of the focus groups with residents and clinical supervisors identified several key themes. These themes highlight the limitations of the traditional method and the benefits of SNAPPS in facilitating learners express their clinical reasoning (CR).

Textual excerpts illustrating the participants' statements are referenced as Participant X – Quote Y (PX-Y) and compiled in **Supplementary Material 1**.

Both clinical supervisors and residents shared similar observations regarding the expression of CR during case presentations.

Intuitive clinical supervision—Lack of medical education training

Clinical educators stated that their supervision of CR is mainly intuitive (P04-1:181 ¶ 810, P08-1:169 ¶ 736-739) and expressed the lack of pedagogical training or strategies for clinical supervision (P06-1:231 ¶ 1189, P05-1:8 ¶ 43, P02-1:2 ¶ 28-29, P03-1:137 ¶ 546).

Supervisors across the four medical disciplines explained that mentors played a key role in passing down teaching and supervision methods (P05-1:8 ¶ 43, P03-1:4 ¶ 36-37, P04-1:137 ¶ 546, P02-1:2 ¶ 28-29).

Lack of clear structure in the traditional method

Discussions with learners revealed that oral case presentations based on medical observation vary between disciplines and contexts (P05-1:3 ¶ 15, P01-1:1 ¶ 12).

Additionally, several supervisors emphasized that presentations are focused on factual reporting (P02-1:23 ¶ 84, P04-1:25 ¶ 90, P07-1:26 ¶ 92).

Difficulties in expressing clinical reasoning

When asked how they usually express their CR, one participant admitted that it is not always easy (P01-1:78 ¶ 161).

Discussions with both learners and supervisors about the traditional method revealed that it does not facilitate CR expression at various stages of the oral case presentation process.

Learners reported difficulties in collecting and sorting relevant data (P05-1:56 ¶ 126, P03-1:53 ¶ 120, P03-1:54 ¶ 121), a concern also raised by supervisors (P07-

1:36 ¶ 140-141, P04-1:38 ¶ 147).

The stage of generating hypotheses and differential diagnoses was particularly challenging, as mentioned by a learner (P01-1:24 ¶ 56) and confirmed by supervisors (P01-1:112 ¶ 439, P05-1:106 ¶ 411-412).

A supervisor pointed out difficulties in prioritizing information among learners (P04-1:124 ¶ 494).

Learners also reported struggling with synthesizing and integrating complementary data (P05-1:22 ¶ 54, P05-1:57 ¶ 127), an issue confirmed by supervisors (P01-1:33 ¶ 130-132, P02-1:103 ¶ 392-394).

Traditional method as a "Case management-centered" approach

Learners described the traditional method as being primarily focused on case management (P06-1:10 ¶ 26), an aspect also confirmed by a supervisor (P08-1:194 ¶ 917).

Lack of interaction between supervisor and learner

According to one supervisor, the traditional method of supervision during case presentations does not promote meaningful interaction between supervisors and learners, nor does it encourage learners to ask questions (P03-1:129 ¶ 518-523).

A learner echoed this concern, stating that supervision is too directive (P03-1:27 ¶ 68).

Challenges related to the supervisors' teaching pace

Residents reported difficulties with the fast-paced and directive teaching approach of clinical supervisors using the traditional method. This approach often leads to a lack of explicit reasoning from the supervisors (P03-1:27 ¶ 68, P03-1:41 ¶ 107).

The challenge of time

Clinical supervisors unanimously highlighted time constraints as a major challenge in CR supervision (P08-1:154 ¶ 638, P09-1:173 ¶ 754, P07-1:44 ¶ 168, P01-1:144 ¶ 593, P04-1:39 ¶ 148).

Advantages of the SNAPPS method

Participants in the SNAPPS group expressed satisfaction with this innovative method, which offers several advantages for structuring and expressing their CR (P06-1:36 ¶ 104, P06-1:38 ¶ 105, P03-1:40 ¶ 107).

Structuring clinical reasoning

Residents agreed that SNAPPS helped them organize their presentations and better articulate their CR process (P06-1:36 ¶ 104, P06-1:38 ¶ 105, P03-1:40 ¶ 107).

They also noted that SNAPPS enabled them to use their knowledge more effectively when generating hypotheses and differential diagnoses (P01-1:98 ¶ 223, P01-1:99 ¶ 224, P05-1:166 ¶ 726), which encouraged an analytical, hypothesis-driven approach.

