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Evaluation of postoperative cognitive dysfunction in non-cardiac surgery

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Abstarct :

The current study aimed to evaluate the emergence of postoperative cognitive dysfunction in non-cardiac surgeries, where a sample of 10 patients participated in the study, who underwent various non-cardiac surgeries according to a unified general anesthesia protocol, in the state of Biskra, who were chosen intentionally to meet certain conditions, to apply a neuropsychological battery consisting of (5 tests: Ray Auditory Verbal Learning Test RAVLT; Tracking Test TMT Part A and Part B; Number Memory Test WAIS III Direct Order, Reverse Order), according to three pre- and post-measurements, within a quasi-experimental research approach.

After statistically processing the results according to the statistical tool (Z-score), the results concluded that postoperative cognitive dysfunction appeared in non-cardiac surgeries in (60%) of the studied sample.

Keywords: Postoperative cognitive dysfunction POCD, cognitive functions, surgical operations.

Problematic of the study:

Cognitive psychology emerged as one of the branches of general psychology to understand human behavior, by trying to explain and understand the cognitive processes that occur to the various stimuli that the human brain receives, whether internal or external, to appear in the form of a response, and accordingly, cognitive processes such as attention, perception, memory, executive functions, language, and learning received the attention of researchers, in conjunction with technological progress in various research fields, which made human mental activity increase to keep pace with this development, by processing a huge and diverse amount of stimuli that the human brain had not been exposed to before, by providing behavioral, sensory, motor and cognitive responses, allowing it to adapt to new situations.

Through the development of scientific research methods, and the introduction of functional medical imaging techniques, in the fields of neuropsychology, researchers were able to determine the neural basis of most cognitive processes, and identify the origin of the disorders that occur in them, whether organic or functional, to try to diagnose and care for them, and develop neuropsychological tests and various rehabilitation programs that suit all age groups, and types of cognitive disorders.

Among the disorders that affect cognitive processes, there are those that a person is born with due to genetic reasons, or acquired as a result of disorders that the mother experienced during pregnancy, which affect the normal growth of the nervous system, and are known as neurodevelopmental disorders, in addition to cognitive disorders resulting from aging, both natural and pathological, caused by degenerative diseases; in addition to functional cognitive disorders that affect the performance of cognitive function after an organic injury, as a result of environmental incidents that a person is exposed to, such as various diseases that affect the nervous system, including viral infections, bacterial infections, metabolic disorders, or accidents such as brain trauma resulting from traffic accidents, falls; in addition to functional cognitive disorders resulting from taking medications that work directly with the central nervous system, such as antiepileptic drugs, antidepressants, sedatives and anesthetics used in surgical operations.

Among the newly discovered functional cognitive disorders, post-operative cognitive dysfunction (POCD) has emerged, which is a common clinical complication after surgery; in this context, Bedford first reported in 1955 a series of neurological complications after surgery in the elderly, who had no cognitive disorder before surgery, such as impaired spatial orientation function and forgetting friends and family members;

since then, researchers from various disciplines have gradually paid more attention to post-operative cognitive dysfunction (Liu, et al, 2021, p 3), which is defined as an impairment in one or more cognitive domains, including attention, memory, executive functions, language, and learning, over and above the patient's normal performance before surgery; POCD is also associated with prolonged hospitalization, increased mortality, and decreased long-term quality of life in affected patients (Chengxuan Quan, 2019, p 1).

With the number of surgical procedures performed worldwide approaching 250 million per year (and an increasing number of elderly patients), improving postoperative cognitive function and preventing postoperative cognitive dysfunction are major public health issues (Berger, et al, 2015, p 518); According to statistics, it was found that postoperative cognitive dysfunction affects up to 16% - 40% (of middle-aged and elderly patients, within 7 days after surgery, and 10% - 13% of elderly patients, after 3 months or more after surgery, while the causes of (POCD) are still unclear and not precisely defined, as it is generally believed that it is related to a set of basic factors, namely the type and duration of surgery, in addition to the type and duration of anesthesia, as well as factors related to the patient (age, educational level, medical history, mental state, ... (Liu, et al, 2021, p1)

Many studies have shown that surgical operations and related variables such as the health and psychological state of the patient before surgery, the type of surgery and the type of anesthesia, infections surrounding surgery, in addition to changes in vital functions during surgery, contribute to the emergence of postoperative cognitive dysfunction, and among these studies is the study (Tribash and Bouafia, 2011), through which the researchers aimed to study The effect of narcotic substances used in general anesthesia on memory function in young people, as the results of the study showed that there were statistically significant differences between the pre- and post-measurements of the sample members' performance, as performance declined after 24 hours of recovery, but it did not last long, as the sample members quickly regained their memory abilities, which was confirmed by the measurement results after 48 hours and 4 days, which confirms the effect of surgical operations on memory function (Tribash and Bouafia 2011, 120).

