**Online Supplemental Tables**

**Supplemental Table A: Alertness promoting strategy text messages**

|  |  |
| --- | --- |
| **Text message** | **Source / reference** |
| If you can, take a short 20-30 minute nap on duty | Bonnefond et al., 2001; PMID-11681794Garbarino et al., 2004; PMID-15586782Petrie et al., 2004; PMID-15204298Sallinen et al., 1998; PMID-9844850Smith-Coggins et al., 2006; PMID-17052562Takahashi et al., 1999; PMID-10459694 |
| When you can, and if allowed, take short naps on duty |
| Try drinking a caffeinated beverage like coffee to stay awake | Ker et al., 2010; PMID-20464765 |
| Try doing some stretches or other exercise to stay alert | Harma et al., 1988; PMID-3359987Harma et al., 1988; PMID-3359988Matsumoto et al., 2002; PMID-12057846 |
| Take a short walk in the parking lot to get exercise and improve alertness |
| Get up and be physically active when you start to feel fatigued or really sleepy |
| When sleepy, jog in place, walk around the station, do jumping jacks. It can help improve alertness |
| Stay alert by talking to your partner when work is slow | Rosekind et al., 1996; PMID-8731492 |
| To stay alert, talk with your partner and rehearse your role in challenging patient encounters |

**Supplemental Table B: Response rates with answering text-messages at the beginning, during, and end of shift**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | Total | Intervention | Control | p-value |
| Text message queries sent  | 42,822 | 20,463 | 22,359 | 0.25& |
| Text message answered | 37,582 | 18,002 | 19,580 | 0.11& |
| Response Rate  | 87.8% | 87.9% | 87.6% |  |
| Median response time in seconds (IQR) | 68(48, 186) | 69(49, 190) | 67(46, 182) | 0.01& |
|  |
| Text message queries sent (start of shift) | 11,487 | 5,743 | 5,744 | 0.44& |
| Text message queries answered (start of shift) | 10,532 | 5,232 | 5,300 | 0.49& |
| Response Rate (start of shift) | 91.7% | 91.1% | 92.3% |  |
| Median response time in seconds (IQR) | 63 (47, 159) | 64 (48, 161) | 62 (46, 156) | 0.59& |
| Text message queries sent (during shift)  | 18,140 | 8,485 | 9,655 | 0.91& |
| Text message queries answered (during shift) | 14,627 | 6,838 | 7,789 | 0.82& |
| Response Rate (during shift) | 80.6% | 80.6% | 80.7% |  |
| Median response time in seconds(IQR) | 75 (49, 255) | 74 (50, 255) | 75 (49, 254) | 0.55& |
|  |
| Text message queries sent (end of shift) | 13,195 | 6,235 | 6,960 | 0.58& |
| Text message queries answered (end of shift) | 12,272 | 5,781 | 6,491 | 0.64& |
| Response Rate (end of shift) | 93.0% | 92.7% | 93.3% |  |
| Median response time in seconds (IQR) | 60 (45, 145) | 61 (46, 160) | 60 (44, 130) | <0.01& |

TABLE NOTES: Frequency counts of text-messages and measures of compliance (response) are based on the schedule of text-message assessments standard for both intervention and control study subjects. These include four text-message queries at the beginning, three queries at every 4-hours during a shift, and six text-message queries at the end of shifts. See Table 1 and Figure 2a in a separate publication of the study protocol for more details of these assessments. [Patterson, et al., 2017]. &indicates use of a test of medians.

**Supplemental Table C: Response rates with answering inter-shift text-messages**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Participation and Response | Total | Intervention | Control | p-value |
| Text message queries sent  | 26,708 | 12,350 | 14,358 | 0.82& |
| Text message queries answered | 23,989 | 11,192 | 12,797 | 0.81& |
| Response Rate (overall) | 89.8% | 90.6% | 89.1% |  |
| Median response time in seconds (IQR) | 89(53, 310) | 90(54, 337) | 85(53, 289) | <0.001& |

TABLE NOTES: &indicates use of a test of medians.