Encouraging learners to express uncertainties

Learners reported that SNAPPS encouraged them to ask questions to their supervisors during case presentations (P04-1:86 ¶ 193, P04-1:94 ¶ 217, P06-1:87 ¶ 195, P02-1:89 ¶ 197, P05-1:91 ¶ 200, P05-1:92 ¶ 203, P03-1:40 ¶ 107) and allowed

them to integrate additional information (P01-1:104 ¶ 229).

Improving perceived teaching pace with SNAPPS

Residents stated that SNAPPS slowed down their supervisors' teaching pace, improving the quality of supervision and allowing them to understand their supervisors' CR without feeling rushed (P03-1:42 ¶ 107, P03-1:43 ¶ 108).

Enhancing supervisor-learner interaction

Residents found that SNAPPS significantly improved their relationship with their supervisors (P03-1:46 ¶ 109, P03-1:103 ¶ 228, P04-1:102 ¶ 227, P06-1:88 ¶ 196). This positive perception was also confirmed by a supervisor (P06-1:171 ¶ 746).

Promoting self-directed learning

Residents valued each step of the SNAPPS method and highlighted the importance of setting self-directed learning goals. This suggests that the method fosters a reflective approach during case presentations (P02-1:89 ¶ 197, P03-1:101 ¶ 226).

Improving confidence—reassuring learners during oral case presentations

Learners reported that the SNAPPS method made it easier for them to present and improved their confidence during oral case presentations (P03-1:101 ¶ 226). Supervisors confirmed this positive perception (P05-1:167 ¶ 730).

The SNAPPS method for optimizing supervision time

Clinical supervisors stated that the SNAPPS method is useful for better time management and providing effective clinical supervision (P08-1:168 ¶ 732-733).

The impact of uncertainties on adjusting and guiding educational content during oral presentations

Residents mentioned that the SNAPPS method encouraged supervisors to provide guidance and support for their clinical reasoning (P06-1:37 ¶ 104). A clinical supervisor emphasized that SNAPPS helps tailor supervision content to the learner's needs and uncertainties (P02-1:179 ¶ 794).

SNAPPS across different medical disciplines: Towards generalizability?

At the end of our study, residents expressed a desire to move away from the traditional oral case presentation method and highlighted the relevance of extending SNAPPS to other medical disciplines (P04-1:35 ¶ 101-102, P03-1:114 ¶ 265).

SNAPPS in emergency settings

Clinical supervisors pointed out the challenges of applying the SNAPPS method in emergency situations (P06-1:174 ¶ 758-759, P02-1:177 ¶ 788). However, a resident suggested that SNAPPS could help reach a diagnosis in urgent cases (P05-1:105 ¶ 231).

Supervisors' openness to pedagogical innovation and the need for time – sustainability of the SNAPPS method

Supervisors expressed satisfaction with the applicability of SNAPPS across different medical disciplines but noted that time is needed for learning and adaptation to ensure its long-term use (P08-1:239 ¶ 1233, P05-1:237 ¶ 1229). Learners showed enthusiasm for using the SNAPPS method (P04-1:35 ¶ 101-102, P03-1:114

¶ 265, P03-1:106 ¶ 234).

Impact of the innovative SNAPPS method on supervision practices in clinical departments

Clinical supervisors emphasized the need to change traditional supervision habits by adopting the innovative SNAPPS method (P01-1:170 ¶ 741-744).

3.3. Integration of Qualitative and Quantitative Data

The integration of quantitative and qualitative data allowed us to gain a deeper understanding of the impact of the innovative SNAPPS method on participants' clinical reasoning (CR) in oral case presentations, compared to the conventional method used in each medical discipline under real-life conditions.

Quantitative data revealed a 19.3% difference in global Bordage DTI score between the two groups. Resident feedback also reinforced this finding, as they expressed positive perceptions of SNAPPS, highlighting its effectiveness in strengthening their CR compared to before its experimentation.

Qualitative data, gathered from case presentations and focus groups, highlighted the limitations of the conventional method, which does not fully support the expression of CR at all its stages. The data also showed how the SNAPPS method helped participants articulate and express their CR process at each stage within an interactive setting with their supervisors.

