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# Assessment of a Computer-Based Tool for Evaluating Psychomotor Recovery After Day-Case Anesthesia: A Comparison with Clinical Criteria

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**Abstract**

**Background and aims:** Day care surgery under general anesthesia offers a number of advantages to patients, health care providers and hospitals. A software program “Computer Aided Psychomotor” (CAP) test was designed by one of the authors for objective evaluation of cognitive and affective domains in patients recovering from anesthesia.

**Method:** The CAP test was evaluated in 40 adult patients of ASA I or II recovering from general anesthesia after day care surgical procedures. Balanced anesthesia technique was administered to all the patients. A series of ten response time (RT) to the CAP test were recorded in the PAC, in the immediate preoperative period and at 30, 60, 90, 120, 180 and 240 minutes in the postoperative period. For comparison, recovery was also assessed by a clinical recovery score (CRS) at the same time interval.

**Result:** Hierarchical ANOVA (F-test) was used to determine significance of difference between the observations recorded by CAP test and by the clinical method. At each time point, Dunnett’s test was applied for comparison. Paired t–test was used for comparison of the two methods. The trends of recovery by the two methods of assessment were similar. However, at one hour and beyond in the recovery period, the CAP test was about 10% more sensitive than the clinical method. At 120, 180 and 240 minutes, the CAP test was able to detect an apparent state of “supernormal” recovery which was not detectable by clinical method.

**Conclusion:** The CAP test is an alternate method for assessment of recovery of psychomotor skills after day care anesthesia. It is a simple bedside test that can be performed in patients recovering from anesthesia. The CAP test is an objective assessment as against high level of subjective bias that could occur with the clinical method of assessment.

**Keywords:** Daycare anesthesia; Recovery; Assessment; Computer solware

## Introduction

Success of a day care surgery unit relies heavily on the speed, quality and reliability of recovery from anesthesia [1]. It is difficult to determine with accuracy the time at which the patient can safely return to home [2]. Measurement of recovery from anesthesia has range from assessment of the patient’s ability to open eyes to their ability to drive a car [3]. Simple clinical tests e.g. Romberg’s test or the ability to walk, seem to be inadequate guideline for safe discharge aler day care anesthesia [4] whereas sophisticated equipment’s with complex psychomotor test batteries or driving simulators are bulky, expensive and too complex for use in routine clinical practice [5].

With this background, a computer solware program ‘computer aided psychomotor’ (CAP) test was designed for objective evaluation of cognitive and affective domains in patients recovering from anesthesia. Ue present study was undertaken to evaluate the CAP test for objective assessment of recovery of cognitive and affective skills in patients aler day care anesthesia. Ue observations were compared with a clinical recovery score used routinely to assess recovery.

## Materials and Methods

Ue solware program of the CAP test was designed using turbo C++ computer language. Ue program was made windows friendly. Ue program incorporates nine colors, each assigned a numerical value as shown in Table 1.

| Numerical Value Assigned | Color incorporated in program |
|---|---|
| 1 | GREEN |
| 2 | BLUE |
| 3 | RED |
| 4 | ORANGE |
| 5 | PURPLE |
| 6 | SKY BLUE |
| 7 | YELLOW |
| 8 | GREY |

| | |
|---|---|
| 9 | WHITE |

Table 1: Numerical values assigned to various colors in the program design.

Colored stickers were pasted on the respective keys on the numeric keypad (Figure 1) e.g. a green colored sticker was pasted on key no. 1 on the numeric keyboard and a blue colored sticker was pasted on key no. 2 and so on.

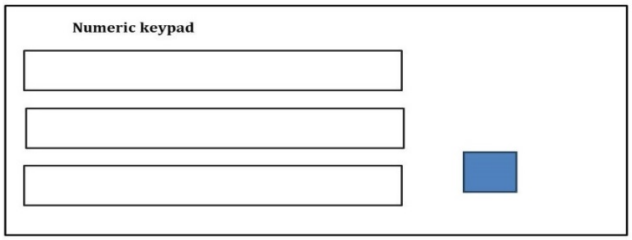


Figure 1: Keyboard showing colored stickers pasted on the numeric keypad.

On clicking the program icon displayed on the desktop, the program starts running and the computer screen displays the main menu listing all the colors with their respective numbers (Figure 2).


Figure 2: Menu displayed on the computer screen.