**Supplemental Table D: Follow up measures of sleep, fatigue, and alertness behaviors (the SFAB survey tool)**

|  |  |  |
| --- | --- | --- |
|  |  | Complete Follow-Up Data  |
|  | Group status | Baseline | End of study 120-days |  |
| Measure |  | N=43\* | Mean (SD) | N=43\* | Mean (SD) | p-value |
| Attitudes (ATT-one subscale)[score range 0-100] | Intervention | 14 | 56.7 (19.9) | 14 | 48.8 (23.1) | 0.2286 |
| Control | 17 | 63.1 (23.3) | 16 | 62.5 (19.3) |
| Attitudes scale (ATT-two subscale)[score range 0-100] | Intervention | 14 | 36.2 (17.5) | 16 | 50.4 (22.2) | 0.3783 |
| Control | 17 | 43.5 (21.3) | 14 | 40.5 (24.2) |
| Normative Beliefs (NB-one subscale)[score range 0-100] | Intervention | 14 | 43.7 (18.3) | 14 | 50.3 (18.9) | 0.9828 |
| Control | 17 | 51.8 (18.9) | 16 | 53.3 (21.6) |
| Normative Beliefs (NB-two subscale)[score range 0-100] | Intervention | 14 | 52.9 (17.4) | 16 | 60.5 (20.5) | 0.6895 |
| Control | 17 | 63.1 (16.0) | 14 | 52.9 (23.3) |
| Self-Efficacy (SE-scale)[score range 0-100] | Intervention | 14 | 69.6 (23.9) | 14 | 63.2 (27.1) | 0.5138 |
| Control | 17 | 71.8 (26.3) | 16 | 68.4 (27.9) |
| Knowledge scale (KNOW-one subscale)[score range 0-100] | Intervention | 14 | 74.0 (17.8) | 14 | 64.5 (23.5) | 0.1888 |
| Control | 17 | 69.8 (20.5) | 16 | 68.9 (18.8) |
| Knowledge scale (KNOW-two subscale)[score range 0-100] | Intervention | 14 | 70.0 (18.3) | 14 | 67.6 (17.1) | 0.6219 |
| Control | 17 | 72.3 (17.6) | 16 | 75.0 (24.3) |
| Importance scale (IMPORT-scale)[score range 0-100] | Intervention | 17 | 71.8 (14.9) | 16 | 80.4 (13.4) | *0.0280* |
| Control | 14 | 71.4 (10.3) | 14 | 70.0 (11.6) |
| Environmental Constraints (EC-one)[score range 0-100] | Intervention | 17 | 67.4 (21.5) | 16 | 67.1 (23.0) | 0.9767 |
| Control | 14 | 60.0 (24.1) | 14 | 61.9 (26.3) |
| Environmental Constraints (EC-two)[score range 0-100] | Intervention | 17 | 62.9 (28.5) | 16 | 61.9 (25.4) | 0.0548 |
| Control | 14 | 52.9 (31.4) | 14 | 40.0 (36.2) |
| Environmental Constraints (EC-three)[score range 0-100] | Intervention | 17 | 36.8 (22.3) | 16 | 29.4 (21.6) | 0.4947 |
| Control | 14 | 34.3 (23.7) | 14 | 30.7 (27.2) |
| Habits scale (HABIT-scale)[score range 0-100] | Intervention | 17 | 57.6 (23.7) | 16 | 60.0 (27.8) | 0.5771 |
| Control | 14 | 57.6 (20.5) | 14 | 56.2 (23.8) |
| Intentions scale (INTENT-scale)[score range 0-100] | Intervention | 17 | 82.0 (10.7) | 16 | 78.8 (12.9) | 0.2909 |
| Control | 14 | 76.7 (19.3) | 14 | 79.0 (18.5) |

TABLE NOTES: The SFAB is a secondary outcome measure of interest. \*n=43 participants (n=16 intervention and n=27 control) provided complete follow-up data for the primary outcomes of interest (i.e., sleep quality as measured by the PSQI instrument). Multiple participants did not complete the SFAB survey at baseline or at follow-up.

