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## Assessing the Functional Performance of Post-Call Hospital Doctors Using a Nintendo Wii®

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### Abstract

Sleep deprivation is an established part of the working life for Non-Consultant Hospital Doctors (NCHDs) in Ireland. Concern exists about the effect of extended NCHD work hours. We utilised a Nintendo Wii® to evaluate motor function of NCHDs both prior to their on-call shift and the day afterwards. Data was exported to SPSS ver.15 for statistical analysis with  $p < 0.05$  considered significant. A total of 72 NCHDs were invited to participate in this study. There was a 62.5% (45) rate of follow-up. Overall 27 (60%) NCHDs were on medical call, with 18 (40%) on surgical call. There was no statistically significant difference between NCHDs pre-and post-call motor assessment scores. The majority of study participants (75.5%,  $n=34$ ) had four or more hours sleep. On-call duty allows for a greater than anticipated amount of sleep per on-call shift and therefore has a negligible effect on the motor skills of medical staff.

### Introduction

Since August 2009, there have been increased efforts to implement the European Working Time Directive (EWTD) in Irish hospitals. There has been concern amongst surgical trainees relating the effect a shortened working week could have on surgical training.<sup>1</sup> The impact of the EWTD on staff fatigue and subsequent patient care is a source of much debate. Work performance by NCHDs sleep-deprived post-call has been demonstrated as comparable to impairment associated with a 0.04 to 0.05 g% blood alcohol concentration.<sup>2</sup> We aimed to assess both motor skills and decision making ability in a cohort of post-call medical and surgical NCHDs in an Irish tertiary centre.

In assessing motor function we have utilised a Nintendo Wii® to evaluate balance, proprioception and visuospatial awareness as has been previously reported in the literature.<sup>3-5</sup> These factors were selected as they are reliably measured and underlie more global tasks, such as driving.<sup>6</sup> Furthermore technical proficiency with the Nintendo Wii® has been shown to translate to intra-operative laparoscopic skill.<sup>7</sup> As regards assessment of clinical reasoning and decision making we utilized the Health Professions Admissions Test (HPAT). Given that the HPAT is currently used to determine aptitude towards working in medicine, we therefore assessed NCHDs for proficiency in HPAT scoring post-call.

### Methods

Interns and senior house officers in Beaumont Hospital were recruited between May and June 2010. The study consisted of two assessments. The first was held with NCHDs immediately prior to going on-call, the second after finishing their on-call shift. Demographics such as age, gender, speciality, and NCHD grade were collected. Three motor function tests were carried out using the Nintendo Wii®. These tests were selected due to measuring proprioception, balance and visuospatial ability in a manner that is objective and reproducible with a standardised scoring system.

The first of the three motor function tests evaluated the NCHDs balance using the Nintendo Wii Balance Board®. This assessed dynamic balance to a prompt on the screen requiring the participant to shift their weight between their feet to the specifications of two dynamically changing bars. This test duration is thirty seconds, with each of the five stages of increasing difficulty being timed. The stage reached and time taken on each stage was logged. The second motor test on the Nintendo Wii® was named the "Table Tilt Plus" test and is an assessment of balance and proprioception. Here the NCHD again balances on a Nintendo Wii Balance Board® in control of the degree and direction of inclination of a table represented on the video game screen, on which a marble like ball rests. The object of the video game is to steer the marble around various mazes on different stages. The stage reached was recorded. The third physical assessment using the Nintendo Wii® was a "Snow ball fight" video game. In this scenario the study participant controls an on-screen avatar who hides behind a cover when the participant is in middle of the Nintendo Wii Balance Board® and leans out to target computerized opposition. Aiming was through use of the Nintendo Wii® Remote. This allowed the assessment of fine motor movement, accuracy, coordination, reaction time, judgment and balance. In combination these three assessments of motor function rendered a reproducible score.