At this point of time, the observer is required to choose any color randomly by pressing any key from numbers 1 to 9. Ue patient is blinded to the color selected by incorporating the numeric code for color selection.

Aler entering the selected number, the computer screen displays “Press any key to start” (Figure 3).

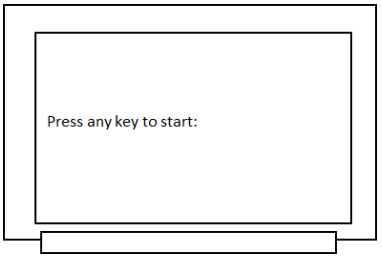


Figure 3: Computer screen aler selection of color.

At this stage, the system is ready to interact with the patient. Ue patient is explained that a color will be displayed on the computer screen and he/she is expected to see the color and press the respective colored key on the keyboard at the earliest possible.

For measuring the response time (RT), the observer presses any of the keys on the key board. Ue selected color gets displayed on the screen (Figure 4) and the bios clock of the computer gets linked to the solware.

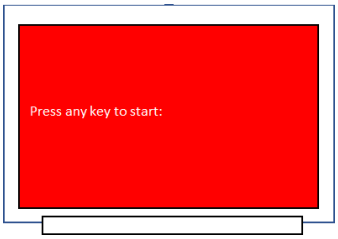


Figure 4: Example of selected color displayed on computer screen.

As soon as the patient presses the correct key, the response time in seconds, to the 6th decimal place, is displayed on the screen (Figure 5).

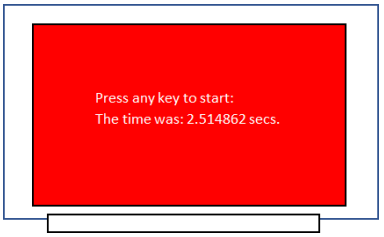


Figure 5: Response time displayed on computer screen.

Uis is the time lapsed between the appearances of color on the screen and pressing the correct colored key on the keyboard. We recorded the response time RT in seconds, to the second decimal place. On pressing the enter key, the computer asks if one wishes to continue with the test for another observation on the same patient (Figure 6).

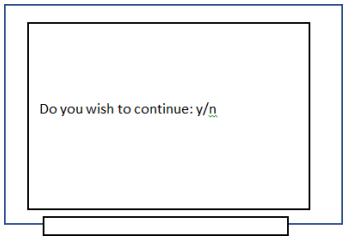


Figure 6: Computer prompt at the end of noting the 'response time'.

If the observer wishes to continue running the program for another observation, he enters "Y". Uis returns the display screen to the main menu (Figure 2), and the system is ready for another observation. If the observer wants to exit the program aler making required number of observations, he needs to enter "n" at this stage. Ue computer returns back to the windows desktop.

## Method

Ue study was approved by the institutional ethical committee. Forty adults aged between 18 and 50 years of either sex scheduled to undergo elective surgical procedures on a day care basis were included in the study. All patients belonged to ASA physical status I or II. An informed consent for the procedure was obtained from each patient. Patients with the past history of mental or neurological illness or taking any treatment affecting central nervous system were excluded from the study.

A day prior to surgery, preanesthetic checkup (PAC) was performed. Ue patients were introduced to the CAP test and the nature of study was explained to them. All the subjects practiced the CAP test for 15 minutes in the training session. Aler the training session a series of ten response time was recorded. In addition, clinical recovery score was obtained by adding scores for vigilance, cognition, orientation, short term memory and evaluation by the patient of his/her condition (Table 2). No premedication was advised. All patients were advised to remain fasting aler midnight prior to the surgery.

| **VIGILANCE** | **SCORE** |
|---|---|
| Unconscious, not arousable | 0 |
| Unconscious, arousable by nociceptive stimuli | 1 |
| Unconscious, arousable by verbal stimuli | 2 |
| Drowsy | 3 |
| Awake, not attentive | 4 |
| Awake, attentive | 5 |
| COGNITION | |
| No understanding of simple orders | 0 |
| Good understanding of simple orders | 1 |
| ORIENTATION | |
| Confused | 0 |
| Disturbed | 1 |
| Well oriented | 2 |
| SHORT TERM MEMORY | |
| Complete Amnesia | 1 |
| Partial Impairment | 2 |
| No impairment | 3 |
| EVALUATION BY THE PATIENT OF HIS/HER CONDITION | |
| Uncomfortable | 1 |
| Comfortable | 2 |
| Excellent | 3 |

Table 2: Clinical Recovery Score (CRS) Maximum Score=14.