**Supplemental Table E: Demographic characteristics of study sample stratified by complete versus incomplete follow-up**

|  |  |  |
| --- | --- | --- |
|  | Complete Follow-Up Data  | Incomplete Follow-Up Data |
|  | Total Sample (n=43) | Intervention Group(N=16) | Control Group(N=27) | p-values | Total Sample (n=40\*) | Intervention Group(N=23) | Control Group(N=17) | p-values |
| Age^ Mean (SD) | 41.4 (9.1) | 40.3 (8.9) | 42.1 (9.4) | 0.54# | 41.3 (10.3) | 41.3 (10.2) | 41.3 (10.7) | 1.00# |
| *Sex^* |  |  |  |  |  |  |  |  |
| Male | 58.2% | 50% | 63.0% | 0.52@ | 56.8% | 50% | 66.7% | 0.50@ |
| Female | 41.2% | 50% | 37% | 43.2% | 50% | 33.3% |
| *Certification/License^* |  |  |  |  |  |  |  |  |
| Flight Paramedic | 27.9% | 12.5% | 37.0% | 0.01@ | 34.2% | 31.8% | 37.5% | 1.00@ |
| Flight Nurse | 53.5% | 81.2% | 37.0% | 57.9% | 59.1% | 56.3% |
| Respiratory Therapist | 18.6% | 6.3% | 25.9% | 7.9% | 9.1% | 6.2% |
| *Clinical setting where work the most^* |  |  |  |  |  |  |  |  |
| Ground-based EMS | 0% | 0% | 0% | n/a | 2.7% | 0% | 6.7% | 0.33@ |
| Air-Medical EMS | 100% | 100% | 100% | 83.8% | 81.8% | 86.7% |
| Other setting\*\* | 0% | 0% | 0% | 13.5% | 18.2% | 6.7% |
| *Yrs of Experience^* |  |  |  |  |  |  |  |  |
| Mean (SD) | 17.7 (10.0) | 15.6 (8.1) | 18.7 (10.9) | 0.36# | 18.5 (10.3) | 17.9 (10.7) | 19.3 (10.0) | 0.68# |
| *Numb. of Jobs* |  |  |  |  |  |  |  |  |
| >2 jobs | 41.9% | 50% | 37.0% | 0.52@ | 64.9% | 57.1% | 75.0% | 0.31@ |
| *Employment Status^* |  |  |  |  |  |  |  |  |
| Full-Time | 92.7% | 100% | 88.9% | 0.53@ | 89.2% | 81.8% | 100% | 0.13@ |
| Part-Time | 7.3% | 0% | 11.1% | 10.8% | 18.2% | 0% |
| *Numb. of Shifts Worked Last Month^* |  |  |  |  |  |  |  |  |
| Mean (SD) | 13.6 (4.9) | 15.1 (5.5) | 12.7 (4.4) | 0.13# | 13.2 (6.3) | 12.5 (6.8) | 14.3 (5.4) | 0.41# |
| *Most Common Shift Length Worked^* |  |  |  |  |  |  |  |  |
| 24-hr | 44.2% | 31.2% | 51.9% | 0.22@ | 52.6% | 59.1% | 43.8% | 0.31@ |
| 12-hr | 55.8% | 68.8% | 48.1% | 42.1% | 31.8% | 56.2% |