In addition to the study by (Li et al, 2019) which aimed to evaluate the occurrence of postoperative cognitive dysfunction (POCD) in the short and long term after knee replacement surgery in patients aged 65 years and older, when using hypnosis with dexmedetomidine, propofol or midazolam, with the use of spinal anesthesia, the incidence of POCD in the propofol group was significantly lower than in the other groups, while after one year of surgery, the incidence of postoperative cognitive dysfunction was not significantly different between the three groups; the results of this study indicate that propofol has the least effect on cognitive functions one week after the

operation, while midazolam tends to impair cognitive functions in the study sample (Li et al, 2019, p 1).

The study oof (Bitner, 2019) also aimed to improve patient care in non-hospital surgical operations, and To know the extent of their ability to return to their daily lives by assessing the extent of the emergence and prevalence of functional cognitive disorders after surgery; as the results of the study showed that 17% of the studied sample had cognitive disorders after surgery ranging from mild to severe, which made these results raise questions about the extent of individuals' ability to take care of themselves after leaving the hospital when receiving non-hospital surgery (Bitner, 2019, p 2).

Through the previous studies presented, we find that some of them focused on one variable related to surgery, which is warning. We also find studies that neglected different age groups by focusing on the elderly and specializing in the study, in addition to the scarcity of studies in the local environment according to the researcher's knowledge; From the above, this study comes to focus on different age groups that will undergo scheduled non-cardiac surgeries (abdominal surgery, ear, nose and throat surgery, breast surgery, chest surgery), and focusing on all variables related to surgery, and it is also considered one of the rare studies in the Algerian and Arab environment.

Through what was evident from the importance of the topic, and to achieve the objectives of the study, we raised the following questions:

- Is there a functional cognitive dysfunction after surgery in non-cardiac surgeries after 24 hours of surgery?
- Is there a functional cognitive dysfunction after surgery in non-cardiac surgeries after 4 days of surgery?

2- Study hypotheses:

- There is a postoperative functional cognitive dysfunction after surgery in non-cardiac surgeries after 24 hours of surgery.
- There is a postoperative functional cognitive dysfunction after surgery in non-cardiac surgeries after 4 days of surgery.

3- The importance of the study:

Starting any academic study requires the researcher and supervisors to be convinced of the feasibility of this study, and from here we tried to control a set of elements of the scientific and practical importance of this study:

3-1- Scientific importance:

- Our study is considered one of the few and rare studies that dealt with post-surgical functional cognitive dysfunction (POCD) in the Algerian environment in particular, and the Arab world in general - according to the limits of our knowledge-.

- Enriching the theoretical aspect in the Algerian library in particular and the Arab world in general due to the scarcity of references in the Arabic language that deal with post-surgical functional cognitive dysfunction in the study.
- Highlighting the most important cognitive areas that are disturbed after surgical operations and neuropsychological tests recommended according to previous studies to evaluate them.

3-2- Practical importance:

- Understand the importance of the reality of neuropsychological evaluation after surgical operations in the Algerian hospital environment.
- Enabling the specialist in clinical neurolinguistics, practicing in a hospital environment, to choose and apply neuropsychological tests to evaluate post-surgical functional cognitive dysfunction in patients undergoing surgical operations.
- Highlighting the role of the specialist in clinical neurolinguistics in evaluating post-surgical functional cognitive dysfunction in the hospital environment.
- This study can provide, through the neuropsychological tests used during it, some data on the duration and course of post-surgical functional cognitive disorder, which may be useful in designing a neuropsychological battery suitable for the Algerian and Arab environment to evaluate it, and it can also be used as a guide to build a rehabilitation program for ongoing post-surgical functional cognitive disorder.

4- Study objectives:

- To identify if there is a functional cognitive impairment after surgery in non-cardiac surgeries after 24 hours of surgery.
- To identify if there is a functional cognitive impairment after surgery in non-cardiac surgeries after 4 days of surgery.

