SCRIPT CONCORDANCE TEST

Monograph

PRACTICUM
INSTITUTE OF APPLIED RESEARCH
IN HEALTH SCIENCES EDUCATION

SCRIPT
CONCORDANCE TEST

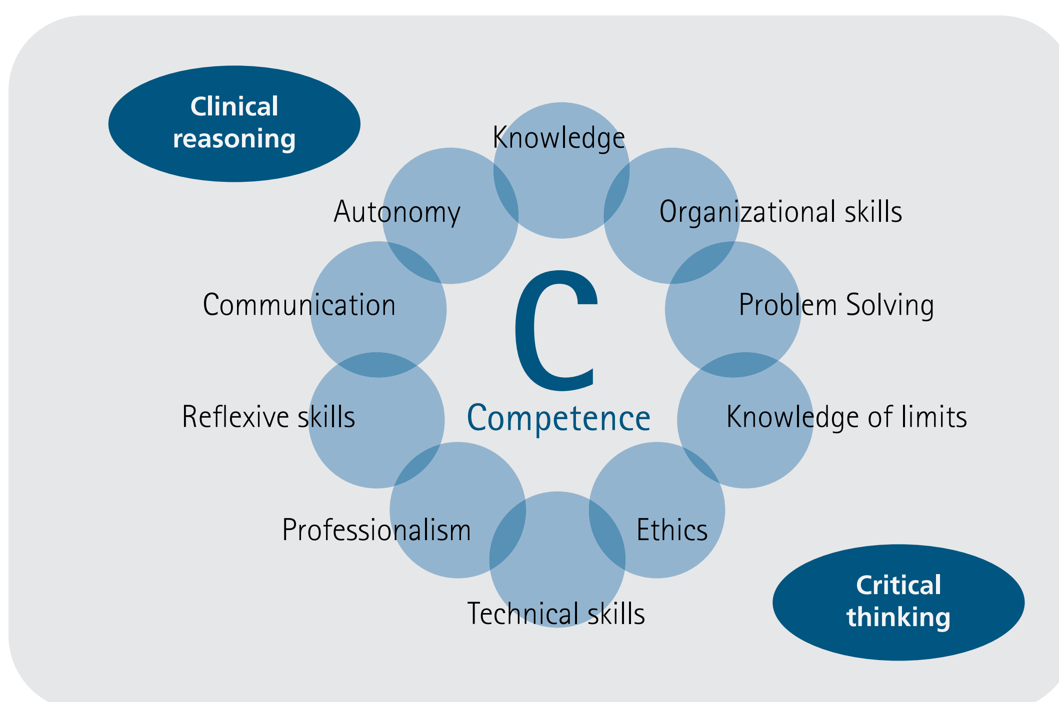
Script Concordance Test

Introduction

Evaluation of **clinical competence** is a huge challenge in the context of medical education and practice. Competence assessment on the basis of the mere measurement of knowledge is an important conceptual issue and an extremely simplistic inference.

Clinical professional competence is a complex, multifaceted and multidimensional construct representing the ability of a professional to use, not only his or her knowledge, but also a set of elements and skills inherent to the medical profession based on the correct clinical reasoning and judgment, to solve complex problems in a specific context.[1]

Clinical Competence Multidimensional Concept competence



From "Medical Education, competence evaluation". Brailovsky CA.[1]

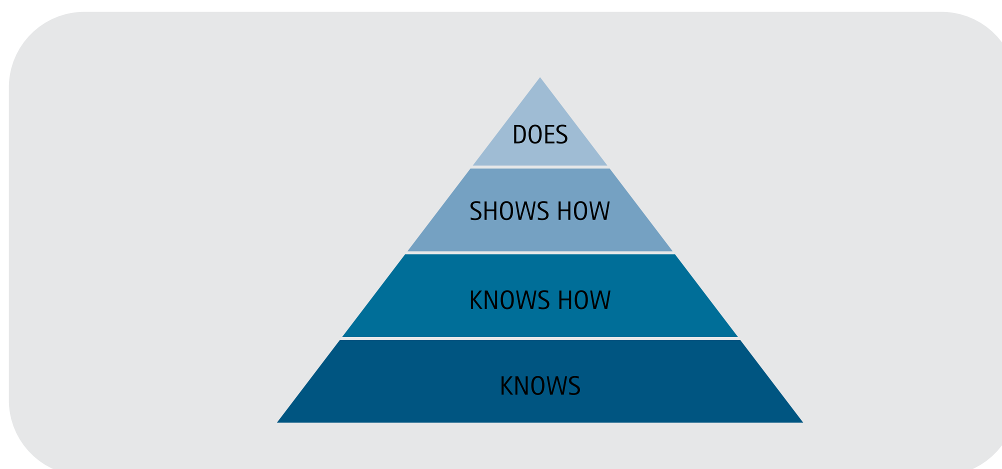
A major issue with most instruments currently used to evaluate clinical competence is the very narrow and inaccurate view they provide because they only measure isolated aspects instead of the global picture.