The motor assessments were again tested in the NCHD post-call. The post-call session also included a verbally taken survey which assessed level of sleep and caffeine usage, as well as five untimed questions taken from HPAT sample questions. These motor assessments and HPAT sample questions were also carried out in a control group. This control group was comprised of medical and surgical NCHDs. A baseline motor assessment was carried out with the second assessment and HPAT questionnaire carried out after a night's sleep where the NCHD was not on call. Data was collected onto Microsoft Excel and exported to SPSS ver.15 for statistical analysis with  $p < 0.05$  considered significant.

### Results

#### Demographics and survey assessment

72 NCHDs were invited to participate in this study. There was a 75% ( $n=54/72$ ) uptake rate to commence the study. However 9 NCHDs could not be contacted post-call and were excluded from analysis. Forty five (62.5%) NCHDs contacted completed the study. Thirty four (75.6%) were interns and 11 (24.4%) were Senior House Officers (SHOs). Fifteen (33.3%) were female and 30 (66.6%) male. Median age of the participants was 27 years (range 23-34), with 27 (60%) on medical call, and 18 (40%) on surgical call. With regard to the survey results, 18 (40%) had consumed no caffeine in the preceding 12 hours at the time of interview. 37.8% ( $n=17$ ) had consumed one to two cups, while 10 (22.2%) had consumed three to four cups. Regarding sleep deprivation, the majority of survey respondents, 34 (75.5%) had four or more hours sleep. Eleven (24.4%) had three or less hours sleep of whom 1 (2.2%) had no sleep (Table 1). Increasing NCHD age was significantly associated with increased sleep on call ( $p=0.041$ ) however gender, speciality or NCHD grade were not predictive. With regard to the HPAT questions, 32 (66.7%) scored four or five correct answers on the five questions given. The remaining 15 (33.3%) scored between one and three. No participant scored less than one. There were no statistically significant associations between gender, grade, speciality, caffeine intake or sleep deprivation with success in the HPAT questionnaire.

Table 1 Post-call interview results of study cohort including number of hours sleep in preceding on-call shift, amount of caffeine consumed in preceding 12 hours and score in the Health Professions Admissions Test (HPAT)		
Postcall interview results		
Variable	Study cohort (n=45)	
Hours slept while on call	0	1(2.2%)
	1	10(0%)
	2	8(17.8%)
	3	2(4.4%)
	4	19(42.2%)
	5+	15(33.3%)
Caffeine consumed in last 12 hours (cupsof coffee/tea)	0	18 (40%)
	1-2	17(37.8%)
	3-4	10(22.2%)
HPAT score post-call	0	0(0%)
	1	5(11.1%)
	2	2(4.4%)
	3	8 (17.8%)
	4	18(40%)
	5	12(26.7%)

#### Nintendo Wii® motor function assessments

In the basic test of balance prior to going on call, 8 (17.8%) completed all five stages. 12 (26.7%) failed to complete the fifth stage, 23 (51.1%) reached the fourth stage and 2 (4.4%) reaching only the second stage. Post-call, 14 (31.1%) of participants successfully completed all five stages. Those reaching the fifth stage but failing to complete it accounted for 19 (42.2%), with 11 (24.4%) reaching the third stage and the remaining 1 (2.2%) reaching the second stage. There was no statistically significant difference in balance observed between NCHDs pre-call and post-call ( $p=0.051$ ).

In the pre-call assessment of the "Table Tilt" test assessing, 9 (20%) completed all four stages. Eleven (24.4%) failed to complete the fourth stage, with 4 (8.9%) reaching the third stage and 21 (46.6%) reaching the second stage. In the same test after being on call, 3 (6.7%) completed all four stages, with 10 (22.2%) reaching but failing to complete the fourth stage. In total 8 (17.8%) reached the third stage with the remaining 24 (53.3%) reaching the second stage. There was no significant decrease in scores by the NCHDs post-call ( $p=0.253$ ). Prior to going on call in the "Snow ball fight" motor assessment, 14 (31.1%) scored between one and ten in the snow ball fight test; 30 (66.7%) scored between eleven and twenty and 1 (2.2%) scored greater than twenty. Post-call the scores were not significantly decreased ( $p=0.156$ ), with 7 (15.6%) scoring less than ten, 35 (77.8%) scoring between eleven and twenty, and 3 (6.7%) scoring greater than twenty.