Furthermore, the qualitative data indicated that introducing SNAPPS offers a promising solution for supervisors, helping them overcome time constraints through a learner-centered approach while enabling residents to structure their CR more effectively.

Integrating both datasets provided a broader understanding of the impact of the SNAPPS method on residents' clinical reasoning and the quality of case presentations. The findings are presented below using a thematic approach (Braun & Clarke, 2006).

Theme 1: Improvement in clinical reasoning

Quantitative data showed that participants in the SNAPPS group had higher Bordage DTI scores compared to the control group. These findings were corroborated by qualitative feedback from residents and supervisors, who reported a better understanding of key concepts through structured case presentations. Participants expressed that SNAPPS helped them strengthen and organize their CR more effectively than before its application. The significant difference in DTI scores was further supported by the quality of oral presentations, which demonstrated an analytical approach and the development of reflective practice among SNAPPS participants.

Theme 2: Limitations of the traditional method

Residents highlighted the limitations of the traditional method. They reported (in focus groups and feedback) difficulties in data collection, synthesis, data integration, and hypothesis generation during their oral case presentations, as well as challenges related to the learning pace. These observations further emphasize the

importance of the structured SNAPPS method.

Theme 3: Supervisors' perceptions

Feedback and focus group discussions with supervisors comparing the two methods revealed the limitations of the conventional approach.

Supervisors noted that the traditional method was inherited from previous generations and had become an established practice over time, primarily focusing on the clinical case. However, they also pointed out that this method posed multiple challenges, particularly in terms of time constraints, effectiveness, and adaptability to evolving educational requirements.

In contrast, supervisors recognized that SNAPPS facilitated a learner-centered approach, providing them with an effective strategy to address these challenges and enhance the educational value of residents' oral case presentations.

Theme 4: Relevance of the SNAPPS Method

The integration of qualitative data (verbatim case presentations, focus groups with residents and clinical supervisors) and quantitative data (Bordage DTI scores, feedback) demonstrated the relevance of SNAPPS in supporting CR development. Findings across four different medical disciplines highlighted participants' strong interest in training and applying this method, with genuine enthusiasm for its long-term adoption in various clinical settings.

Theme 5: Impact of uncertainties on content adaptation in oral presentations

Supervisors emphasized that SNAPPS allowed them to identify residents' difficulties, enabling them to tailor their supervision content based on the uncertainties residents expressed during case presentations. Clinical educators reported being ready to respond even to the smallest question and align their teaching with residents' inquiries. These in-context, just-in-time learning moments can be created by residents through the application of SNAPPS (Wolpaw et al., 2012). This critical step further strengthens learner-centered supervision.

4. Discussion

This work follows from a pilot study that revealed gaps in the traditional method (Debbache et al., 2025). The present study therefore investigated an innovative method "SNAPPS" as a means of overcoming these limitations.

We carried out a mixed-methods randomized study with a pragmatic approach, including four medical disciplines in a hospital-university setting, to address our research questions regarding the impact of the SNAPPS method on the clinical reasoning of postgraduate medical residents and the quality of their oral case presentations.

A review of the literature demonstrated the positive impact of using the SNAPPS method on the clinical reasoning of healthcare professionals, but rather in outpatient settings than in hospitals (Kapoor et al., 2017; Pierce et al., 2020; Sawanyawisuth et al., 2015; Jain et al., 2019; Pascoe et al., 2015; Seki et al., 2016). This trend led us to conduct our study in our specific hospital setting.

Numerous comparative studies have demonstrated the effectiveness of the

SNAPPS method in various contexts, including physiotherapy (Berg-Poppe et al., 2022) and midwifery (Abbasi Senjedari et al., 2023; Seki et al., 2016), pediatrics (Barangard et al., 2016; Kapoor et al., 2017), psychiatry (Feijó et al., 2023), nursing students (Nair et al., 2024), ambulatory internal medicine (Sawanyawisuth et al., 2015), forensic medicine (Farrugia et al., 2019), and oral medicine (Khasbage et al., 2018). However, we chose to examine it simultaneously across four disciplines to assess its generalizability.

