Cognitive Performance Evaluation in Perfusion Settings: advancing practice through structured assessment

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ABSTRACT:

Introduction: Despite the decrease on the incidence of side effects related to the cardiac surgery, alterations on cognition are frequently experienced by the patients postoperatively. The ethiology of this impact is multiple and there is no specific assessment tool for our purpose. **Objective**: to purpose the Perfusionist Cognitive Assessment Battery (P-CAB) methodology as a new tool to audit the postoperative cognitive performance to implement cardiac surgery outcomes. **Design ans Setting:** A narrative review and a focal group was applied to determine the tests, the timing and the workflow to be applied in our centre. The P-CAB was composed by the Phototest, the Clock Drawing test and the Visuospatial Memory test, performed preoperatively, in a short-term and during the mid-term recovery **Results:** The P-CAB was achievable with the multidisciplinary cooperation on 116 patients with a remarkable acceptance from the patients. **Discussion:** Its application permits to detect a cognitive decline and even subtler changes in functions like the episodic, semantic and visuospatial memory, the language, attention and executive functions. **Conclusion:** P-CAB represents a valuable multidisciplinary assessment tool that offers information about the neurocognitive performance after the cardiac surgery. **Limitations:** Its findings should be complemented by specific diagnostic tests. **Ethics and disclosure:** This is a part of a clinical trial approved by the Ethic Commitee of the Centre and the publication is sponsored by Terumo Europe España S.A not carrying any conflict of interest.

INTRODUCTION:

The cardiovascular surgery (CVS) under cardiopulmonary bypass (CPB) has experienced a substantial evolution during the last decades. Thus, a significant reduction on mortality, morbidity and recovery time has been observed. It has been achieved as a goal of the surgical improvements like the Minimally Invasive Cardiac Surgery (MICS) and new clinical approaches on anaesthesia and perfusion as well(1–3). Despite the fact, some postoperative cognitive performance alterations are still frequent after cardiac surgery. Its evaluation and reduction currently still represents a challenge(4).

Vasquez and Chitwood defined the term “postcardiotomy syndrome” after CVS during the early 70´s by observing that a variety of changes in cognition frequently appeared postoperatively. Some patients presented affective disorders (depression/anxiety) or confusion during the early postoperative period, that used to improve after 5 days. Other patients developed a delirium status during the first week (hallucinations, illusions and/or motor excitation) that eventually conducted to death. The post-mortem analysis, revealed a correlation between the Post-Operative Cognitive Decline (POCD) and the presence of anoxic lesions on the hippocampus as well as other focal infarctions(5).

Patel et al, observed POCD after CVS in 50-70% of patients, decreasing to 30-50% in a mid-term follow-up (8-10 weeks) and remaining for 10-20% after one year. Further investigations with magnetic resonance imaging (MRI) revealed the presence of cerebral micro-bleeds in 76% of patients after CVS. This insult was caused by blood brain barrier (BBB) disruptions where the CPB played an important role(6,7). The elderly and the presence of co-morbidities like a previous stroke, low cardiac output, peripheral vascular disease, hypertension, diabetes, depression, low preoperative cognitive level, pulmonary disease or acute kidney injury increase the patient frailty favouring the POCD development(8).

Despite the incidence of stroke after CVS is low (1-6%)(9), at least three quarters of the patients present a subclinical alterations that are not deeply understood nor properly determined(10). Many of this silent or understudied events could be related to the lack of a consistent relation between DSM-V diagnostics like delirium or dementia and many alterations on cognition(11,12) resulting in an interference on the recovery of the patient. This lack may be related to the use of the unadequate tools to deepen on the changes in cognition after CVS (13). Thus, the postoperative alterations on the cognitive performance are a major cause of short and long term morbidity, mortality and substantially affect the life quality of patients after CVS(14), its evaluation should be tailored and adapted considering the current knowledge of the pathogenesis of the process.

In one hand has been observed that, after a CVS, some microbleeds are spread along the brain with a higher incidence on the frontal and parietal lobes(6). Meanwhile, after CPB, also the Nrdp1 protein is altered on the hippocampal neurons inducing an apoptosis process linked to the inflammatory response(15). In primates, like the human, the hippocampus is involved on the episodic and visuospatial memory functions(16). Zanatta et al referred that the early and mid-term postoperative psychomotor and executive alterations are correlated to microemboli in the left middle cerebral artery but not to the right(17). Further than the microemboli release, the presence of impaired perfusion, chronic cardiovascular disease, and inflammatory response seemed to be determinant also on the neurocognitive decline(6,7).

On the other hand, the benefit of the CPB avoidance in coronary patients is still unclear since the current evidence confers to the extracorporeal procedure just a contributory role(18). The CPB duration and the sudden haemoglobin drop increase the postoperative brain microbleeds incidence. Additionally, there are modifiable factors like the glycaemic misbalance, the haemodilution, the embolic delivery, the rapid patient rewarming, the cross-clamp manipulation manoeuvres, and/or the oedematization (as a result of a low blood osmolarity) that affect the BBB permeability also(8,19).