In the control group, 20 NCHD were tested before and after a night they were not on-call. Of these 12 (60%) were interns and 8 (40%) were SHOs. Four (20%) were female and 16 (80%) were male. Median age was 26 years (range 24-42), with 13 (65%) medical NCHDs and 7 (35%) surgical. The mean amount of sleep per participant between the two assessments was 6.8 hours (range 4-8). Comparable to the pre- and post-call group there were no significant differences noted in the control group between participants' first and second motor assessments on the balance board ( $p=0.599$ ), the tilt table test ( $p=0.155$ ), or the snow ball fight test ( $p=0.621$ ). There were no significant differences in scores between the study group post-call and the control group in answering the HPAT questionnaire ( $p=0.225$ ).

#### Discussion

Our study demonstrates no significant decrease in motor function in NCHDs post-call. Furthermore we have shown that the majority of NCHDs on call get four or more hours sleep per night. Implementation of the EWTD was as a result of findings relating to negative effects of sleep deprivation on the NCHD performance.<sup>9</sup> Sleep deprivation may be a factor in clinical error, sharing in the burden of healthcare associated morbidity and mortality to patients.<sup>10</sup> Because of the amount of sleep experienced by our cohort of NCHDs while on call, our study looks at the effects on being on-call duty rather than sleep deprivation. Partial sleep deprivation involves an insufficient duration of sleep, which is considered less than five hours over a 24 hour period.<sup>11</sup> The quality of the sleep was not ascertained in our study and frequently interrupted sleep of any duration is of poor efficacy.<sup>12</sup> Notwithstanding this it was surprising that the majority of NCHDs had over four hours sleep, with over a quarter (27.8%) having than five hours sleep thus not meeting criteria for being sleep-deprived. This level of sleep could have happened due to such factors as the effects of the study being a carried out relatively late in the intern year (the study was commenced in May) which given the more experience the NCHDs had may have led to less sleep deprivation. This is borne out in our finding that older NCHDs were significantly more likely to get a greater amount of sleep while on call ( $p=0.041$ ).

Technical ability and the avoidance of intra-operative error is of critical importance in an operating theatre and has been extensively researched, particularly in association with laparoscopic performance.<sup>13,14</sup> Furthermore motor skills have also been assessed in association with monitoring of anaesthetized patients.<sup>15</sup> However these are duties seldom performed by doctors of Intern or SHO grades. Instead we focused our study on proprioception, balance and visuospatial awareness, which affect any overnight shift worker and are essential aspects in driving ability. Sleep deprivation has been associated with a threefold increase in risk of road traffic accident.<sup>16</sup> It has also been compared with alcohol intoxication to approximately half the legal limit while operating a motor vehicle.<sup>17</sup> Sleep deprived NCHDs are at increased risk of blood-borne virus transmission as a result of sharps injuries- a recent study reporting that fatigue is linked to one third of such injuries.<sup>18</sup> We found no statistically significant relationship on the Nintendo Wii motor assessment scores by NCHD either pre- or post call. While this may indeed demonstrate that motor skills post-call are not significantly decreased, we must also consider the possibility that this may be due to a habituation effect. When compared to interval motor assessments in a group of NCHDs not on call, a similar pattern emerges with no increase or decrease in scores when completing the motor assessments for the second time.

Sleep deprivation amongst NCHDs has also been associated with decreased patient satisfaction with their care.<sup>19</sup> This may be due to decreased patient care quality as a result of diminished reasoning ability, or decreased empathy shown towards patients by sleep deprived doctors. In our study we have demonstrated high medical aptitude test scores using the HPAT in NCHDs who are post-call, and HPAT scores by NCHDs post-call are comparable to a control group who were not on call. The data found in this study leads us to the conclusion that on-call duty allows for a greater than anticipated amount of sleep per on-call shift and has a negligible effect on the motor skills of medical staff. Scoring in the HPAT test which is considered an assessment of medical aptitude is not decreased in post-call doctors.

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