***Original Article***

# Effects of Opioids on Driving Ability

Thomas Galski, PhD, J. Bradley Williams, PhD, and Holly T. Ehle, OTR
*Psychology and Neuropsychology Services (T.G.), The Pain Management Program (J.B.W.), and Occupational Therapy Service (H.T.E.), Kessler Institute for Rehabilitation, East Orange, New Jersey; and Department of Physical Medicine and Rehabilitation (T.G.), UMDNJ–New Jersey Medical School, Newark, New Jersey, USA*

***Abstract***
*Driving has been regarded as an activity of daily living that is important in maintaining a person's independence in the community, access to employment, and social activities. Many patients, however, using opioid medications on a regular basis (*C*hronic* O*pioid* A*nalgesic* T*herapy: COAT) to ameliorate their intractable pain have been restricted from driving out of concern that skills would be impaired and driving safety compromised by these medications. Yet there are no driving studies which have explored the effects of using opioid analgesics for an extended period of time. This pilot study was designed to determine the effects of medically prescribed, stable opioid use on the driving abilities of patients with persistent, nonmalignant pain. Sixteen patients with chronic nonmalignant pain on COAT, who met criteria for participation in the study, underwent a comprehensive off-road driving evaluation using measures which have been shown to be sensitive in predicting on-road driving performance. The evaluation consisted of a pre-driver evaluation (PDE), a simulator evaluation (SDE), and behavioral observation during simulator performance. Patients in the COAT group were compared to a historical control group of 327 cerebrally compromised patients (CComp) who had undergone the same evaluation and then passed an on-road, behind-the-wheel evaluation (BTW Pass;* n = *162) or failed (BTW Fail;* n = *165). Results revealed that COAT patients generally outperformed the CComp patients as a group by equaling or exceeding PDE and SDE scores of the BTW Fail patients as well as the BTW Pass patients on all measures that differentiated the groups. Notably, COAT patients had a relatively poorer performance than CComp patients on specific neuropsychometric tests in the PDE; however, the differences were not statistically significant and did not imply a systematic pattern of scores that reflected domain-specific deficits. Behaviorally, COAT patients were generally superior to CComp patients, also; however, COAT patients had greater difficulty in following instructions and as well as a tendency toward impulsivity, like the BTW fail group. While there was general support for the notion that COAT did not significantly impair the perception, cognition, coordination, and behavior measured in off-road tests that have been regarded as requisite for on-road driving, methodological problems may limit the generalizability of results and recommendations are made for research beyond a pilot study.* J Pain Symptom Manage 2000;19:200–208. © *U.S. Cancer Pain Relief Committee, 2000.*

***Key Words***
*Opioids and driving, prescription drugs and driving*

*Address reprint requests to:* Thomas Galski, PhD, Director of Psychology and Neuropsychology Services, Kessler Institute for Rehabilitation, East Orange, NJ 07018., USA

*Accepted for publication: April 29, 1999.*


Published by Elsevier, New York, New York
0885-3924/00/$–see front matter
PII S0885-3924(99)00158-X

## Introduction

Many patients with chronic, intractable pain from malignant or nonmalignant causes have been unable to experience periods of normalcy in their life without the temporary or lasting relief provided by opioid medications. Physicians, however, have not been inclined to prescribe opioids on a regular basis (*C*hronic *O*pioid *A*nalgesic *T*herapy: COAT) to nonmalignant pain patients for several reasons, including concern about the potential for adverse pharmacologic outcomes, such as major organ toxicity and risk for developing addiction; adverse effects, particularly the potential for cognitive impairment ("mental clouding"); and doubts about its efficacy in treating nonmalignant pains.[1,2]

Physicians have felt supported in their caution by experimental and epidemiologic studies which have revealed that many medications used for the relief of pain can interfere with psychomotor and cognitive functioning, results of surveys in which some addicts attributed the onset of their addiction to opioids prescribed for painful medical disorders, and theoretical works that linked addiction to pharmacologic properties of tolerance and physical dependence even in previously normal patients.[2–8] However, others have reported favorable experiences with the long-term use of opioids in managing noncancer pain or nonpainful disorders, including the relative absence of cognitive impairment and no evidence of drug abuse or addictive behaviors.[9–14] Clinicians who treat cancer pain have reported similar outcomes with long-term opioid use and, in contradiction to notions about adverse effects, found that sedation, cognitive impairment, and management problems are uncommon without other predisposing causes for encephalopathy.[2,11,15]