On the day of surgery, response time (RT) to the CAP test was recorded in the preoperative room. Mean of a series of ten observations for RT was noted as a control value. CRS was also assessed and taken as a baseline for comparison with CRS scores in the postoperative period.

In the operating room, intravenous access was established. Devices for monitoring ECG, heart rate (HR), blood pressure (NIBP) and oxygen saturation ($SPO_2$) were applied to the patient. Balanced general anesthesia technique using Propofol, fentanyl and isoflurane were used for all the patients. Time at which nitrous oxide was switched off was recorded as ''zero time'' for observations in the recovery period.

Patients were shiled to the recovery room for further observations. Vital signs including oxygen saturation, HR and NIBP were monitored. In addition recovery from anesthesia was assessed by CRS and by CAP test. Mean response time of 10 observations was recorded at 30, 60, 90, 120, 180 and 240 minutes in the postoperative period. Simultaneously, the CRS was recorded at the same time intervals. No patient received narcotics or sedatives during the postoperative period.

Assessment of recovery by clinical method was done by using the parameters by Bellaiche et al. Patients were assessed by the clinical method in the PAC, preoperative room and at 30, 60, 90, 120, 180 and 240 minutes in the postoperative period. Ue preoperative CRS on the day of surgery was taken as control in each patient individually. Ue control was compared with PAC value and with CRS recorded at different time intervals in the postoperative period.

CAP test and CRS as methods of assessing recovery of psychomotor skills were compared. For this purpose the preoperative value of RT measured by CAP test and the preoperative value of CRS were taken as the control. Uese were designated as 100%, i.e normal level of psychomotor skills for each patient under study. Observations by the CAP test, at different time intervals in the postoperative period were converted into the percentage of recovery as compared to the preoperative control value by the following formula.

%age recovery of RT with CAP test=Mean RT/Preoperative mean RT × 100.

Similarly, the observations recorded by the clinical method at different time interval in the postoperative period were converted into the percentage of recovery by using the formula.

%age recovery of CRS=CRS ⁄Preoperative CRS X 100.

## Statistical analysis

Mean RT to CAP test was calculated from ten observations in the PAC, preoperative room on day of surgery and at different time intervals in the postoperative period.

Hierarchical ANOVA F+ test was used to determine significant difference between the observations recorded by the CAP test. At each point of time, Dunnett's test was applied for comparison. Ue observations with the clinical method were similarly analyzed using hierarchical ANOVA F test and the Dunnett's test. Paired t test was used for comparison of the two methods for assessing recovery from anesthesia. Significance level was kept at 5% i.e p value <0.05.

## Results

Ue demographic data of the patients included in the study are shown in Table 3.

| Variables | Mean (SD) |
|---|---|
| Age (years) | 27.25 (5.05) |
| Weight (kg) | 51.45 (4.25) |
| Sex (M:F ) | 16:24 |
| ASA status I : II | 12:4 |
| Duration of anesthesia (min) | 40.35 (8.24) |

Table 3: Demographic data of the patients, their ASA status and duration of Anesthesia (n=40)

Ue study comprised of 40 ASA I or II adult patients of 18-50 years of age. All the patients were of average height and built. Ue mean age was 27.25 ± 5.05 years; the mean body weight was 51.45 ± 4.25 kg. Four patients belonged to ASA II and the remaining were ASA I. Out of the patients included 24 were females. Duration of anesthesia ranged from 30 - 50minutes.

Various surgical procedures performed on the patients are shown in Table 4. All the procedures have been recommended for day care surgery.

| Surgical procedures performed | Number of patients |
|---|---|
| Diagnostic hysterolaproscopy | 14 |
| Fibroadenoma breast excision | 8 |
| Gynecomastia excision | 4 |
| Microlaryngeal surgery | 4 |
| Functional endoscopic sinus surgery (FESS) | 5 |
| Examination under anesthesia and biopsy | 5 |

Table 4: Surgical procedures performed on the patients (n=40)

Assessment of recovery by CAP test (Figure 7).