| Other | 0% | 0% | 0% | 5.3% | 9.1% | 0% |
| *General Health^* |  |  |  |  |  |  |  |  |
| Excellent | 30.2% | 31.3% | 29.6% | 0.75@ | 47.4% | 59.1% | 31.3% | 0.11@ |
| Good | 65.1% | 68.7% | 62.9% | 52.6% | 40.9% | 68.8% |
| Fair/Poor | 4.7% | 0% | 7.4% | 0% | 0% | 0% |
| *BMI* |  |  |  |  |  |  |  |  |
| Underweight | 0% | 0% | 0% | 0.41@ | 7.5% | 4.4% | 11.8% | 0.81@ |
| Normal weight | 41.9% | 56.3% | 33.3% | 30.0% | 34.8% | 23.5% |
| Overweight | 39.5% | 31.3% | 44.4% | 50.0% | 47.8% | 52.9% |
| Obese | 18.6% | 12.5% | 22.2% | 12.5% | 13.0% | 11.8% |
| *Sleep Quality^* |  |  |  |  |  |  |  |  |
| PSQI Mean (SD) | 6.9 (3.7) | 8.0 (3.9) | 6.3 (3.5) | 0.14# | 6.4 (3.2) | 5.5 (3.2) | 7.7 (2.8) | 0.03# |
| % Poor Sleep Quality (PSQI >6) | 58.1% | 75% | 48.2% | 0.11@ | 60.5% | 50.0% | 75.0% | 0.18@ |
| *CFQ Fatigue Scale^* |  |  |  |  |  |  |  |  |
| % Fatigued | 65.1% | 62.5% | 66.7% | 1.00@ | 76.3% | 63.6% | 93.8% | 0.05@ |
| *ESS Results^* |  |  |  |  |  |  |  |  |
| ESS Mean (SD) | 7.3 (4.3) | 8.2 (4.9) | 6.8 (4.0) | 0.32# | 6.3 (3.6) | 5.9 (4.2) | 6.9 (2.5) | 0.38# |
| Excessive Sleepiness (ESS >16) | 4.7% | 6.3% | 3.7% | 0.22@ | 0% | 0% | 0% | 0.11@ |
| Situational Sleepiness(ESS 10-15) | 23.3% | 37.5% | 14.8% | 18.4% | 22.7% | 12.5% |
| Average Sleepiness(ESS 8-9) | 16.3% | 18.8% | 14.8% | 21.1% | 9.1% | 37.5% |
| Unlikely Abnormally Sleepy (ESS 0-7) | 55.8% | 37.5% | 66.7% | 60.5% | 68.2% | 50.0% |
| *OFER* Mean (SD)*^* |  |  |  |  |  |  |  |  |
| Chronic Fatigue | 20.8 (19.0) | 21.3 (19.8) | 20.5 (18.9) | 0.90# | 20.5 (17.0) | 16.2 (14.7) | 26.5 (18.5) | 0.06# |
| Acute Fatigue | 47.1 (23.2) | 50.8 (21.7) | 44.9 (24.2) | 0.66# | 46.7 (21.5) | 42.4 (24.5) | 52.5 (15.3) | 0.15# |
| Inter-Shift Recovery | 63.5 (21.1) | 60.4 (22.1) | 65.3 (20.7) | 0.46# | 65.5 (19.6) | 69.7 (19.3) | 59.8 (19.0) | 0.12# |
| *SAS Score* Mean (SD)*^* | 38.1(21.8) | 44.7(18.1) | 34.3 (23.2) | 0.13# | 38.4 (20.8) | 31.6 (21.2) | 47.8 (16.6) | 0.01# |