While the literature has not been compelling in favor of long-term opioid use in treating chronic, nonmalignant pain, at least in part because little is known about the class of opioids in current use and the paucity of adequately designed research that evaluates the effects of opioids on psychomotor and cognitive functioning, a growing number of clinicians have accepted the notion that chronic use of opioids is consistent with the goal of functional restoration and may offer benefits that outweigh the disadvantages in some cases.[16–18] However, even when physicians have prescribed opioids to ameliorate relentless pain, patients' return to normalcy has been axiomatically thwarted by restriction of driving, a central activity of daily living that is important in maintaining independence in the community, access to employment and social activities, and a personal sense of autonomy.

A few studies have determined that opioid use has little or only mild and selective effects on psychomotor and cognitive abilities regarded as important in driving.[18–20] In general support of this conclusion were results of epidemiological studies on the relationship between opioids and accidents/injuries or driving violations/infractions; these studies determined that opioid users did not experience significantly more accidents or driving violations than nonusers and the risk tended to vary with the type of drug.[21–25] Others studies, however, showed that drug users, including opioid users, had higher accident rates and motor vehicle violations as well as increased crash risk.[26–29]

There has been no research exploring the effects of stable, long-term opioid use on the driving abilities of patients with persistent noncancer pain. On the other hand, there has been a large number of studies in recent years which have focused on the driving abilities of people whose skills are suspect because of cerebral injury (i.e., traumatic brain injury and stroke), cardiovascular and other medical conditions, progressive brain disorders (i.e., Alzheimer's disease), and medical frailty due to advancing age. This line of research has resulted in identification of deficits in drivers' physical, perceptual, cognitive, and psychological abilities and skills that compromise driving safety. The compendium of abilities derived from this research (e.g., problems in scanning and attention, information processing speed, visual–spatial perception, motor strength and coordination, and behaviors) provided a basis for selection of appropriate measures used in this pilot study.[30–40]

This study was designed to evaluate the effects of COAT on perception, cognition, coordination, and behavior that have been regarded as essential for safe driving. COAT was not expected to significantly impair ability to drive based on results of clinical experiences with opioid therapy for malignant pain which

have shown that long-term opioid use was compatible with normal function in most cases, including activity in work, social interactions, and driving.[2,18] Confirmation of this notion would offer promise to patients with intractable nonmalignant pain who were interested in achieving or regaining functional independence and provide physicians with a basis for using pharmacologic regimens to accelerate functional restoration in a noncancer population. Alternatively, disconfirmation would substantiate physicians' concerns about driving safety with opioids.

Specifically, it was hypothesized that (1) COAT patients possessed abilities and skills equal to other patients who have passed behind-the-wheel testing despite their known deficits in perception, cognition, and behavior and (2) COAT patients' performance would exceed the performance of patients with cerebral compromises who ultimately failed their behind-the-wheel evaluation on driving-related measures that differentiate passes and fails.

## Methodology

*Subjects*

A retrospective review of 128 records for patients admitted to the Pain Management Program (PMP) at Kessler Institute for Rehabilitation (KIR) for pharmacological management of nonmalignant pain was conducted by a physiatrist, who specialized in pain management, in order to cull out approximately 16 patients who met the following criteria for participation in the pilot study:

1. primary diagnosis of chronic pain syndrome of various types and etiologies (e.g., osteoarthritis, reflex sympathetic dystrophy, fibromyalgia, low back pain);
2. no active involvement in a pain management program;
3. absence of concomitant mental and/or neurological disorders that affect arousal, perception, cognition, coordination, and behavior as reflected in documented psychological evaluations;
4. greater than 6-month history of responsivity to opioids for pain reduction without complications;
5. current use of a long-acting opioid (e.g., controlled-release oral morphine or transdermal fentanyl equivalent to 30 mg oral morphine or greater, as calculated by the medical specialist in pain management, and a short-acting opioid (e.g., hydromorphone or oxycodone) used as a rescue dose only in conjunction with timed administration;
6. freedom from using other medications that might affect arousal, perception, cognition, coordination, and behavior;
7. adequate vision, including minimal visual acuity of 20/50 with correction, if necessary, and intact visual fields; and,
8. possession of a valid driver's license.