However, there are many reasons to measure professional competence not only as part of the education evaluation process in formal education models but also as a quality control certification objective of professional practice, as a mechanism to confirm the medical profession values and standards, and because of the responsibility and liability of practitioners before the community.

George Miller has described the professional competence evaluation model as a 4 tier pyramid. Knowledge **(knows)** and application thereof **(knows how)** are placed at the two bottom levels. At the third level **(shows how)** examinees shall show what they are capable of doing in simulated clinical situations, while performance **(does)** is placed at the top of the pyramid, that is, what a physician

SCRIPT CONCORDANCE TEST

actually does at his/her independent practice to show what he/she is capable of doing.



G. Miller's Pyramid, 1990.

Reflective skills and reasoning to resolve clinical issues is the core of clinical competence[1, 2], which has turned the development of evaluation instruments to assess these two crucial elements into a difficult challenge. These elements are not easily accessible by traditionally used measurement instruments.[1]

What is the SCRIPT CONCORDANCE TEST?

The **Script Concordance Test** emerges as a new clinical reasoning evaluation model based on the hypothetical – deductive model and on the so called ***"Script Theory"***. This theory is founded on the existence of increasingly complex memory-structured knowledge networks, due to the advancement of clinical experience, which are triggered in professional practice to understand clinical situations and to be used for categorization and decision-making purposes.[3,4,5,8,9]

Consequently, their main objective is not the measurement of knowledge but rather the
organization of clinical knowledge into conceptual networks **(scripts)** basically evidencing the actions taken and the decisions made by a physician before a given clinical situation in the context of professional practice, particularly evaluating the interconnection among items in the individual cognitive structure and the breadth and depth of these networks constituting the fundamental basis of clinical reasoning and competent professional practice.[3, 4, 5, 8, 9]

Why was the SCRIPT CONCORDANCE TEST?

The creation of the Script Concordance Test as an evaluation instrument was based on 3 fundamental assumptions:

- The importance of decisions based on clinical reasoning as the corner stone of medical practice.
- The constraints of written traditional instruments to evaluate clinical reasoning.
- The difficulty of measuring with written traditional examinations, particularly to infer and predict clinical competence, considering the different results frequently found among senior resident students and specialists when using evaluation instruments such as multiple choice systems to respond to questions in tests.

SCRIPT CONCORDANCE TEST

As surprising as it may seem, learning research has consistently shown that when using multiple choice response systems only assessing knowledge, there is an **inverted U-shaped** performance in students', resident students' and experts' grades, with the highest being in the senior residents group. This phenomenon, which has been called the "intermediate effect", is possibly due to the use of medical knowledge in a qualitatively different manner among the various groups and to the presence of an "encapsulated knowledge" among experts, who usually base their professional performance on experience-enriched organized knowledge rather than on lineally accumulated knowledge and on clinical reasoning linked to causal mechanisms as is the case with students and during the early stages of medical practice. [3, 5, 8, 9, 10, 11, 12, 13] The perception of this phenomenon has surfaced the fact that the inference of competence on the basis of measurement instruments would not be altogether acceptable.

On the contrary, with most evaluation instruments focusing on clinical reasoning, including the Script model, this "intermediate effect" disappears, due to the fact that they are based on clinical data interpretations to make decisions in genuine problematic situations closer to professional reality and not on the mere use of knowledge or algorithmic memory to find solutions.[5]

The Script model objective is to mobilize conceptual elements and assess the clinical reasoning process, the organization of that knowledge into relevant conceptual networks and the ability to trigger these networks when it comes to decision-making in front of a specific clinical situation. [3, 4, 5, 8] This is a major qualitative difference with most questions in multiple choice tests and with traditional oral tests, which take place in a non contextualized manner and primarily measure knowledge and memory learning.