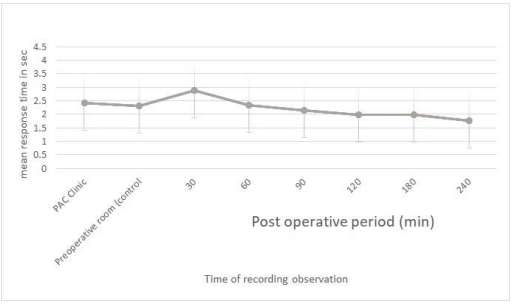


Figure 7: Comparison of preoperative mean response time RT by CAP test with PAC and at different time intervals in the postoperative (n=40).

Ue mean RT in PAC was 2.43 sec as compared to the control of 2.31 sec recorded in the preoperative room on the day of surgery. Ue difference is not statistically significant. Uis confirmed that the patients have had enough practice in the PAC and individual performance did not improve any further during the actual trial period.

At 30 minutes in the postoperative period, the RT was 2.88 sec as compared to the control of 2.31 sec. Uis is significantly higher than the control value, indicating a very low level of recovery. At 60 and 90 min, the mean RT was 2.34 and 2.15 respectively. Uere is no statistical difference as compared to the control value. Ue RT has approximated the preoperative control value. Uis is the time, when we expect near complete pharmacological recovery from drugs used in our study. At 120, 180 and 240 min, the mean RT was 1.99, 1.99 and 1.76 sec respectively. Uese values are significantly lower than the preoperative control value, indicating marked improvement beyond the control. Uis implies an apparent state of 'supernormal recovery'.

Assessment of recovery by clinical method (CRS) (Figure 8).

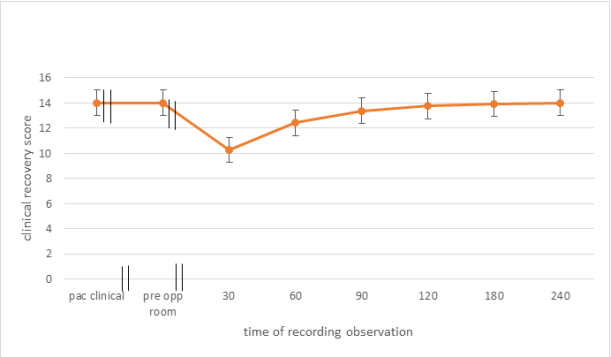


Figure 8: Comparison of preoperative clinical recovery score (CRS) with PAC and at different time intervals in the postoperative.

CRS in the PAC and in the preoperative period was compared with a score of 14. At 30 min in the postoperative period, the mean CRS was 10.23, at 60 min CRS was 12.40, at 90 min, CRS was 13.37. At 90 min, the mean CRS approximated the preoperative control value. Incidentally at this time pharmacological recovery was also expected. At 120, 180 and 240 min, the CRS was 13.73, 13.90 and 14 respectively.

Uese values have compared well with control preoperative CRS value ($p < 0.05$).

COMPARISON OF CAP TEST AND CRS (Figure 9).

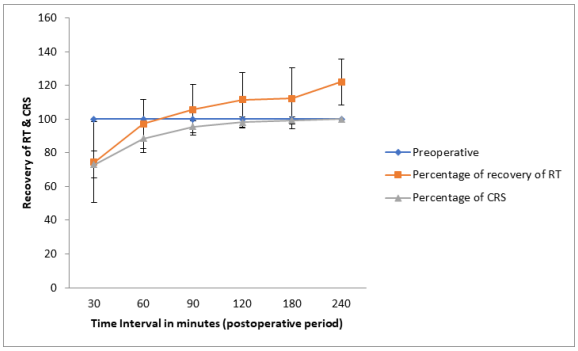


Figure 9: Comparison of the percentage recovery at various time intervals in the postoperative period by the two methods of assessment.

Ue percentage recovery assessed by the two methods were compared at each time point in recovery and compared with preoperative control value. Paired t test was used for statistical analysis. At 30 min, the recovery as assessed by CAP test was 74.45% as compared to 73.10% by CRS. Difference was not statistically significant. At 60 min, the recovery by CAP test was 97.21% while clinical recovery was 88.57%. Difference between the two was statistically significant with p value 0.001. At 90 min, there was 105.58% recovery as assessed by CAP test while it was 95.48% by CRS. Uese values at 90 min have approximated the preoperative control value, indicating almost complete recovery. Ue difference is statistically significant with p value 0.002. Uis indicates that at 60 and 90 minutes, the CAP test is 8-10% more sensitive than the CRS in assessing recovery. At 120, 180 and 240 min, the recovery assessed by the CAP test was 111.64, 112.18 and 122.17% respectively, while the CRS was 98.10, 99.29 and 100.00 respectively. Ue difference is significant with p value <0.001. Ue recovery above 100% by the CAP test at 120, 180 and 240 min indicates an apparent state of ''supernormal" recovery but this is not seen with the clinical method.