COAT patients averaged 48.38 ± 11.10 years in age. Approximately 87% of the original patients pool ($N = 128$) was not included in the pilot study because of concomitant medical conditions and/or use of medications, e.g., beta blockers, that could potentially confound results. At the time of the driving evaluation, patients as a group experienced pain in the milder range (mean = 3.65 ± 1.94) secondary to COAT as measured on a numeric pain rating scale from 0 (no sensation) to 10 (most intense possible sensation); pain was not regarded as a significant distractor. There was not significant difference in estimates of pain during actual driving (mean = 3.48 ± 2.40) or during simulator evaluation in this study (mean = 3.66 ± 2.50).

Another group of 327 cerebrally compromised patients (CComp), who had undergone rehabilitation as well as evaluation for fitness to resume driving, served as a comparison group. This group comprised patients who had experienced a cerebrovascular accident, traumatic brain injury or anoxia, and were referred by their physician for a driving evaluation prior to discharge from rehabilitation. For purposes of this study, the group was divided into CComp patients who passed (BTW Pass; $n = 162$) or failed (BTW Fail; $n = 165$) an on-road, behind-the-wheel driving test. BTW Pass and BTW Fail patients averaged 46.62 ± 17.36 years of age and 46.12 ± 20.05 years old, respectively. There was no significant difference in age between COAT and CComp groups.

The privacy of patients was maintained at all times according to standards for the conduct

of research with human subjects established by the American Medical Association, the American Psychological Association, and KIR.

*Procedure*

Patients who met the criteria for inclusion were invited by a member of the research team to participate in the pilot study. This effort included (1) an explanation of its purpose and procedures as well as the risks and benefits of participation and other participant-related matters, such as confidentiality, and (2) collection of endorsed consent to participate in the study.

Following standard procedures for the conduct of driving evaluations at KIR based on results of previously published studies, all COAT patients underwent a comprehensive off-road driving evaluation, which consisted of a predriver evaluation (PDE) and a simulator evaluation (SDE), conducted by trained driving evaluators at KIR.[32,33,41]

While studies of drugs and driving have been criticized because measures of performance have been used without any theoretical rationale or relationship to actual driving, the PDE used in this study is a battery of psychometric tests selected on the basis of their demonstrated sensitivity in measuring perceptual and cognitive abilities that predicted behind-the-wheel performance.[32–34,39,41–45] These tests included measures of visual scanning, attention, and information-processing speed (i.e., Digit Symbol subtest/Wechsler Adult Intelligence Scale–Revised;[46] Trail Making Test, Part A;[47] Double Letter Cancellation Test;[48] visuospatial perception, visuopraxis, and visual memory (i.e., Visual Form Recognition Test;[49] Block Design subtest/Wechsler Adult Intelligence Scale–Revised;[46] Rey-Osterreith Complex Figure Test;[50] and planning-problem solving (i.e., Raven's Progressive Matrices;[51] Porteus Maze Test.[52] Administration and scoring of tests followed standard procedures. Approximately 1.5 hours was required for completion of the PDE.

After completion of the PDE, each patient underwent the SDE using the Doron L225 Driving System/Analyzer. Patients were seated in the simulator and provided an opportunity to become familiar with the equipment; additionally, they received instructions about operating the simulator in response to the driving films used in the simulator.