Differences between the Script Concordance Test and Multiple Choice Written Tests

Multiple Choice Tests	Script Concordance Test
All data necessary to select the answer choice **are present** in the clinical vignette	All data necessary to solve the problem **are not present** in the vignette.
Consensus exists among experts regarding the **only acceptable answer.**	There may be **disagreement** among experts' answers. **There isn't only one acceptable answer.**
It basically assesses **level of knowledge.**	It evaluates **clinical reasoning.** Problems are not solved by simply applying knowledge.

SCRIPT CONCORDANCE TEST

Differences between the Script Concordance Test and traditional oral tests

Traditional oral tests	Script Concordance Test
Usually **non contextualized** questions.	**Contextualized** questions in clinical situations.
There is **consensus** among experts regarding **acceptable or expected answers.**	Disagreement may exist among experts' responses.
It particularly evaluates **knowledge.**	It evaluates **clinical reasoning**
An essentially **subjective measurement.**	Standardized **objective measurement.**
Low reliability as an evaluation instrument. Limited content sampling.	**High reliability.** It provides for a broad sampling of contents.

SCRIPT CONCORDANCE TEST Theoretical Background

The importance of knowledge structures in professional competence has been often underscored [14] and specifically so, in health practitioners' clinical competence. [15] Cognitive structures determine a person's situation-analysis and problem-solving skills. According to many researchers, knowledge operates using flexible guides to conduct experience-based actions and allowing individuals who possess the knowledge to rapidly solve situations. These **interiorized experience matrices** (scripts) are capable of offering efficient routes in a maze of alternatives avoiding the problem of having to consciously analyze and select at every step ahead; this happens in an automatic manner, without the person being aware of the process and allows an answer to be found intuitively and very rapidly when confronted with a specific situation.

Kart Weick calls intuition "condensed expert knowledge", a phrase vividly suggesting how knowledge works.[16]

The classic hypothetical – deductive clinical reasoning model is based on a reiterative multiple hypotheses production process regarding the patient's initial information, the re-evaluation of hypotheses based on data collection, the creation of new hypotheses if necessary and new hypotheses analysis and validation.[3,4,5,8]

However, the basis for the modern view of clinical thinking process rests on a model of conceptual networks and its problem-solving and decision-making modifications and interactions. [8, 18, 19] There are theoretical grounds in cognitive psychology regarding the transformation of reasoning dynamics in medicine practice as experience increases, transitioning from the classic cognitive scheme to a model of sequential and organized reasoning, in which the practitioner's knowledge is structured for problem-solving and decision-making in clinical practice. [3, 4, 8, 11, 13, 20, 21] At the theoretical level, the Script concept is based on the existence in memory of previously formed well-structured knowledge networks enriched by experience (scripts) that are triggered by every concrete clinical case and guide the

selection and interpretation of new information, providing for the rapid understanding of the situation and to accordingly decide diagnosis, investigation or treatment actions. In this cognitive framework, the expert's reasoning when confronted with the patient goes through a rapid sequence of events given by a perception of the relevant key elements, the almost unconscious automatic triggering of knowledge networks containing these significant clinical elements ("script triggering"), rapid access to a hypothesis or to the most relevant hypothesis (through Abductive reasoning or inference mental process combining two abduction types: selective and automatic) [21], the verification of symptoms and signs confirming or dismissing the diagnosis and the rational use of his/her knowledge to successfully guide investigations and treatment ("script processing"). In this manner, scripts operate as cognitive structure organizers present in every professional, providing in most cases, for an efficient use of knowledge and for promptly finding competent solutions.[3,4,5,8,13]