5- Procedural concepts of the study:

5-1- Postoperative cognitive dysfunction (POCD):

A functional cognitive disorder that affects one or more cognitive domains, including attention, memory, executive functions, language and learning, that appears after surgical operations as a result of the impact of variables associated with surgery (type and duration of surgery, type of anesthesia, changes in vital functions, infections associated with surgery) on the nervous system, including cognitive processes; where postoperative cognitive dysfunction exceeds the expected time required to recover from the acute effects of surgery and its variables, which can be measured by the Track Tracing Test (TMT Part A and Part B), the WAIS Digit Memory Test (III), and the Ray Auditory Verbal Learning Test (RAVLT).

5-2 Non-cardiac surgeries:

It is any surgical intervention under general anesthesia applied to the human body except the heart and circulatory system, as it does not require creating blood circulation outside the body.

6- Study limits:

6-1- Spatial limits:

This study was conducted in the state of Biskra, at the public hospital institution (Bachir Ben Nasser), the Department of Surgery for Women and Men, the Department of Breast Diseases and Surgery, in addition to the Department of Ear, Nose and Throat.

6-2- Time limits:

The study was conducted in its theoretical and applied aspects within a time limit between September 2023 and May 2024.

6-3- Human limits:

The study was applied to (10) patients who underwent scheduled non-cardiac surgeries, of whom (05) underwent abdominal surgery, (02) underwent ear, nose, and throat surgery, (02) underwent breast surgery, and (01) underwent thoracic surgery.

Field aspect

First: The exploratory study:

1- The goal of the exploratory study:

- Controlling the title of the study and its variables.
- Controlling the characteristics of the sample that are consistent with the requirements for applying the study tools.
- Identifying the conditions and aspects in which the study will be conducted.
- Identify the field difficulties the researcher may face during the study application.
- Training on the steps of conducting the study and the extent to which the researcher can apply the study tools.
- Controlling the time required for each tool, and arranging it during its application to the sample.
- To achieve these goals, we started conducting the exploratory study on January 20, 2024, until the beginning of the application of the basic study in another institution.

2- Exploratory study tools:

The tools of the exploratory study were represented in a semi-directive interview with surgeons and anesthesiologists, an observation network, in addition to a questionnaire distributed to patients before conducting the study, to determine the availability of application conditions for the sample.

The axes of the semi-directive interview included administrative questions about the doctor's specialty, and years of practice, in addition to the observations they see in patients after surgery, especially from a cognitive perspective; where we noticed a clear lack of knowledge and interest of the the medical staff in the cognitive aspect of the

patient after surgery, as anesthesiologists did not receive lectures on postoperative cognitive dysfunction (POCD) during the years of studying the specialty, which prompted us to provide a simplified explanation, and the most common definitions, in addition to presenting some previous foreign studies, most of which were conducted by research groups that include anesthesiologists, and the studies were published in medical journals.

We relied on two dimensions and several indicators in the observation network, the most important of which was the dimension of the patient's psychological and cognitive state before surgery, and whether we were able to apply the tests or whether it required prior psychological intervention and preparation, in addition to the dimension of the patient's health condition after non-cardiac surgery, and his ability to perform the tests. We also distributed a questionnaire to the patients, to identify their psychological readiness before surgery, the most complications of surgery that they feared would occur, and the extent of their acceptance of the health and psychological state that they would become in after the operation.

3- Procedures of the exploratory study:

The exploratory study is considered the first and basic step that the researcher must conduct before starting any field study, as our exploratory study was conducted at the public hospital institution "Alaq Al Saghir" in the district of Zriba Al Wadi - Biskra, in the surgical departments for women and men, in addition to the surgical operations department, due to the available facilities considering that the researcher is a medical assistant in resuscitation and anesthesia, practicing at the institution level; some study tools were applied to a sample not concerned with the study to train on their application.

4- Results of the exploratory study:

The results of the exploratory study were positive, as all the objectives set were achieved, starting with controlling the study variables and the appropriate method, in addition to determining the characteristics of the sample and the availability of all study tools, and the difficulties of conducting the study were identified, which were represented in the researcher's inability to apply the study in his work institution, due to:

- Lack of a sufficient number of sample that meets the conditions.
- The researcher's field of work overlapped with the field of study, as the examinees included questions during their application of the tests such as the risks of the surgical operation, anesthesia, the time of their discharge from the hospital, and the dates of cleaning the wound..., which led to a decrease in their performance due to lack of concentration and continuous distraction. - The examinees felt responsible for the correct answer and improving their performance because the researcher was practicing in the institution, which put them under pressure and rushed to answer,

which prompted us to go to another hospital institution to start applying the basic study after obtaining administrative approval.