Three films that have been related in previous research to driving outcomes were used in this study: (1) *Good Driving Strategies*, an introductory film depicting general driving situations as well as (2) *Threat Recognition* and (3) *Evasive Action*, films that depicted danger by international road signals, an impending crash, or other hazardous situations.[32,33,35] Patients were required to respond to traffic situations captured in these films by appropriately braking, accelerating, and/or steering the simulator. The number of errors in braking, steering, accelerating, controlling speed, and signaling were automatically tabulated by the Doron simulator.

Additionally, behaviors shown in previous research to correlate with driving performance were scored as present or absent by the evaluator during simulator evaluation.[32] Observation focused on the following behaviors: (1) distractibility, that is, the inability to focus on specific driving tasks because the patient is drawn to irrelevant or unimportant stimuli, e.g., trivial noises and events; (2) difficulty in following directions, that is, the inability to conform driving behaviors or actions to instructions; (3) impulsivity defined as verbal or behavioral manifestations of failure in allotting time to mentally organize a response, offering an automatic rather than a thoughtful response, or problems in delaying a response, e.g., acting or answering too quickly for the situation; (4) inattention, that is, difficulty in sustaining concentrating; and (5) mental slowness, or the inability to think with customary or appropriate speed, e.g., long latency between stimulus and response or hesitation in responding. Approximately 1 hour was required for completion of the SDE.

*Data Analysis*

SPSS for Windows (Release 7.51) was used to conduct an analysis of variance (ANOVA) with *post hoc* comparisons using Tukey's honest significant differences (HSD) test to determine the significance of differences between COAT and CComp patients who passed or failed their behind-the-wheel driving test (BTW Pass or BTW Fail) on neuropsychometric tests from the PDE, results of the SDE, and observed behaviors.

The analysis served as the basis for evaluating if opioid-treated drivers had the kind of

deficits in cerebral functioning similar to those shown in previous studies to affect driving and whether or not they were able to achieve a level of performance needed to pass an on-road test when compared to patients with deficits in cognition that affected driving.[32,33]

## Results

COAT and CComp patients possessed an equivalent degree of visual acuity and peripheral vision (Table 1.)[a] There was no significant differences in visual abilities between COAT drivers and CComp drivers who passed or failed their on-road test or between subgroups of CComp patients. This is an expected finding since COAT patients were not included in the study and CComp patients were not referred for comprehensive driving evaluation without meeting vision standards established by the governmental agency in charge of licensing within the State.

Additionally, COAT patients outperformed the CComp patients as a group by equaling or exceeding the scores of BTW patients on all except one measure of driving-related abilities. Notably, there were no statistically significant differences between COAT drivers and CComp patients on any measures of the PDE or SDE (Table 1). COAT drivers tended to make more errors than BTW Pass patients on particular neuropsychometric tests, i.e., Letter Cancellation Test, Visual Form Recognition Test, Porteus Maze Test, but the differences were not statistically significant.

COAT patients demonstrated relatively rapid completion times on tasks that required speed of responding for successful performance, e.g., Letter Cancellation Test, Rey Complex Figure Test–Time to Copy. In fact, COAT drivers were approximately 45–67% faster than CComp drivers who passed their road test on several measures. However, COAT drivers also made more errors than expected for persons without cerebral compromise, e.g., almost twice as many errors than comparison drivers on a particular scanning and attention task (Letter Cancellation Test).

COAT drivers demonstrated no major problems in visual–spatial perception and organization as indicated by close approximation of test scores reflecting graphomotor abilities and praxis (i.e., Rey Complex Figure Test–Copy Units; WAIS-R Block Design Test) to the average score obtained by BTW Pass patients (Table 1). However, COAT drivers demonstrated relative weakness in immediate and short-term visual memory (i.e., Visual Form Recognition Test, Rey Complex Figure Test–Recall) although scores were not significantly less than those of the BTW Pass patients.

On tasks assessing higher order cognitive abilities, COAT drivers showed no serious difficulty in problem-solving on any measures. Notably, however, they had a lower test age and made more errors than CComp drivers who passed their road test on a specific psychometric measure tapping planning and careful motor execution, i.e., Porteus Maze Test.