"Scripts" begin to appear when students and young doctors are exposed to their first clinical cases and are developed and fine-tuned throughout the entire professional practice while associations are established among symptoms, signs and illnesses. This leads to a 4-stage transition in the form of clinical thinking as summarized in "Schmidt's medical experience model". According to this model, initial clinical thinking is based on a broad and poorly organized structure of knowledge first resting on biomedical concepts and at a second stage on explicit reasoning, "consciously" relating signs and symptoms with concepts within existing physiopathological networks (first and second stages of Schimdt's model). The structure of knowledge adapted to clinical practice, instantly triggered at a timely moment and operating through scripts (of diseases or symptoms and clinical signs) characterizes the 3rd and 4th stages in this model and determines a fundamental difference between experts' clinical reasoning and the reasoning characterizing beginners in medical practice. [4,5,10,13,23]

Medical education clearly states that evaluation, using customized instruments has a major learning impact leading, guiding and reinforcing learning strategies significantly. Introducing clinical reasoning evaluation instruments in medical education at different levels such as the Script Test may promote a more efficient form of learning, leading to the construction of a better organized, integrated and articulated knowledge for clinical practice.[11,13,18,19,21] The positive effects of using this type of evaluation model have even been apparent in medical education for specialists, by causing participants to trigger previous knowledge, and to reflect about the quality of their knowledge, and has also lead to a higher retention rate of knowledge and concepts, according to various reports. [3,5]

SCRIPT CONCORDANCE TEST Format

The Script Concordance Test is structured in the following manner: [3,4,6]

1st: Clinical vignettes describing real clinical situations and problems that physicians must solve in their practices.
2nd: Diagnostic hypothesis, investigations or treatment options in accordance with the clinical situation described in the vignette.
3rd: New relevant information for every hypothesis, independent from each other, to solve the existing problem.

> If you are considering hypothesis or option A and find sing Z.
> What impact or effect does it have over your hypothesis?

4th: Answers fundamentally based on the possibility of disagreement of opinion.

Construction of the Script Concordance Test

Script Concordance Tests are built by teams of experts in every field who put clinical situations together that are representative of their daily practices involving diagnosis and investigation or treatment decisions. These clinical situations are formed by 2 parts: the clinical vignette and 5 items roughly in each one of them consistent with the described situation contributing new clinical information, encouraging practitioners to reflect while helpful enough to solve the problem at hand reasoning what impact new information may have on the proposed hypothesis or decision. [3,4,10]

Clinical vignettes:

Should briefly describe a relevant and problematic real clinical case or situation, only providing basic information, in a not very clearly differentiated manner to provide for several diagnosis possibilities or decisions, but at the same time containing all the necessary elements to reach a consistent answer. The length and complexity of vignettes may vary according to the evaluation objectives sought and the indispensable data required arriving at a solution of the problem via clinical reasoning; in some cases they may be simple whereas others may require more complex and detailed vignettes. The number of vignettes will also vary in accordance with test goals: training evaluation, final evaluation, continuing medical education of specialists, certification or recertification, promotion, etc. In some cases it may be helpful, or even desirable, to design comprehensive clinical vignettes describing the situation evolution or providing consecutive diagnosis and investigation decisions and/or treatments.[3, 4] In supplementary investigation and treatment models, vignettes may describe an unclear clinical situation including implicit diagnosis hypothesis or may contain presumptive diagnosis.

Test Items:

Items are formed by 3 parts:[3,4]

- A diagnosis situation, a supplementary investigation or a proposed treatment which should always be relevant to the situation described in the vignette.
- New information provided which may have a specific impact on the diagnosis hypothesis, the described investigation option or treatment. This new piece of information is built on the bases of key positive or acceptable elements backing the hypothesis, negative or unacceptable elements rejecting it or making it less probable and neutral elements that would have no impact on the hypothesis described in the item.
- A 5-point evaluation scale (Likert type).

Principles of Construction of Test Items:

1. Items should contain the most helpful elements to solve the clinical problem presented. The hypothesis and the investigation and treatment options proposed should be relevant enough and related to the situation described in the vignette.
2. Items should necessarily require practitioners to reflect and not be limited to merely using knowledge to select an answer.
3. All items included in the vignette should be independent from each other, and should not be additional information about the patient.
4. The hypothesis and investigation and treatment options should be, whenever possible, different.
5. The purpose of each item is to determine the effects or impact of the clinical information identified about the proposal and not additional effects in a series of new clinical elements about it.
6. Items should be clinically reasonable, meaning that all elements should be consistent and should contribute to the solution of the described case.
7. The number of items following the clinical vignette depends on the relevance of the hypothesis or on the diagnosis or treatment options for the specific situation.
8. New information provided by the items should be built on the basis of data having a positive, neutral and negative impact on the hypothesis or diagnosis, investigation or treatment options to ensure some level of dispersion among possible responses.