Second: The basic study:

1- Study method:

Since the subject of our study is to evaluate postoperative cognitive dysfunction in non-cardiac surgeries, the scientific necessity required the application of the quasi-experimental method.

2- Study community:

Our study community is represented by all individuals who will undergo non-cardiac surgery, with a general anesthesia protocol, are good at reading and writing, and do not suffer from apparent neuropsychiatric disorders.

3- Study sample:

Our primary study sample consisted of 12 individuals (males - females) aged between (21-71 years) selected intentionally, from among patients scheduled to undergo surgeries at the level of the operating department at the "Al-Bashir bin Nasser" Hospital - Biskra, where the sample specifications were:

Type of surgery	Number	Gender
Breast Surgery	2	Female
Internal Surgery	6	3 Female,3 Male
Ear, Nose and Throat Surgery	2	Male
Thoracic Surgery	2	Male
Total	12	7 Male, 5 Female

Table 4: Number of sample members and type of surgery

The following conditions must be met in each patient to be selected as part of the research sample:

- They agree to conduct the study.
- They can read and write.
- They are psychologically ready before the operation, enabling them to apply the tests after undergoing psychological preparation by the researcher.
- They have good vision and hearing.
- They do not suffer from apparent neuropsychiatric disorders.
- They are scheduled to undergo a non-cardiac surgery.
- They will undergo a general anesthesia protocol, using the same drugs.

- They did not experience any complications during the operation that would prevent them from completing the post-measurement.

After the start of completing the pre-measurement, two individuals from the sample were exposed to health complications, which prevented them from completing the post-measurements, so our study sample was (n=10),

- Study tools:

To conduct this study, we relied on the tests proposed in the 1995 consensus document, to assess postoperative cognitive dysfunction to unify the research results, where our study tools were:

- Neuropsychological budget.
- WAIS-3 Digit Memory Test to evaluate working memory, direct order to assess the phonological loop.
- WAIS-3 Digit Memory Test to evaluate working memory, reverse order to assess the executive center.
- Trail Making Test (TMT) Part (A) to measure the speed of cognitive-motor information processing.
- Trail Making Test (TMT) Part (B) to measure cognitive flexibility, selective attention, inhibition, and planning.
- Rey Auditory Verbal Learning Test (RAVLT) to measure learning ability and auditory verbal memory.

- Basic study procedures:

After adjusting the study variables and determining the conditions for selecting the sample, it was necessary to determine the neuropsychological tests that the study would be conducted with, as we had two tests adapted to the Algerian environment (WAIS 3-3 test, TMT test part A and part B), out of three tests proposed by the consensus document; we also built a neuropsychological budget to collect the necessary information about the case and facilitate communication with it to determine the date and place of the post-measurement.

The patients' surgical operations were scheduled on different days, as each individual in the sample underwent three applications of the tests: a pre-test one day before surgery (24 hours), and two post-tests (one day after surgery, and 4 days after surgery), and the tests were applied according to a specific order for reasons that we will mention:

- We started by applying the Ray Auditory Verbal Learning Test (RAVLT), because it contains a delayed recall list after at least 15 minutes.
- The (TMT) test was applied, because it does not contain any tasks to remember so that the examinee does not get bored.
- The WAIS test was administered as the last test because it contained a list of numbers.

Third - Statistical methods:

In analyzing and interpreting the results of our study, we relied on the statistical method (Z-score), which is a statistical tool that allows for the expression of a person's performance in a test in a standardized way. The use of (Z-scores) is generally associated with threshold scores, through which it is determined whether an individual's performance is normal or pathological. (Aguert et Capel 2018, 61)

The computational method (Z-score) for a single test is: subtracting the baseline test score and the average change in the test in the control group from the follow-up score, then dividing the result by the standard deviation in the control group, producing a combined (Z-score) for each individual, by dividing the sum of (Z-scores) for all subgroups of one person by the standard deviation of the total Z-score in the control group. (POCD) is defined as (at least two Z-scores) in individual tests, or that the combined (Z-score) is 1.96 or more; Some studies also take 2 as the Z-score, and the diagnostic criterion for POCD is that the combined score, or Z-scores for at least two subgroups, or 20% of the individual neuropsychological tests are 2 or greater.

The Z-score method usually requires the appointment of a control group that meets the same exclusion criteria as the experimental group, which has prompted some researchers to propose a different method without appointing a control group, which simply replaces the mean and SD of the arbitration group with the mean and SD of the experimental group, and the aggregated Z-score is the average of all the Z-scores for the tests for one individual, and a negative aggregated Z-score means a decrease in cognitive status (Liu, et al. June 2021, 7).