Previous studies have examined undergraduate (Fagundes et al., 2020; Pierce et al., 2020; Sawanyawisuth et al., 2015; Xu et al., 2021) and postgraduate participants (Barangard et al., 2016; Jain et al., 2019; Kapoor et al., 2017). A systematic review with a meta-analysis of five randomized controlled trials found that SNAPPS might be more beneficial for residents than for medical students (Flores-Cohaila et al., 2024). Its learner-initiated, learner-driven, and learner-centered nature is considered one of its strengths, making it more suitable for advanced learners, according to several medical educators (Chacko et al., 2007).

However, in our specific setting, SNAPPS has not yet been recognized as a supervision method for training residents in clinical reasoning, and no studies have assessed either the conventional method or SNAPPS in our context. This highlights the importance of our study in exploring its applicability and implementation among postgraduate residents.

4.1. Quantitative Data: Diagnostic Thinking Inventory (Bordage DTI)

On the quantitative side, our results showed a significant difference in the global DTI score between the groups, particularly in memory structuring ($p < 0.05$), while cognitive flexibility did not show a significant difference ($p > 0.05$).

The lack of difference observed on the subscale could be explained by the fact that the implementation of the SNAPPS method was limited to the study period. It is likely that participants did not acquire the practical experience necessary to bring about significant changes in cognitive flexibility, which is considered a relatively stable trait, unlikely to evolve in the short term and requiring time to develop.

Furthermore, the SNAPPS method specifically targets clinical reasoning skills by structuring case analysis and the expression of uncertainties, rather than focusing on cognitive flexibility itself. Participants practiced the method only during the study, and therefore did not gain sufficient experience.

However, some studies, such as those by Jain et al. (Jain et al., 2019) and Shindala et al. (Shindala et al., 2024), did not find a statistically significant difference between groups. Others, like Heinerichs et al. (Heinerichs et al., 2013), reported an increase in within-group scores over time but no significant difference between the SNAPPS and conventional methods. These mixed findings highlight the importance of using a multimodal approach to assess different aspects of clinical reasoning. What strengthened our interest in exploring the dimensions of our

participants' diagnostic thinking is the fact that Bordage's DTI has been used to measure the effectiveness and success of educational programs, where students were assessed throughout their academic training to track their progress (Findyartini et al., 2016; Gehlhar et al., 2014; Groves, 2005; Groves et al., 2002, 2003; Sobral, 2000).

4.2. Qualitative Data

4.2.1. Oral Presentation Duration

In our study, the longer presentation time with SNAPPS can be attributed to its structured approach, which requires learners to articulate each step of their clinical reasoning. In contrast, the traditional method did not always make all steps explicit.

Our results are similar to those of Heinerichs et al. (Heinerichs et al., 2013) and Jain et al. (Jain et al., 2019), who reported a significantly longer presentation time in the SNAPPS group compared to the traditional method. Furthermore, the systematic review by Cohaila et al. (Flores-Cohaila et al., 2024), which includes a meta-analysis of five randomized controlled trials, highlights that the SNAPPS method can increase discussion time, the number of differential diagnoses, and the expression of uncertainties, while also promoting self-directed learning. In contrast, the study by Sawanyawisuth et al. (Sawanyawisuth et al., 2015) found no difference between the two methods, which differs from our findings.

4.2.2. Summarize

The comparative analysis of our participants' transcripts revealed differences between the SNAPPS method and the usual approach in terms of expressing and explaining clinical reasoning (CR). With SNAPPS, learners from four medical disciplines were able to articulate their CR at all steps, suggesting its applicability in various clinical settings. Case summaries were generally clear and structured, including relevant data (chief complaint, symptoms, history, past medical history, physical exam). These findings align with Heinerichs et al. (Heinerichs et al., 2013), who reported better-structured presentations and more comprehensive CR expression in the SNAPPS group. Jain et al. (Jain et al., 2019) and Shindala et al. (Shindala et al., 2024) also found more complete and relevant case summaries with this method.

4.2.3. Narrowing Differential Diagnosis

In our study, a major distinction between the two methods lies in the generation of hypotheses and arguments. With the SNAPPS method, this step was consistently present in the presentations across all disciplines, and learners generated more than three diagnoses, whereas participants in the conventional group performed less well in formulating diagnostic hypotheses and tended to move more quickly to the steps of complementary exams and case management. This result is consistent with studies by Ebrahimzadeh & Ramezanzdeh (Ebrahimzadeh & Ramezanzdeh, 2016) and T. Wolpaw et al. (T. Wolpaw et al., 2012).