Since many avoidable maneuvers and circumstances related to the CVS protocols and theperfusionist interventions may affect the cognition postoperatively in a different manner(20,21), a tailored Cognitive Assessment Battery of tests promoted by the Perfusionist (P-CAB) could offer a new perspective to enhance the recovery and reduce the insult to the patient.

METHODS:

Cognitive Assessment:

Considering the available resources in our centre, a neurocognitive assessment team (NAT) was constructed aiming to deepen in the cognitive performance changes along the CVS perioperative period. The NAT involved cardiac surgeons, hospitalization nurses, neuro-psychologist, statistics, a perfusionist and it was supervised by the chief of Neurology Department of the centre (Fig. 1).

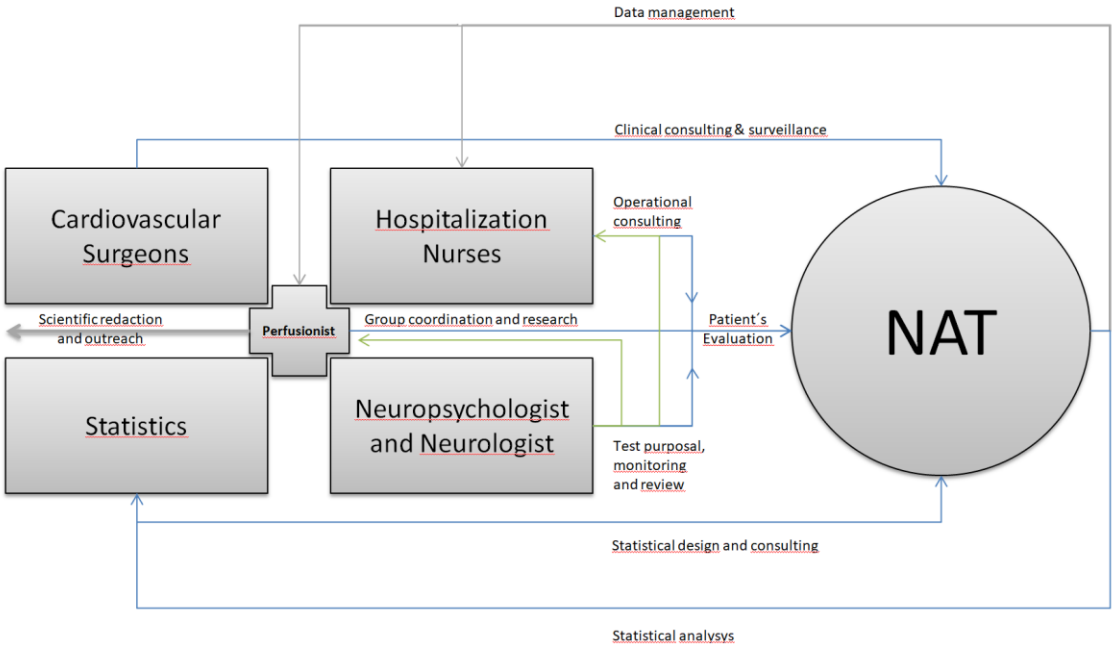

Fig.1: Neurocognitive Assessment Team (NAT) workflow.

A comprehensive literature review was conducted by the neuropsychologist to purpose a feasible and reliable test battery. The proposals were evaluated by the team under the focal group technique, attending to the accuracy and operational factors as well. The coordination of the process was carried out by the perfusionist and moderated by the neuropsychologist that performed a monthly training with the evaluation staff.

It was assumed that, the effect of the BBB disruption and the presence of solid emboli present a different relevancy in the timeline (10,17). Considering that, the evaluation program included 3 sessions per patient, being determined as follows:

- Patient reception: The perfusionist received the patient during the admission and promoted coping skills as a first approach. After signing the consent form and solving

any lack of information about the process (by demand), proceeded with the cognitive assessment.

- Early period: The reference nurse performed the P-CAB within the 24-48h after ICU discharge. As requirements to proceed, the patient had to consent and have an acceptable level of comfort being seated, and the chest drainage had to be removed.
- Mid-term: It was carried out by the reference nurse or the perfusionist during the mid-term follow up within the 3-4 months after the hospital discharge.

The Perfusionist Cognition Assessment Battery (P-CAB) was constructed involving three rapid tests mainly focused on episodic and visuospatial memory, language, attention and executive functions. It included the Phototest (Pht)(22), the Clock Drawing test (CDt) following the Cacho et al. methodology(23). Additionally, the Visuospatial Memory test (VMt) was included as a gamification of the Corsi´s Visuospatial Span test(24).

The Pht consists on the identification of 6 items on a printed sheet. Afterwards, the evaluator asked the patient to enounce as much male and female names as possible during 20" per gender, beginning with of the patient. Then, it is requested to remember the 6 pictures by means of free memory, considering a penalty of 50% per item if a clue is demanded. The drawings were changed for each evaluation(22,25).