The Z-score is calculated according to the following equation: where X represents the initial score of the examinee in the test, mx represents the mean of the distribution of scores, and sx is the standard deviation of the distribution of scores (Aguert, Capel 2018, p 61)

$$z = \frac{x - mx}{sx}$$

- Presentation, analysis, and discussion of the results of the study hypotheses:

1-1- Presentation and analysis of the results of the first hypothesis:

Reminder of the hypothesis: "There is a postoperative functional cognitive dysfunction after surgery in non-cardiac surgeries after 24 hours of surgery."

To verify the validity of this hypothesis, we applied a pre-measurement (24 hours) before the operation, and a post-measurement (24 hours) after the surgery, using a battery of difficult psychological tests consisting of (5 tests), and diagnosing the case with post-surgical functional cognitive impairment, by using the statistical tool Z-score:

- Test results for the pre-measurement:-

Test Status	RAVLT			TMT Part A and B	WAIS III Direct order	WAIS III Test Reverse Order
	LR	MVC	MVL			
Case 1	0.85	15/14	15/12	11.06 sec	16/09	14/6
Case 2	0.77	15/10	15/11	34.8 sec	16/08	14/05
Case 3	0.4	15/08	15/05	33.08 sec	16/07	14/04
Case 4	0.6	15/10	15/10	23.78 sec	16/11	14/08
Case 5	0.6	15/07	15/08	24.4 sec	16/08	14/04
Case 6	0.33	15/07	15/08	16.82 sec	16/08	14/03
Case 7	0.77	15/14	15/12	13.08 sec	16/09	14/07
Case 8	0.7	15/10	15/08	36.65 sec	16/08	14/08
Case 9	0.57	15/07	15/04	39.42 sec	16/08	14/06
Case 10	0.64	15/10	15/08	41.07 sec	16/08	14/04
Mean	**0.623**	**9.7**	**8.6**	**27.416**	**8.4**	**5.5**
Standard Deviation	**0.16**	**2.63**	**2.72**	**11.11**	**1.07**	**1.78**

Table 6: Pre-test results

Post-test results 1: (24 hours):

Test Status	RAVLT			TMT Part A and B	WAIS III Direct order	WAIS III Test Reverse Order
	LR	MVC	MVL			
Case 1	0.5	15/11	15/13	13.22 sec	16/08	14/04
Case 2	0.71	15/11	15/11	15.1 sec	16/06	14/03
Case 3	0.33	15/08	15/07	9.00 sec	16/08	14/04
Case 4	0.4	15/14	15/14	19.13 sec	16/10	14/09
Case 5	0.25	15/07	15/09	12.24 sec	16/05	14/03
Case 6	-0.16	15/06	15/09	22.42 sec	16/08	14/04
Case 7	01	15/15	15/14	6.93 sec	16/08	14/05
Case 8	0.63	15/11	15/07	40.42 sec	16/08	14/07
Case 9	0.11	15/05	15/05	29.95 sec	16/07	14/06
Case 10	0.67	15/10	15/09	28.80 sec	16/06	14/04
Mean	**0.444**	**9.8**	**9.8**	**19.721**	**7.4**	**4.9**
Standard Deviation	**0.33**	**3.29**	**3.12**	**10.65**	**1.43**	**1.91**

Table 7: Test results for the first post-test (24 hours)

Z-score results for the pre-test:

Test	RAVLT Test			TMT Test	WAISIII Test	WAISIII Test
Case	LR	MVC	MVL	Part A and B	Direct order	Reverse order
Case 1	1.39	1.64	1.25	1.47-	0.56	0.28
Case 2	0.90	0.11	0.88	0.66	0.37-	0.28-
Case 3	1.36-	0.65-	1.33-	0.51	1.30-	0.84-
Case 4	0.14-	0.11	0.52	0.33-	2.42	1.40
Case 5	0.14-	1.03-	0.22-	0.27-	0.37-	0.84-
Case 6	1.79-	1.03-	0.22-	0.95-	0.37-	1.40-
Case 7	0.90	1.64	1.25	1.29-	0.56	0.84
Case 8	0.47	0.11	0.22-	0.83	0.37-	1.40
Case 9	0.32-	1.03-	1.69-	1.08	0.37-	0.28
Case 10	0.10	0.11	0.22-	1.23	0.37-	0.84-

Table 8: Pre-test z-score results

Z-score results for the first post-measurement (24 hours):