SCRIPT
CONCORDANCE TEST

SCRIPT CONCORDANCE TEST Types

• For diagnostic assessment:

If you were thinking of the following diagnosis:	And then you find:	It has the following effect on your hypothesis:				
A diagnostic hypothesis	A new clinical information, an imaging study or a laboratory test result	A	B	C	D	E

A. The hypothesis becomes very unlikely or almost eliminated.
B. The hypothesis becomes less probable.
C. The new information has no effect on the hypothesis.
D. The hypothesis becomes more probable.
E. The hypothesis becomes very likely.

Examples:

"A 3 years and 11 months old child, presented to emergency room with fever, which had begun 48 hours earlier. Four days earlier, he started having symptoms of a cold. He had already received all the required vaccinations and has no significant medical history.

On physical examination, the child is listless and feverish. He shows marked irritability alternating with a tendency to sleep and apparent functional weakness (paresis) of the right leg. Kernig and Brudzinski signs are positive. In the respiratory auscultation there are wide spread rhonchi, wheezing and decreased air intake in both lung bases."

If you were thinking of the following diagnosis:	And then you find:	It has the following effect on your hypothesis:				
		A	B	C	D	E
Acute disseminated encephalomyelitis	The following results in the cytochemical examination of CSF: 27/mm3 cells; glycorrhachia 75 mg/dL and proteinorrachia 42 mg/dL.					
Acute infectious encephalitis	Brain CT is normal.					
Meningoencephalitis	Ultrasound of hip joint shows slightly increased fluid. The chest radiograph shows rounded opacity in the upper segment of right lower lobe.					

SCRIPT
CONCORDANCE TEST

"A sixty year-old female, with a history of hypertension, type 2 diabetes, dyslipidemic, ex-smoker and obese complains of cough, grade III dyspnea and peripheral edema in lower limbs. She has been treated with angiotensin-converting enzyme inhibitors for 2 years, with inadequate blood pressure control".

If you were thinking of the following diagnosis:	And then you find:	It has the following effect on your hypothesis: A	B	C	D	E
Systolic heart failure	Electrocardiogram with no signs of sequelae. Echocardiogram performed 6 months ago showing left ventricular hypertrophy and normal ejection fraction.					
Diastolic heart failure	Electrocardiogram with no signs of sequelae. Echocardiogram performed 6 months ago showing left ventricular hypertrophy and normal ejection fraction.					
Dilated cardiomyopathy	Electrocardiogram showing signs of left ventricular hypertrophy. Chest radiograph showing mild increase of cardiothoracic index.					
Chronic obstructive pulmonary disease with acute exacerbation due to pulmonary infection	Fever for the last 24 hours. Electrocardiogram showing signs of biventricular hypertrophy. Incomplete right bundle branch block.					
Recurrent pulmonary microemboli	Chronic venous insufficiency. Normal ventilation/perfusion scan					

SCRIPT
CONCORDANCE TEST

- For investigation assessment:

If you were considering to prescribe the following investigation:	And then you find:	It has the following effect on the proposed diagnostic test:				
A diagnostic test	A new clinical information, an imaging study or a laboratory test result	A	B	C	D	E

A. The diagnostic test becomes useless or contraindicated.
B. The diagnostic test becomes less useful or detrimental.
C. The new information has no effect on the diagnostic test.
D. The diagnostic test becomes useful.
E. The diagnostic test becomes absolutely necessary.

Examples:

"An active 81 year-old patient with a history of type 2 diabetes mellitus and severe hypertrigliceridemia suffers from intermittent claudication at 50-100 meters (100-200 yards). A rough systolic murmur, intensity 2/6 in the aortic valve focus is found during the pre-surgical evaluation for a peripheral vascular intervention. Signs of necrotic sequel in the diaphragmatic wall, and frequent ventricular premature complexes can be observed in the ECG."