For the SDE, COAT drivers had consistently faster complex reaction times than comparison drivers as indicated by shorter estimated distances between onset of stimuli in films and simulator (vehicular) responses, i.e., braking or steering. COAT patients also had greater accuracy in responding to situations captured in films as indicated by the percentage of valid responses, i.e., appropriate braking and steering when faced with hazards or dangerous scenarios, in comparison to CComp drivers and others who passed their road test. There was one exception, however, as COAT drivers manifested a slightly lower percentage of valid steering responses in the *Threat Recognition* film; the difference, however, was not statistically significant.

Behaviorally, the COAT drivers were regarded as having significant difficulty in following instructions and, in fact, were more similar in ratings to those who failed rather than passed their behind-the-wheel evaluation. Additionally, COAT drivers' manifested a proclivity toward impulsive behavior as suggested by ratings nearer to BTW Fail than BTW Pass patients although the differences between COAT drivers and BTW Pass patients were not statistically significant.

Additionally, the sample of COAT patients in the present study generally performed better than the CComp drivers who failed their behind-the-wheel evaluation on all PDE, SDE,

[a]Readers are referred to Table 1 for the means and standard deviations which provide the basis for comparison of performance across groups.

*Table 1*
**Comparison of Driving-Related Variables (Means and Standard Deviations) Between COAT and CComp Drivers**

| Variable | COAT drivers | CComp drivers | |
|---|---|---|---|
| | | BTW FAIL | BTW PASS |
| Physical attributes | | | |
| Acuity[a] | 28.75 ± 8.85 | 30.71 ± 18.90 | 29.23 ± 11.66 |
| Age[a] | 48.38 ± 11.10 | 45.87 ± 20.80 | 46.62 ± 17.36 |
| Peripheral Vision Left[a] | 85.00 ± 0.00 | 82.59 ± 14.87 | 84.42 ± 10.79 |
| Peripheral Vision Right[a] | 84.06 ± 3.75 | 83.72 ± 12.09 | 84.53 ± 7.38 |
| Pre-driver evaluation | | | |
| Scanning–Attention–Information Processing | | | |
| Cancellation Test Time[b,c] | 121.31 ± 26.96 | 205.99 ± 101.28 | 175.81 ± 94.52 |
| Cancellation Test Errors[b] | 6.81 ± 8.19 | 6.76 ± 9.35 | 3.66 ± 5.31 |
| Trail Making Test A Time[b,c] | 30.00 ± 17.22 | 68.13 ± 65.41 | 48.37 ± 33.74 |
| WAIS-R Digit Symbol Scaled Score[b,c,d] | 8.81 ± 3.43 | 5.26 ± 2.46 | 6.30 ± 2.66 |
| Visuospatial Abilities | | | |
| Rey Complex Figure Test–Copy Units[a] | 32.38 ± 5.31 | 29.73 ± 26.16 | 33.60 ± 20.55 |
| Rey Complex Figure Test–Time to Copy[c,d] | 142.06 ± 71.60 | 266.24 ± 157.28 | 237.38 ± 145.09 |
| Rey Complex Figure Test–Recall Units[b] | 14.28 ± 5.12 | 10.73 ± 8.06 | 15.09 ± 9.75 |
| Rey Complex Figure Test–Time to Recall[a] | 143.60 ± 103.55 | 157.53 ± 103.28 | 157.74 ± 100.44 |
| Visual Form Test Errors[b] | 3.50 ± 3.01 | 3.55 ± 3.14 | 2.29 ± 2.51 |
| WAIS-R Block Design Scaled Score[b] | 8.13 ± 2.45 | 6.95 ± 2.88 | 8.26 ± 2.97 |
| Planning-Problem Solving | | | |
| Porteus Mazes Test Age[b] | 14.84 ± 2.29 | 13.17 ± 3.44 | 15.06 ± 2.16 |
| Porteus Mazes Test Errors[b] | 39.13 ± 23.83 | 41.64 ± 34.31 | 32.05 ± 27.82 |
| Raven Progressive Matrices Errors[b,c] | 7.81 ± 5.69 | 12.92 ± 7.63 | 10.22 ± 6.79 |
| Simulator evaluation | | | |
| Basic Acceleration % Errors[a] | 3.50 ± 6.26 | 10.82 ± 14.83 | 7.15 ± 11.47 |
| Basic Signaling % Errors[b,c] | 14.63 ± 15.01 | 35.99 ± 25.18 | 23.30 ± 20.27 |
| Basic Braking % Errors[a] | 31.25 ± 26.22 | 38.24 ± 19.92 | 37.66 ± 23.12 |
| Basic Steering Distance[a] | 56.19 ± 24.74 | 68.32 ± 15.47 | 70.74 ± 20.47 |
| Evasive Action Braking Distance[b,c] | 39.83 ± 19.33 | 63.93 ± 30.36 | 48.95 ± 25.95 |
| Evasive Action Braking % Valid[a] | 73.44 ± 24.95 | 58.50 ± 33.73 | 65.17 ± 31.55 |
| Evasive Action Steering Distance[a] | 75.79 ± 39.36 | 82.93 ± 43.53 | 69.46 ± 37.44 |
| Evasive Action Steering % Valid[a] | 43.79 ± 32.09 | 29.67 ± 30.53 | 40.86 ± 29.67 |
| Threat Recognition Braking Distance[b,c] | 113.74 ± 22.13 | 140.60 ± 34.22 | 125.95 ± 34.22 |
| Threat Recognition Braking % Valid[b,c,d] | 82.50 ± 29.10 | 40.80 ± 36.94 | 60.47 ± 33.63 |
| Threat Recognition Steering Distance[b,c] | 102.88 ± 32.72 | 132.48 ± 31.74 | 117.99 ± 25.10 |
| Threat Recognition Steering % Valid[b,c] | 75.00 ± 28.75 | 52.10 ± 35.62 | 78.59 ± 27.51 |
| Behaviors | | | |
| Distractibility[b,c] | 0.00 ± 0.00 | 0.25 ± 0.43 | 0.02 ± 0.15 |
| Following Directions[b,d] | 0.19 ± 0.40 | 0.19 ± 0.39 | 0.02 ± 0.12 |
| Impulsivity[b] | 0.13 ± 0.34 | 0.16 ± 0.37 | 0.02 ± 0.15 |
| Inattention[b,c] | 0.00 ± 0.00 | 0.63 ± 0.48 | 0.07 ± 0.25 |
| Slowness in Thinking[b,c] | 0.06 ± 0.25 | 0.55 ± 0.50 | 0.02 ± 0.15 |