Furthermore, SNAPPS showed effects similar to those observed by Jain et al. (Jain et al., 2019) and Heinerichs et al. (Heinerichs et al., 2013) who found greater generation of diagnoses in this group. The study by Shindala et al. (Shindala et al., 2024) also highlights the effectiveness of SNAPPS, which encourages more discussion and student engagement.

The hypothesis generation step reflects the deliberate analytical process that occurs through activating a framework of knowledge, linking hypotheses with their clinical signs, and actively searching for positive or negative signs that confirm or rule them out. If a student is unable to formulate a diagnostic hypothesis, the clinical supervisor may have difficulty assessing their level of diagnostic reasoning (Eva, 2005).

4.2.4. Analysing Differential Diagnosis

We observed that students in the SNAPPS group supported their hypotheses by drawing on their overall understanding of the case and their knowledge, which strengthened the quality of their case summaries. Through these steps, they demonstrated a more analytical approach, whereas many participants in the conventional group either did not present a diagnostic hypothesis or failed to provide supporting arguments.

Our results align with those of Jain et al. (Jain et al., 2019), who found that SNAPPS students justified their diagnostic hypotheses more rigorously and compared different diagnoses more effectively. In contrast, as reported by Jain (Jain et al., 2019) and Sawanyawisuth (Sawanyawisuth et al., 2015), students in the control group had less clear hypotheses and tended to move quickly to management decisions, making evaluation and feedback more challenging diagnostic.

Additionally, Heinerichs et al. (Heinerichs et al., 2013) also showed that SNAPPS students articulated their clinical reasoning more clearly and analyzed their hypotheses more precisely.

This step is crucial in the SNAPPS method, as asking students to analyse their diagnostic hypotheses helps prevent tunnel vision and diagnostic errors (Eva, 2005).

4.2.5. Probe Preceptor—Expressing Uncertainties

We observed that all participants in the SNAPPS group, across the four disciplines, expressed their uncertainties with their clinical supervisors regarding hypotheses, complementary tests, or treatment decisions. This led to interactive discussions with supervisors, who also explained their own clinical reasoning.

A targeted mini-teaching session was provided to learners, adapted to their learning pace. Additionally, some learners mentioned in focus groups that traditional supervision felt more directive.

Our results align with those of Jain et al. (Jain et al., 2019), who found that students in the SNAPPS group expressed their uncertainties more frequently and engaged in better interactions with their supervisors. They also match the findings of Heinerichs et al. (Heinerichs et al., 2013), who highlighted that this method

encourages students to ask questions and clarify their doubts.

Connell et al. (Connell et al., 1999) observed that when supervisors encouraged students to articulate their thought processes during case presentations, students expressed their clinical reasoning more effectively. The SNAPPS strategy allows educators to gain insight into students' reasoning, make an educational diagnosis (Audétat et al., 2017), and create opportunities for immediate feedback and targeted teaching moments.

This approach helps correct errors, reinforce sound reasoning, and support students' learning (Bowen & Irby, 2002).

4.2.6. Discussed Patient Management Plan

This step was consistently presented in all presentations from the SNAPPS group, which aligns with Bordage's findings. According to his study, students in the SNAPPS group initiated discussions about patient management nearly 20% more often than those in the control group. Addressing management questions allows instructors to better assess students' level and adjust the management plan accordingly (Bordage et al., 1990).

Once again, this creates a valuable space for immediate feedback, clarifying doubts, and providing timely guidance. Our findings showed that traditional case presentations focus primarily on patient management and that supervision tends to be directive, suggesting a lack of interaction.

This was also highlighted by Brose, who pointed out that the traditional method has limitations due to a lack of engagement and interaction (Brose, 1992).

Our findings are further supported by Jain et al., who observed that students in the SNAPPS group initiated patient management discussions about 20% more often than those in the control group (Jain et al., 2019).

4.2.7. Identifying Case Related Topics and Resources for Self-Study

In our study, all participants in the SNAPPS group systematically identified one or two self-directed learning objectives. Our results align with those of Heinerichs et al. (Heinerichs et al., 2013), who found that 81% of students in the SNAPPS group identified a learning topic, while none did in the conventional group.

They also match the findings of Jain et al. (Jain et al., 2019), who reported that all students in the SNAPPS group defined self-directed learning topics, compared to only one-third in the control group (Jain et al., 2019).