## Discussion and Conclusion

Methods of assessing recovery from general anesthesia have ranged from simple and crude test [6,7] of clinical recovery to the fine performance tests designed to detect lesser degrees of functional impairment [2-13]. Some of the tests are time consuming and require the use of elaborate equipment's. Most of the studies related to the assessment of recovery from anesthesia have used different psychomotor test to compare recovery characteristics of two or more anesthetic agents. Most of the authors have used two or more psychomotor tests in a single test and only few studies till date, have used a single test procedure.

Ue computer solware program i.e the computer aided psychomotor (CAP) test employed in this study trial was designed essentially for objective assessment of psychomotor skills in patients recovering from general anesthesia. Being a simple test it was universally applicable in all patients irrespective of their intelligence levels. Similar computer assisted psychomotor tests have been described in the literature [10-12]. However they are more complex to perform as compared to our test [14]. Uey require a fairly high degree of intelligence in patients undergoing the test procedure. Ue solware program incorporates measurement of the response time of the patient to a visual stimulus. Some of the similar test use more complex stimuli as in the perceptive accuracy test and in the semantic memory test8. Some of the tests have measured the response time to a stimulus while others have a time limit and the patient has to respond correctly within that limit, e.g. finger tapping test (FTT), perceptive accuracy test (PAT) [8-15]. Use of the bios clock of the computer system in designing the program helped us to record the response time with high accuracy.

Most of the studies have either compared two or more methods of assessment or have compared the pharmacological effects of different anesthetic agents using the psychomotor test [16-18]. In our study, we chose to compare the clinical assessment method CRS with the CAP test. To minimize the learning effect with repeated application of CAP test in any patient, enough training was provided with the computer system in the PAC clinic. Similar training sessions have been employed by other workers in their study. As with many other tests, the preoperative value on the day of surgery was taken as a control. Ue mean RT recorded in the PAC and in the immediate preoperative period was comparable. Uis ensured that the patients have had enough practice in the PAC and individual performance did not improve any further with practice. At 90 min, the RT had approximated the preoperative control value. Uis is the time when we had expected the pharmacological recovery from drugs used in our study. At 120, 180 and 240 min, the RT had remarkably improved beyond the control value. Uis implies an apparent state of supernormal recovery.

Various probable causes of this apparent supernormal recovery observed in our study at 120, 180 and 240 min in the postoperative period are as follows.

1. Learning effect: Uis is seen in most of the existing psychomotor tests.

2. Anxiety allayed in the postoperative period: Patient commonly approach with anxiety caused by real threats such as enforced unconsciousness, the entry of surgical instruments into the body, and the possibility of the discovery of unwelcome features of disease or of death. Ue patients who have been awaiting surgery for some time are obviously very anxious in the preoperative period. Aler the surgery is over, the anxiety level falls dramatically. Uis reduction in anxiety level could also result in significant improvement in their psychomotor skills.

3. Effect of residual levels of anesthetics: Studies have demonstrated that general anesthesia reduces the manifestation of anxiety in the immediate postoperative period. It is very likely that the residual effects of anesthetics in this study may have caused the supernormal recovery in the postoperative period [19]. Propofol has been found to produce euphoria and it reduces fatigue in the postoperative period. Ue supernormal response seen in our patients may be the result of this subclinical euphoria.

4. Other factors: Most of the authors have observed that the knowledge of test results may cause an increase in performance. It was found that motivation of the subject has an influence on the performance. Subjects are more likely to show the expected result, if the purpose of the result is explained to them. Incentives like early discharge from the postoperative ward with better performance on the

applied test can improve the response time. All these factors might have had some effect on our study also.

## Limitations

Ue CAP test has the following limitations

1. Ue test involves identification of different colors, so it is not feasible in color blind patients,

2. For assessing postoperative recovery, the test requires the preoperative control value and training of the assessee during the preoperative period. Uis may not be feasible in all the setting like in emergency situation.

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