During the CDt, the evaluator asked the patient to draw an analogical clock pointing at ten minutes past eleven in three phases just offering the centre of the circumference. First, the patient drawed the circumference, and then wass required to place the twelve numbers. Afterwards the patient is required to draw the clock hands pointing to ten minutes past eleven hours (23).

Finally, the VMt was carried out using a mobile phone under an Android OS. Before every test, the evaluator explained to the patient that a group of cubes will be fixed on the screen and a hand will describe a sequence that must remember and reproduce afterwards. Due to that, a first demo sequence was performed by the patient to confirm that comprehends the procedure prior to the VMt. During the evaluation, after the patient completed a sequence a new one started increasing the difficulty. The test was interrupted by the system by the increment of recurrent or cumulative errors(26).

DISCUSSION

The extracorporeal procedures may influence the neurocognitive performance in the early postoperative period and further. This impact should be carefully assessed according to the ethiology to properly determine the influence of the diverse factors that could be involved(18,27).

Frequently, the cognitive evaluation of the cardiovascular patients represents a challenge due to the lack of dedicated resource assignment. There are some single-test studies using the MiniMental Status Examination (MMSE) and the Montreal Cognitive Assessment (MoCA) but there are several facts that should be considered also, further than the limited information that may offer. Despite the MMSE is one of the most frequently used test for clinical setting because of its ease of use, results influenced by the educational level, cultural biases and

sensorial impairments(28,29). On the other hand, in spite of the MoCA is a great screening tool for dementia (DEM) in elderly patients, the time extension, the certification and the license required for its use decrease substantially the MoCA´s operational value (30,31).

The Pht was included as a non-influenced test by the educational level. It provided a test-retest and inter-evaluator reliabilities comparable to the offered by MMSE or MoCA tests detecting DEM and cognitive impairment (CI) in Spanish population. It was specifically designed by Carnero-Pardo for Spanish population and provides valuable information about the language, the executive functions and the episodic memory as well(25,32).

The CDt was been validated for Spanish population evaluation by Cacho et al., resulting independent to age, educational level and gender, and offers a sensitivity and specifity comparable to MMSE. It involves linguistic abilities, semantic and episodic memory functions that are physically related with temporal lobes (left and both respectively). It also includes executive functions, allowing to observe changes in the function of the frontal lobe(23).

The VMt, applied in the direct version, evaluated the visual and working memory as well as executive functions, involving the verbal encoding and the attentional processes as a gamified version of the Spatial Span Test (SSt) purposed by Corsi. Being upgraded as a digital tool, it offered several results like the longest sequence achieved (LS) correct answers count (CA) omissions (O) and perseverations (P) that were not influenced by patients age in contrast to the reaction time (RT), in the forward setup. Despite VMt has not a former validation yet as a screening tool for DEM and CI, its results could be observed as tendencies that could be correlated with the data observed on the other tests(24,33,34).

Considering that, our team developed the P-CAB and applied it successfully in 116 patients purposed for elective cardiovascular surgery. It was not rejected by any patient during the admission. During the short-term evaluation was skipped in a 3,4% of the patients (2 denials, and 2 deaths) as well as in a 4,3% in at mid-term(1 denial and 4 deaths). Thus a considerable acceptance for the patient is evident representing, per se, a success of the NAT.

The current evidence points that the patients with preoperative cognitive impairment present a higher neurocognitive affection CPB(18). Performing a baseline analysis allows to identify the patients frailty and predict cognitive disturbances in the postoperative period (35). Furthermore, the postoperative P-CAB follow up may identify major changes in cognition and even the subtler changes in the cognitive performance, with a relative comparison considering the baseline, to deepen in the influence of changes in the CPB strategies. Considering that, seems to be mandatory to implement the perfusion practice with a proper neurocognitive assessment to improve the outcomes.

LIMITATIONS:

Albeit P-CAB offers valuable information about different areas of the brain its validation should include a correlation with MRI, emboli detection and specific blood determinations. Should be considered also that the P-CAB has been designed for Spanish population and its appliance in other scenario may require additional validation. Further prospective randomized studies

should be carried out to properly determine the phisio-pathological mechanisms behind the obtained observations.

CONCLUSIONS

The PCAB was successfully introduced in the cardiovascular surgery process involving a multidisciplinary group of caregivers with an excellent acceptance by the patient. Its implementation offers an evaluation of the cognitive performance evolution during the process considering memory, language and executive functions. It´s inclusion offers a detailed cognitive performance assessment that offers an audit of the impact related to the CPB strategy variations, representing an upgrade of the safety and quality duing the surgical process. Despite that, to properly determine the neurocognitive impact, the P-CAB findings should be complemented with diagnostic tests like the MRI and specific blood determinations.

ETHICS:

This procedure paper is considered as a part of the HARjbm Clinical Trial and was approved by the Ethic Commitee of the centre (NCT03720184)(36).

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