While SNAPPS emphasizes reflection-in-action, this technique can serve as a key bridge in developing clinical reasoning, helping students make sense of their learning and integrate new experiences (Murphy, 2004).

Garrison showed that self-directed learning within SNAPPS fully engages students, boosting their motivation and success (Garrison, 1997).

Sackett highlights that this structured process supports evidence-based practice through five steps, from formulating clinical questions to evaluating interventions (Sackett et al., 1996).

This structured approach also enhances knowledge retention. Bowen and Irby observed that identifying self-directed learning topics was almost systematic in the SNAPPS group, leading to optimal cognitive encoding (Bowen & Irby, 2002).

Similarly, Heinerichs et al. noted that this approach strengthens self-regulation, lifelong learning habits, and intellectual curiosity (Heinerichs et al., 2013).

Finally, according to Schön (Schon, 1987), experts reflect in action, while novices assess retrospectively. SNAPPS encourages real-time reflection, improving clinical reasoning and decision-making (Sackett et al., 1996).

4.2.8. Generalisabilty

We believe that the findings of our randomized pragmatic mixed-methods trial, conducted across four medical disciplines, have demonstrated the applicability, impact, and relevance of the SNAPPS method in various medical settings. Our methodological approach aligns with the recommendation made by Jain et al. in their systematic review of ten studies, which highlights the need for further research to assess its long-term impact and generalizability (Jain et al., 2018).

4.2.9. SNAPPS in Emergency Context

The effectiveness and relevance of the SNAPPS method in emergency medicine training have been clearly established. Indeed, Chen et al. (Chen et al., 2022) and Feijó et al. (Feijó et al., 2023) demonstrate in an emergency hospital context, that combining the one minute preceptor (OMP) and SNAPPS teaching methods significantly enhances the clinical training of emergency medicine interns.

Compared to traditional teaching, this integrated approach improves theoretical knowledge, procedural skills, clinical reasoning, and learner engagement. Its efficiency aligns with the time-sensitive demands of emergency care, offering a practical solution to cultivate competency in fast-paced settings. Future adoption should prioritize faculty training to ensure effective implementation (Chen et al., 2022) (Feijó et al., 2023).

Overall, our research findings highlight the need to innovate and transform clinical supervision practices, emphasizing the importance of moving from intuition to educational action in supervision (Debbache et al., 2025), in line with the recommendations of the ENGAGE framework (**Table 5**) (Martin et al., 2022).

Examine: On the one hand, we underscore the importance of examining current practices in order to identify the limitations of supervision as it is currently implemented through traditional methods.

Normalize: This research suggests the necessity of normalizing clinical supervision through clear institutional policies, so that it is recognized as an important activity.

Gather: In addition, our findings illustrate the effectiveness of the SNAPPS method in supporting professionals and learners, particularly in the expression and development of clinical reasoning, in strengthening learners' confidence, and in enhancing the supervisee–supervisor relationship in the context of oral case presentations.

Table 5. ENGAGE strategies (Martin et al., 2022).

Call for action	Strategies
Examine	We call upon healthcare and professional organizations to urgently examine current clinical supervision practices of their employees and develop and implement measures to ensure participation and adherence to evidence-informed supervision practices.
Normalize	We call upon policymakers to strengthen existing clinical supervision policies and guidelines that would facilitate and normalize healthcare workers prioritizing their clinical supervision, including telesupervision or distance supervision.
Gather	We call upon healthcare workers to gather and attend to their mental health and well-being by prioritizing clinical supervision. We recommend using a clinical supervision model such as the Proctor's model that incorporates supportive functions within clinical super vision, which is crucial in the current context. We urge healthcare workers, especially those considered to be at a higher risk of experiencing mental health issues (i.e. doctors, nurses and female healthcare workers) to make use of support avenues provided by employers including clinical supervision. This is even more important for recent graduates, those new in their roles, and those that have had a change in duties/responsibilities owing to the pandemic.
Access	We encourage healthcare workers, especially those in new or changed roles, to seek out clinical supervision and ensure their supervisor is the best fit to meet their new/revised learning goals.
Grow	We call upon training providers to grow evidence-informed training opportunities on enhancing the effectiveness of clinical supervision, evidence-informed telesupervision and restorative clinical supervision.
Evaluate	We call upon clinical supervision researchers to evaluate current clinical supervision practices, any changes implemented and resulting outcomes to ensure that these strategies deliver the outcomes they set out to achieve. We encourage researchers to undertake targeted research on telesupervision of healthcare workers as this area continues to remain outdated and under-researched.