Test	RAVLT Test			TMT Test	WAISIII Test	WAISIII Test
Case	LR	MVC	MVL	Part A and B	Direct order	Reverse order
Case 1	0.17	0.36	1.03	0.61-	0.42	0.47-
Case 2	0.80	0.36	0.38	0.43-	0.98-	0.99-
Case 3	0.34-	0.55-	0.90-	1.01-	0.42	0.47-
Case 4	0.13-	1.28	1.35	0.06-	1.82	2.14
Case 5	0.58-	0.85-	0.26-	0.70-	1.68-	0.99-
Case 6	1.81-	1.15-	0.26-	0.25	0.42	0.47-
Case 7	1.67	1.58	1.35	1.20-	0.42	0.05
Case 8	0.56	0.36	0.90-	1.94	0.42	1.10

Case 9	1.00-	1.46-	1.54-	0.96	0.28-	0.58
Case 10	0.68	0.06	0.26-	0.85	0.98-	0.47-

Table 9: z-score results for the first dimension (24 hours)

Z-combnined results for the first pre- and post-test (24 hours):

Z-combnined	Z-combnined, for pre-measurement	Z-combnined, for first post-measurement (24 hours)
Status	0.61	0.149
Status 1	0.318	-0.143
Status 2	-0.829	-0.474
Status 3	0.664	1.066
Status 4	-0.479	-0.844
Status 5	-0.962	-0.504
Status 6	0.649	0.644
Status 7	0.371	0.581
Status 8	-0.342	-0.457
Status 9	0.002	-0.020

Table 10: z-combiend results for the first pre- and post-test (24 hours)

Table 10 shows the z-combined results, which are the average z-scores in each measurement, the pre-and post-test (24 hours), where it appears from the pre-test that (4 cases), which corresponds to (40%) of the sample, had negative z-combined results for the psychological battery that was applied to them, while the rest of the sample recorded positive results; while in the first post-test (24 hours), the z-combined results were negative for 6 cases of the sample, (60%) suffering from post-surgical functional cognitive impairment after 24 hours of the operation.

1-2 Discussion and interpretation of the results of the first hypothesis:

The results of the first hypothesis showed that (40%) of the sample suffer from pre-surgical cognitive impairment, which corresponds to the results of the study (Brendan et al, 2015), which recorded a decrease in the cognitive baseline score in a percentage of its sample members before surgery, as this weakness is temporary and is caused by the psychological consequences of the operation and its seriousness; The test results are also affected by the place of application, which was in the hospital, specifically in the patient's room during the pre-measurement, which appeared in (Case 3), who was going to undergo thyroidectomy surgery, and was afraid of vocal cord paralysis after the doctor informed her of the expected risks of the surgery; it could also be a permanent cognitive impairment that was not previously diagnosed, and the patient does not notice it in his life due to his low cognitive reserve, advanced age, chronic diseases, neurological injuries, and taking narcotic drugs, which appeared in Case (9), 61 years old, and stopped studying in primary school. The results of the first hypothesis also showed that (60%) of

the sample suffer from functional cognitive dysfunction after surgery, namely (cases 4), who suffered from cognitive dysfunction before surgery, which is consistent with the results of the study (Brendan et al, 2015), which confirmed that patients who suffer from prior cognitive dysfunction are more likely than others to develop functional cognitive dysfunction after surgery, as the results of the Z-combined for the first post-measurement indicated the registration of two cases suffering from functional cognitive dysfunction after surgery, which is consistent with the results of (Bitner, 2019), which aimed to improve the care of patients in non-hospital surgeries, and to know the extent of their ability to return to their daily lives by assessing the extent of the emergence and spread of functional cognitive disorders after surgery, where the results of the study confirmed the emergence of cognitive disorders after surgery ranging from mild to severe, affecting patients' independence and their return to their lives one day after surgery; Case 4 also recorded cognitive improvement after surgery, which was confirmed by the study (Berger, et al. 2015), patients may show cognitive improvement after surgery for several reasons, including the effect of practice and learning in some neuropsychological tests, without neglecting the psychological aspect of the patient, which certainly improves after the success of the surgery.

1-3- Presentation and analysis of the results of the second hypothesis:

Reminder of the second hypothesis: "There is a postoperative functional cognitive dysfunction after surgery in non-cardiac surgeries after 4 days of surgery".