If you were considering to prescribe the following investigation:	And then you find:	It has the following effect on the proposed diagnostic test:				
		A	B	C	D	E
Coronary cineangiography	SPECT: inferior fixed defect, ischemia of peri-necrotic area and of lateral wall. Ejection fraction of 50% at rest and 44% after stimulation with dypiridamole.					
Coronary cineangiography	Peripheral angiography has not been performed yet.					
SPECT	Episode of unstable angina 8 months ago, with normal ECG and normal troponin levels.					
Dobutamine stress echocardiogram	Ventricular arrhytmia. Doppler echocardiogram: aortic valve opening restriction and mean gradient of 55 mmHg.					

SCRIPT CONCORDANCE TEST

"J.L.M., 32 years old, is an acute lymphoblastic leukemia patient. He has had 2 rounds of chemotherapy. The patient is suffering now from a 38°C fever for the past 12 hours, moderate-to-severe dyspnea and cough. Chest X-ray shows diffuse interstitial opacities in both lungs".

If you were considering to prescribe the following investigation:	And then you find:	It has the following effect on the proposed diagnostic test:				
		A	B	C	D	E
Spirometry using a Flow-Volume loop	The carbon monoxide diffusion test indicates a net increase in the highest result at 160% of its predicted value.					
Bronchoalveolar lavage	ECG with sinus tachycardia of 120 beats / min. and monofocal premature ventricular complexes.					
Carbon monoxide diffusing capacity	Blood gas analysis indicates a 46 mmHg A-a O2 gradient increase.					
Bronchoscopy with transbronchial biopsy	The carbon monoxide diffusion test indicates a net increase in the highest result at 160% of its predicted value.					

• For treatment assessment:

If you were considering to prescribe the following treatment:	And then you find:	It has the following effect on the treatment option:				
A treatment option	A new clinical information, an imaging study or a laboratory test result.	A	B	C	D	E

A. The treatment becomes useless or contraindicated.
B. The treatment becomes less useful or detrimental.
C. The new information has no effect on the treatment plan.
D. The treatment becomes useful.
E. The treatment becomes strongly indicated.

Examples:

"A 8-year old patient with a history of recurrent otitis media presents with a 3-day history of earache, mucopurulent rhinorrhea and cough. He had fever of 101°F (38.3°C) 2 days before."

SCRIPT CONCORDANCE TEST

If you were considering to prescribe the following treatment:	And then you find:	It has the following effect on the treatment option: A	B	C	D	E
Amoxicillin	Fluid in the middle ear.					
Amoxicillin-clavulanate	Redness of the tympanic membrane.					
Oral analgesics and follow up within 48 hours	Patient had been given amoxicillin course 2 weeks before, due to respiratory symptoms.					
Single-dose intramuscular ceftriaxone	Radiopaque image in maxillary sinuses.					

"A fifty year-old male patient, ex-smoker, type 2 diabetic and dyslipidemic, suffers from severe peripheral vasculopathy for which revascularization was performed through a stent angioplasty. He complains of recent onset angina pectoris which started a month ago".

If you were considering to prescribe the following treatment:	And then you find:	It has the following effect on the treatment option: A	B	C	D	E
Medical treatment (Beta-blockers, calcium channel antagonists, nitrates, statins and antiplatelet drugs)	Myocardial perfusion test (gammagraphy) showing inferior wall ischemia, normal ejection fraction at rest and flat behaviour with strain.					
Initial medical treatment. If no favourable outcome is observed, coronariography and revascularization.	Myocardial perfusion test (gammagraphy) showing inferior wall ischemia, with compromise of more than 2 vascular territories. Normal ejection fraction at rest, which falls 10% with strain.					
Initial medical treatment. If no favourable outcome is observed, coronariography and revascularization.	Myocardial perfusion test (gammagraphy) showing inferior wall ischemia. Normal ejection fraction at rest and flat behaviour with strain.					
Coronariography and revascularization if possible.	Myocardial perfusion test (gammagraphy) showing inferior wall ischemia. Normal ejection fraction at rest and flat behaviour with strain.					
Medical treatment (Beta-blockers, angiotensin converting enzyme inhibitors, calcium channel antagonists, nitrates, statins and antiaplatelet drugs)	Myocardial perfusion test (gammagraphy) showing inferior and lateral wall ischemia. Normal ejection fraction at rest, which falls 10% with strain. Patient normally hypotensive, and with a carotid murmur.					