[a]No significant difference.
[b]BTW Pass ≠ BTW Fail ($P < 0.05$).
[c]BTW Fail ≠ COAT ($P < 0.05$).
[d]BTW Pass ≠ COAT ($P < 0.05$).

and behavioral measures of driving ability. COAT drivers performed significantly better than the BTW Fails on measures with inherent reward for speed of responding or information processing, such as Cancellation Test time, Trail Making Test time, Rey Complex Figure Test time to copy, *Evasive Action* and *Threat Recognition* braking distance, and behavioral manifestations of slowness in thinking. Interestingly, however, COAT drivers approximated the performance of BTW Fail drivers on several tasks, i.e., Visual Form Test errors, Cancellation Test errors, problems in following directions, and impulsivity.

## *Discussion*

Reasonable support for the hypothesis that stable opioid use does not interfere with driving ability would be provided by COAT group performance that was significantly better than the performance of CComp patients on all measures of driving ability, particularly performance similar to the CComp Pass group and

significantly superior to the CComp Fail group. The results of the current study offered nominal support for the hypothesis in that the COAT group was generally more similar to the CComp Pass groups and largely but not entirely dissimilar to the CComp Fail group on measures regarded as important in driving.

Closer examination of the results suggested that the current sample of COAT patients had neuropsychological abilities, simulator skills, and behaviors that could be expected to result in behind-the-wheel performance comparable to CComp patients who had previously passed an on-road driving test and resumed driving on public roads. Moreover, COAT patients manifested no systematic pattern of scores that reflected domain-specific deficits, e.g., impairments in scanning, visuospatial abilities, related in previous research to problems in driving; this finding is consistent with a number of studies on the effects of opioids on psychomotor, cognitive, and neuropsychological functioning.[18] The relative adequacy of most responses to measures of driving abilities was evident in comparison to patients with deficits that compromised their driving ability, i.e., BTW Fail patients, as well as to patients whose specific deficits did not preclude them from legally driving, i.e., BTW Pass patients.