Access: In this study, participants expressed the need for training, highlighting the importance of facilitating access to innovative supervision methods, such as SNAPPS method, which has demonstrated greater effectiveness compared to traditional supervision approaches. SNAPPS is particularly valuable to foster, promote, and facilitate the expression of learners' reasoning, while supporting them in acquiring this crucial competence.

Grow: It is essential to adopt evidence-based methods to ensure the quality and effectiveness of clinical supervision practices. Our results calls for organizing continuing education programs on clinical supervision strategies and methods, including the structured SNAPPS approach, in order to strengthen the skills of clinical supervisors and improve pedagogical practices in clinical settings.

Evaluate: In this study, we assessed the effectiveness of the SNAPPS method with the aim of improving supervision practices. The compelling results support

its implementation in our specific geographical and professional context

Thus, our work is fully aligned with the strategic recommendations proposed by the ENGAGE framework (**Table 5**) (Martin et al., 2022).

5. Strengths and Limitations

Given the depth and relevance of the results, we emphasize that this is the first study to explore the impact of SNAPPS clinical supervision method on clinical reasoning of post-graduation medical residents in our specific geographical and Algerian institutional context, using a pragmatic mixed-methods approach, thus addressing a complex gap in the current literature that is methodological, contextual, and epistemological in nature.

One of the key strengths of our original research lies in conducting a mixed-methods randomized study with a pragmatic, flexible, and adaptable approach, which reduces selection bias and enhances the external validity of our findings.

As part of pragmatic randomization and to best reflect the real learning context, we chose not to use double-blinding, as our goal was to assess the SNAPPS method in routine real-world practice. This decision allows data collection in a real-life clinical setting (Christian et al., 2019; Ford & Norrie, 2016). Moreover, we believe that blinding would have hindered the balance and comparability of the two groups.

This methodology allowed us to meet the study's objectives while accounting for the diversity of the four medical disciplines involved, the constraints of participants, and enhancing the external validity of the results.

Our approach aligns with the perspective of Brown et al., who emphasize the importance of moving from philosophy to practice by adopting a methodology focused on the relevance of outcomes in medical education (Brown & Dueñas, 2020). This approach enabled us to adapt the study to real-world learning and practice conditions, ensuring sustained and active participant engagement at every stage, thereby minimizing attrition bias. As a result, it improves the generalizability of findings. Unlike strictly experimental studies, this approach better reflects actual teaching conditions.

This flexibility contributes to feasibility and ensures that findings can be directly applied to educational practice.

Pragmatism, as a rigorous methodological framework, is a valuable approach for researchers seeking to explore educational issues in a holistic and practice-oriented manner (Clarke & Visser, 2019).

Torgerson highlighted that randomized controlled trials (RCTs) are the gold standard for evaluating educational interventions. However, they have been criticized for their low ecological validity (Torgerson & Torgerson, 2007).

The essence of a pragmatic trial is its ability to assess the effectiveness of an intervention in real-world conditions while ensuring optimal external validity, making the results more generalizable across different contexts (Patsopoulos, 2011). Unlike traditional explanatory RCTs, which seek to homogenize conditions

to minimize bias and errors, pragmatic trials embrace heterogeneity by incorporating various factors such as patients, treatments, and clinical settings (Patsopoulos, 2011).

First introduced by Schwartz and Lellouch (Schwartz & Lellouch, 1967), pragmatic trials offer a balance between the concrete nature of observational studies and the scientific rigor of randomized trials, providing more relevant insights for everyday clinical practice. In addition to flexibility, pragmatism emphasizes real-world experience and action, encouraging researchers to adjust their methodological approaches based on observed results and acquired knowledge. This interaction between reflection and action makes it particularly suited to studying educational practices (Morandi, 2004).

Furthermore, clinical reasoning defined as the cognitive process of decision-making that applies acquired knowledge to determine the most appropriate course of action in a given healthcare scenario (Boshuizen & Schmidt, 1992), aligns with this perspective. We believe that Morandi's emphasis on the interplay between action and thought (Morandi, 2004), as well as reflective practice, is especially relevant in analysing the complexity of clinical reasoning.