SCRIPT CONCORDANCE TEST

SCRIPT CONCORDANCE TEST Validation

Once the Script Test is completed, it is submitted to a group of 10 to 20 experts [3] who will be responsible for:

1. The test validation, verifying the relevance of medical contents included by authors and the construction validity and reliability to effectively assess clinical reasoning.
2. Clinical cases responses (by using a Likert* type scale), which will be used by the Evaluation Committee as the bases for the scoring method.

In this evaluation model there isn't a single answer that everybody agrees to; any response selected by panel members, based on their opinion and clinical experience is accepted as valid.
The test's internal consistency is measured using Pearson's correlation coefficient. Reliability is estimated with Cronbach's alpha coefficient. [3]

SCRIPT CONCORDANCE TEST Strengths

As a measurement tool, the Script Concordance Test has proven to have interesting properties in terms of content validity, construction validity, prediction validity, reliability, acceptability, education costs and impact. All factored into the following formulae estimating evaluation models utility**:

$$\mathbf{U = [_{(p)} F + _{(p)} V + _{(p)} E + _{(p)} A] \times _{(p)} 1/C}$$

where U is the instrument validity equal to the sum of reliability proportion (F), plus validity proportion (V), plus the impact on learning proportion (E), plus the acceptance proportion (A), the whole multiplied by the cost inverse. [3,10,21]

This test may be used as: [3,9]

- · Final evaluation model, for specialist certification and recertification.
- · Training evaluation model (graduate and undergraduate medical education) and in continuing medical education in both distance-learning and onsite-learning strategies.

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* Likert Scale: Instrument to measure examinees attitudes and opinions in the most objective possible manner, with a grading system similar to the one used in intensity scales (excellent grade, passing grade with some reservation, undefined position, failing in certain aspects, total failing grade). It is based on the sigma grading method used to rate dispersion. Answers are classified in this ordinal scale based on 5 formulations and the overall grade for each respondent is the result of the sums gained in each answer.[24]

The Cronbach alpha coefficient assesses internal consistency and reliability of the instrument. Its values range between 0 and 1.[24]

**Reliability of an evaluation instrument: is linked to stability, to internal consistency and to accuracy of the measures obtained with the instrument. It depends on sampling across the multiplicity of contents. [1, 21]

Validity: refers to the extent to which the instrument actually measures what it is expected to measure. [1, 21]

SCRIPT
CONCORDANCE TEST

Elaboration of the Scoring System

In this type of test, the scoring method takes into account the variation of answers among members of a panel of reference. It therefore allows assessment of clinical reasoning in context of uncertainty.

Because there is no single correct answer, scoring is based on the comparative assessment of the examinees`answers with those given by the experts, faced with the same diagnostic dilemmas and management. In this manner, the test evaluates the concordance rate among experts' conceptual networks and examinees conceptual networks. A high score demonstrates higher agreement with experts about the different items, and vice versa.

In this scoring system, the answer selected by the largest number of experts is given the highest score and remaining options get proportional scores. For example, if for a given item 6 out of 10 experts chose option **C**, 3 selected **B** and 1 selected **D**, option **C** will get the highest score of 1 credit (10/10 = 1 credit), whereas option B is assigned a 0.5 score (3/6) and **D** 0, 17 credits (1/6). Answers not chosen by panel members receive 0.

The total score for the test is equal to the sum of credits obtained in each individual item, divided by the number of items. All scores are taken to proportional credits in an agreed upon maximum scoring scale (typically 100 credits) for ease of interpretation.

SCRIPT
CONCORDANCE TEST

Conclusion

The strengths of the **Script Concordance Test** as an evaluation instrument and its utility to face the huge challenge of clinical reasoning assessment turn it into an evaluation model with an interesting outlook to be used in undergraduate and graduate medical education and in continuing medical training for specialists. Its use in medical education strategies may contribute to the development and training of clinical reasoning skills and to a better organization of decision-making medical knowledge. As an evaluation model, it helps to infer and predict professional practice competence and performance quality to a greater extent than traditional written instruments.

SCRIPT
CONCORDANCE TEST

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SCRIPT
CONCORDANCE TEST

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