COAT drivers, however, showed an inclination for relatively weaker performances on a few measures which were scattered across the neuropsychological domains and measures of driving abilities. Specifically, they tended to make errors on tasks which, neuropsychologically, require speed and accuracy at the same time for proficiency, such as the Letter Cancellation or Porteus Maze Tests. Interestingly, the relatively weaker performances were not due to psychomotor retardation or incoordination, as might be suggested by some who expound that opioids adversely affected these functions; in fact, COAT patients were usually faster than the comparison group, a finding consistent with some research on reaction times and speed of performance in addicts.[24,53] COAT drivers made the kind of errors that often come about as a result of hurrying and not checking work and, thereby, sacrificing accuracy for speed of completion. This conclusion was at least partially supported by the speed at which COAT drivers completed timed tasks and by ratings of proclivity for impulsive, nonreflective behavior.

Interestingly, Zacny,[18] in his thorough of the review of the literature on the effects of opioids on psychomotor and cognitive functioning, described studies which showed that speed and accuracy were affected by some opioids, e.g., morphine, but not others, e.g., meperidine; this finding suggests that driving-related cognitive abilities may be differentially affected by the selection of opioid. However, caution is recommended in such an interpretation because dosage inequivalencies, variations in duration of use, and researchers' selection of tests unrelated to prediction of driving abilities, make it difficult for comparison of results among studies.

Other influences on performance in this area have to be assessed in future studies, such as motivational factors, personality traits or fatigue, in light of observations that COAT patients seemed to occasionally lose interest in some tasks, perhaps because they were not personally invested in the results or tired from medication or distracted by lancinating pain. Failure to take these factors into account may result in erroneous conclusions about the performance of COAT patients on some tasks, especially when there are comparisons to others, i.e., patients, who are powerfully motivated to resume driving and, therefore, to perform at their best in evaluations or simply less easily fatigued without opioids in their system.

Interestingly, while COAT drivers manifested no major problems in coordination during the PDE and SDE, including problems in simple and complex manual movements, eye-hand or eye-foot coordination, psychomotor control and praxis, 25% of the sample, all of whom were females, experienced simulator sickness characterized by feelings of mild but not debilitating nausea. Notably, none of the CComp patients reported simulator sickness; either they did not experience or failed to report the condition. In the absence of base rates for such malaise in the general population of the CComp group, however, little can be determined from this study about the exact nature and extent of its effect on COAT patients' simulator performance. Future research would benefit from consideration of simulator sickness, including study of its determinants and effects on performance (e.g., proximity of dose administration to simulator testing), identification of susceptible populations, and exploration of its relationship to stable opioid use.

## Conclusion

Safe operation of a motor vehicle is a learned activity demanding the complex interaction of physical, cognitive, perceptual, and psychological skills and abilities. And, while the results of this study and other research have suggested generally that stable opioid use in treating nonmalignant pain does not significantly impair abilities inherent in this complex activity, the validity and generalizability of this conclusion must be regarded with caution because of various methodological imitations in the assessment of human performance, e.g., absence of standardized, valid and reliable procedures for driving evaluations; limited sample of COAT patients who did not actually take a behind-the-wheel test; use of a historical control group and/or an absence of controls who are healthy or nonopioid using pain patients for comparison; heterogeneity of pain etiologies; and the presence of variables besides the drug that may affect performance.

Nevertheless, results of this study represent an initial step in the process of determining the capacity to operate a motor vehicle while managing chronic pain utilizing COAT. Future researchers may benefit from use of methods for driving assessment used in this pilot study and opportunities to limit methodological flaws.

## Acknowledgment

The authors wish to thank Elizabeth Narcessian, MD, for her assistance in the conduct of this research.

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