To verify the validity of the second hypothesis, we applied a second post-measurement (4 days after surgery), and the results were as follows:

- Results of the tests in the second post-measurement (4 days):

Test - Status	RAVLT			TMT Test Part A & B	WAIS III Direct Order WAIS III Reverse Order	WAIS III Direct Order WAIS III Reverse Order
	LR	MVC	MVL			
Case 1	0.42	15/11	15/09	6.88 sec	16/06	14/04
Case 2	0.25	15/08	15/10	20.68 sec	16/08	14/03
Case 3	0.1	15/05	15/07	4.28 sec	16/06	14/04
Case 4	0.25	15/13	15/13	24.3 sec	16/10	14/08
Case 5	0.25	15/10	15/10	9.99 sec	16/08	14/06
Case 6	0.33	15/10	15/08	15.82 sec	16/09	14/06
Case 7	1	15/15	15/14	9.7 sec	16/08	14/06
Case 8	0.6	15/12	15/10	37.3 sec	16/08	14/06
Case 9	0.36	15/08	15/06	28.22 sec	16/08	14/05

Case 10	0.65	15/09	15/08	17.12 sec	16/08	14/04
Mean	0.421	10.1	9.5	17.429	7.9	5.2
Standard Deviation	0.26	2.85	2.51	10.39	1.20	1.48

Table 11: Test results in the second post-test (4 days)

Z-score results for the second post-test (4 days):

Test	RAVLT Test			TMT Test Part A and B	WAISIII Test Direct order	WAISIII Test Reverse order
Case	LR	MVC	MVL			
Case 1	0.004-	0.316	0.200-	1.016-	1.587-	0.813-
Case 2	0.650-	0.738-	0.200	0.313	0.084	1.491-
Case 3	1.221-	1.792-	0.998-	1.266-	1.587-	0.813-
Case 4	0.650-	1.019	1.397	0.661	1.754	1.897
Case 5	0.650-	0.035-	0.200	0.716-	0.084	0.542
Case 6	0.346-	0.035-	0.599-	0.155-	0.919	0.542
Case 7	2.202	1.722	1.796	0.744-	0.084	0.542
Case 8	0.681	0.668	0.200	1.913	0.084	0.542
Case 9	0.232-	0.738-	1.397-	1.039	0.084	0.136-
Case 10	0.871	0.387-	0.599-	0.030-	0.084	0.813-

Table 12: z-score results for the second post-test (4 days)

Z-combnined results for the first (24 hours) and second (4 days) pre- and post-measurement:

Z-combnin.status	Z-combnined for pre-measurement	Z-combn. 1st post-measur. (24 h)	Z-combn. 2nd post-measur. (4 days)
Case 1	0.61	0.149	-0.550
Case 2	0.318	-0.143	-0.380
Case 3	-0.829	-0.474	-1.279

Case 4	0.664	1.066	1.013
Case 5	-0.479	-0.843	-0.096
Case 6	-0.962	-0.503	0.054
Case 7	0.649	0.644	0.933
Case 8	0.371	0.581	0.681
Case 9	-0.342	-0.457	-0.230
Case 10	0.002	-0.02	-0.146

Table 13: z-combiend results for the first pre- and post-test (24 hours) and the second post-test (4 days)

We note from Table 13 that (6 individuals) of the sample recorded a negative z-combined result in the second post-measurement (4 days) after surgery (60%), while the rest of the sample individuals had positive results, meaning that they do not suffer from functional cognitive impairment after surgery.

1-4- Discussion and interpretation of the results of the second hypothesis:

Through the above analysis of the results of the second hypothesis, it appears that there is a functional cognitive impairment after surgery (POCD) after (4 days) of surgery, as it appeared in (60%) of the study sample. These results are consistent with the study of (Liu, et al. June 2021) and the study of (Borchers, et al. 2021), which confirmed that the timing of the neuropsychological assessment of patients and the specificity and sensitivity of the neuropsychological tests used affect the diagnosis of postoperative cognitive dysfunction, because there is no unified and complete set of neuropsychological tests as diagnostic criteria for POCD, as postoperative cognitive dysfunction appeared in the second measurement only in one case, as a result of the various variables and consequences of surgery, and the patient's psychological state deteriorated after being diagnosed with breast cancer, while (3 cases) of patients who were diagnosed with postoperative cognitive dysfunction (POCD) suffered from prior cognitive dysfunction, and postoperative cognitive dysfunction in the first post-measurement, and cognitive dysfunction continued with them 4 days after surgery, which is consistent with what was confirmed by the study of (Berger, et al. 2015) that the persistence of postoperative cognitive dysfunction is related to the reason for its appearance, and differs between cases.