Comparative studies on the SNAPPS method versus traditional approaches indicate that most research in this area relies on RCTs (Pierce et al., 2020). While SNAPPS has demonstrated benefits for clinical reasoning and independent learning, evidence of its effectiveness in real-world clinical settings and its impact on patient outcomes remains limited (Flores-Cohaila et al., 2024). These limitations of RCTs reinforced our choice of a pragmatic methodological approach, which is better suited to assessing the applicability of this method in an authentic clinical training context.

As for the limitations of our study, they relate to the small number of participants, but we were able to collect and analyse forty-eight relevant presentations. Comparable studies, for instance, have included only four participants but analyzed more than forty oral presentations, thereby producing solid and meaningful results (Kapoor et al., 2017). In the same way, our study draws its strength from the diversity of clinical settings and supervised interactions, providing sufficient empirical material to examine the development of clinical reasoning.

Also, we did not aim to compare the scores across disciplines or participants' levels of study, as this was not part of our objectives. Our initial goal was to conduct an inter-group evaluation rather than an intra-group analysis. However, this aspect could be further explored in future research. The current investigation targeted post graduate students, and we believe that extending this work to graduate learners would be a relevant direction for future research.

Another limitation lies in the fact that the pragmatic approach can affect internal validity due to reduced control over external variables. However, since our aim is to assess the effectiveness and applicability of the technique in real learning and practice settings across four medical disciplines, we prioritize external validity.

The practical adjustments we implemented helped minimize selection bias en-

suring group comparability and strengthening internal validity. In contrast, strict randomization aims to demonstrate causality by rigorously controlling biases, which strengthens internal validity but limits the applicability and generalizability of the results to the specific conditions of the protocol.

This study was conducted in our specific hospital setting, and further research in other health institutions would be valuable for the implementation of innovative SNAPPS method in our context by comparing a control group using traditional method and a SNAPPS method group and assessing the long-term impact.

6. Conclusion

This pragmatic randomized comparative study evaluated the effectiveness of the SNAPPS method versus the traditional approach in oral case presentations across four medical disciplines in our specific context. The consistent results highlighted a significant improvement in the performance of participants in the SNAPPS group, confirming its relevance and positive impact.

This learner-centered method, both innovative and engaging in our context, promotes and facilitates the expression of clinical reasoning at all stages in a structured, engaged, active, responsible, and reflective manner. It was well received by all participants.

Finally, the SNAPPS method is based on an evidence-based approach and a continuous learner-clinician supervisor interaction. Furthermore, the adopted methodology ensured a realistic and contextually adapted application in the four medical disciplines, strengthening the external validity of the results and their generalizability.

As Sir William Osler stated, "Undoubtedly the student tries to learn too much, and we teachers try to teach too much. We can only instill principles, put the student on the right path, give him methods, teach him how to study, and early to discern between essentials and non-essentials" (Osler, 1905).

Based on our research findings, we propose the implementation in Algerian context of the innovative and effective clinical supervision method "SNAPPS" to facilitate and support the development of clinical reasoning among residents. However, further research will be needed to assess its long-term effects.

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Authors' Contributions

This research is part of the lead author's PhD in Biomedical Sciences, with a spe-

cialization in Medical Education, at the Faculty of Medicine, University of Geneva, Switzerland, under the supervision and support of the co-authors. All authors made a significant contribution to this study. They were involved in designing and carrying out the research, analysing and interpreting the data, as well as writing and revising the manuscript.

Ethical Considerations

Approval for this research was granted by the Committee for Integrity and Ethics in Health Professions Education Research (Société Internationale Francophone d'Education Médicale, n.d.). The project was conducted with the informed consent of participants, and collected data were anonymized to preserve confidentiality.

Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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Supplementary Materials

The supplementary materials for this study contain the following referenced materials:

Supplementary Material 1: Data Collection Tools and Results.

Supplementary Material 2: Completed CONSORT Checklist (Adapted for Pragmatic Trials).

Supplementary Material 3: PRECIS-2 Tool for Trial Pragmatism.

Access all supporting documents at:
https://doi.org/10.26037/yareta:igm4ac55hnhajjudysfc7pdpie.