TABLE NOTES: \*Two participants (n=1 intervention and n=1 control) failed to complete the baseline assessments immediately following enrollment and randomization. Column percentages may not add up to 100 due to rounding decimal places. SD=standard deviation. ^indicates participants did not report values/answers for baseline questions: (Age: n=2 intervention, n=2 control); (Sex - n=1 intervention, n=2 control); (Certification – n=1 intervention, n=1 control); (Clinical Setting – n=1 intervention, n=2 control); (Years of Experience – n=3 intervention, n=1 control); (Multiple jobs – n=2 intervention, n=1 control); (Employment status – n=3 intervention, n=2 control); (Shifts worked last month – n=1 intervention, n=2 control); (Shift length – n=1 intervention, n=1 control); (Health – n=1 intervention, n=1 control); (PSQI – n=1 intervention, n=1 control); (CFQ fatigue – n=1 intervention, n=1 control); (ESS – n=1 intervention, n=1 control); (OFER – n=1 intervention, n=1 control); (SAS score – n=1 intervention, n=1 control). \*indicates working in the Intensive Care Unit (ICU) or other clinical location. #indicates use of a student’s t-test. @indicates use of a Fisher’s exact test.

**Supplemental Table F: Follow up measures of sleep and fatigue**

|  |  |  |  |
| --- | --- | --- | --- |
|  |  | Complete Follow Up | Incomplete Follow-Up |
|  | Group status | Baseline | End of study 120-days | Baseline |
| Measure |  | N=43 | Mean (SD) or percentage | N=43 | Mean (SD) or percentage | N=40\* | Mean (SD) or percentage |
| Pittsburgh Sleep Quality Index (PSQI) | Intervention | 16 | 8.0 (3.9) | 16 | 7.9 (3.6) | 22 | 5.5 (3.2) |
| Control | 27 | 6.3 (3.5) | 27 | 6.5 (4.0) | 16 | 7.7 (2.8) |
| Percent with poor sleep (PSQI >5) | Intervention | 16 | 75.0% | 16 | 68.8% | 22 | 50.0% |
| Control | 27 | 48.2% | 27 | 55.6% | 16 | 75.0% |
| Chalder fatigue questionnaire (CFQ) | Intervention | 16 | 62.5% | 16 | 62.5% | 22 | 63.6% |
| Control | 27 | 66.7% | 27 | 63.0% | 16 | 93.8% |
| Epworth sleepiness scale (ESS) | Intervention | 16 | 8.2 (4.9) | 16 | 9.3 (6.6) | 22 | 5.9 (4.2) |
| Control | 27 | 6.8 (4.0) | 27 | 7.3 (5.3) | 16 | 6.9 (2.5) |
| OFER-chronic fatigue subscale | Intervention | 16 | 21.3 (19.8) | 16 | 25.4 (19.7) | 22 | 16.2 (14.7) |
| Control | 27 | 20.5 (18.9) | 27 | 20.5 (22.6) | 16 | 26.5 (18.5) |
| OFER-acute fatigue subscale | Intervention | 16 | 50.8 (21.7) | 16 | 50.6 (31.5) | 22 | 42.4 (24.5) |
| Control | 27 | 44.9 (24.2) | 26 | 47.2 (31.6) | 16 | 52.5 (15.3) |
| OFER-intershift recovery subscale | Intervention | 16 | 60.4 (22.1) | 16 | 51.7 (20.0) | 22 | 69.7 (19.3) |
| Control | 27 | 65.3 (20.7) | 25 | 56.3 (18.8) | 16 | 59.8 (19.0) |
| Shift Attitudes Survey (SAS)  | Intervention | 16 | 44.7 (18.1) | 16 | 45.6 (28.2) | 22 | 31.6 (21.2) |
| Control | 27 | 34.3 (23.2) | 26 | 34.0 (23.9) | 16 | 47.8 (16.6) |

TABLE NOTES: \*Two participants (n=1 intervention and n=1 control) failed to complete the baseline assessments immediately following enrollment and randomization. PSQI scores range (0-21). ESS scores range 0-24 (>10=excessive sleepiness). OFER-chronic fatigue scores range 0-100 (50-100 imply moderate to high fatigue). OFER-acute fatigue scores range 0-100 (50-100 imply moderate to high fatigue). OFER-intershift recovery scores range 0-100 (50-100 imply moderate to high recovery). SAS instrument with select items

scores range 0-100 with no defined cut point.

**Supplemental Figure 1a-1c: Sleep hours pre-shift, during shifts, and inter-shift**

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**Supplemental Notes:**

Twenty-five unique participants (30%) reported a high level of intra-shift fatigue at the start of a scheduled shift. More participants in the control group than the intervention group reported high levels of fatigue at start of shifts (3% vs. 1%, respectively; p=0.01). Nine participants reported high fatigue at shift start for more than one shift; 7 were randomized to the control group.

Thirty participants (36%) reported a high level of intra-shift sleepiness at the start of a scheduled shift. The proportion of shifts with high sleepiness at the start of shift was similar among participants in the control and intervention groups (3.3% vs. 1.7%, respectively; p=0.07). Twelve participants reported high sleepiness at shift start for more than one shift; 8 were randomized to the control group.

Seven participants (8%) reported a high level of intra-shift difficulty with concentration at the start of a scheduled shift. The proportion of shifts with high difficulty with concentration at start of shift was similar for participants in the control and intervention groups (1.4% vs. 0.23%, respectively; p>0.05). Four participants reported high difficulty with concentration at shift start for more than one shift; 3 were randomized to the control group.