The results of our study did not conflict with the results of previous studies, because the timing of the neuropsychological assessment and the battery of tests used were not standardized.

Based on the results, we can verify the validity of the results of the first and second hypotheses, where:

- The first hypothesis states that: "There is a postoperative functional cognitive dysfunction after surgery in non-cardiac surgeries after 24 hours of surgery", and since we recorded negative values for the aggregated Z value in (60%) of the study sample in the first post-measurement, we can say that it has been achieved.
- The second hypothesis states that: "There is a postoperative functional cognitive dysfunction after surgery in non-cardiac surgeries after 4 days of surgery ", and since we recorded negative values for the aggregated Z value in (60%) of the study sample in the second post-measurement, we can say that the hypothesis has been achieved.

General conclusion:

This study aimed to evaluate the emergence or absence of postoperative cognitive dysfunction (POCD) in non-cardiac surgeries; accordingly, the researchers tried to adhere to all scientific and methodological steps of scientific research that studied this disorder, which were mostly foreign studies, which prompted us to translate the theoretical basis, a recommended test to evaluate the disorder, and the statistical method adopted to evaluate the disorder, where the research was divided into a theoretical framework in which we presented a general conception of the emergence of the disorder in non-cardiac surgeries.

Based on previous studies on the subject, we proposed two hypotheses stemming from a perception of the emergence of the disorder or not, and the nature of the selected sample. We also selected the appropriate study tools from among the tests recommended by the 1995 consensus statement, as well as applied pre- and post-measurements to determine the cognitive baseline of patients before the effect of the surgical variable on them, where the battery of neuropsychological tests used was represented in (Ray Auditory Verbal Learning Test to assess verbal memory and learning RAVLT, Path Tracking Test with its two parts -A- and -B- to evaluate executive functions "cognitive flexibility, planning, and directed attention" TMT, Number Memory Test - Direct Order - and - Reverse Order - to assess working memory "Phonological Loop and Central Executor WAIS III"). Based on the field study, and the results of the statistical analysis of the study data that focused on knowing the emergence of (POCD) in non-cardiac surgeries after 24 hours and 4 days, and after answering the study questions and testing its hypotheses, this study yielded the following results:

- Postoperative cognitive dysfunction is one of the consequences of non-cardiac surgery that appears 24 hours and 4 days after surgery.
- The presence of prior cognitive dysfunction contributes strongly to the emergence of functional cognitive dysfunction after POCD surgery.
- The emergence of postoperative cognitive dysfunction is not related to age or gender, but to the specificity of each case.

- The possibility of cognitive improvement after POCI surgery.
- The persistence of POCD after surgery is related to the reasons for its emergence.

We conclude from the above that postoperative cognitive dysfunction exists in the Algerian hospital environment, like all other global hospital environments, despite its lack of diagnosis and follow-up in our environment, which makes research into improving and standardizing methods for its diagnosis and prevention a rich and broad field for research.

In conclusion, this study remains a serious attempt to research an important topic that addresses a large sample of society, namely people who will undergo non-cardiac surgeries; It should be noted that we encountered many difficulties in the theoretical aspect, due to the lack of references about the disorder (POCD), which took us a lot of time in collecting and translating research sources; and among the difficulties we encountered in the field aspect, is that research into this disorder requires a research team to stand on the three measurement stages, such as moving to conduct the post-measurement, and the privacy of the sample from the health and psychological aspect makes it difficult to pass the tests.

Suggestions and recommendations:

Through the results of our study, we can suggest recommendations to send a message to researchers and practitioners in the hospital environment, and to all those who have direct contact with patients before and after surgery, which can be summarized as follows:

- Expanding the study sample to include a larger number of patients to generalize the results.
- Evaluating the appearance of postoperative cognitive dysfunction in specific types of surgical operations.
- Proposing standardized neuropsychological tests to evaluate postoperative cognitive dysfunction, to be applied by practitioners in the Algerian environment.
- The presence of clinical neurolinguistics in the hospital environment to evaluate cognitive processes before and after surgery, and early detection of any postoperative cognitive dysfunction that may persist with the individual for a long time, or cause permanent cognitive dysfunction.
- Preparing a pre-neuropsychological assessment in coordination with the anesthesia departments during anesthesia consultations, to identify patients at risk of developing postoperative cognitive dysfunction.
- Raising awareness of the impact of surgical operations on the individual's cognitive performance, which affects his decisions and behavior after hospitalization and recovery.

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