

Supplementary Appendix

This appendix has been provided by the authors to give readers additional information about their work.

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ROSTERS STUDY GROUP

Clinical Coordinating Center: Laura K. Barger, PhD; Charles A. Czeisler, PhD, MD; Melissa A. St. Hilaire, PhD; Elizabeth B. Klerman, MD, PhD; Christopher P. Landrigan, MD, MPH*; Steven W. Lockley, PhD; Conor S. O'Brien, BA; Andrew J.K. Phillips, PhD; Salim Qadri, BS; Shadab A. Rahman, PhD, MPH; Jason P. Sullivan, BS; and Natalie C. Viyaran, BS.

Data Coordinating Center: Terri Blackwell, MA; Dana R. Kriesel, MPH, MS; and Katie L. Stone, PhD.

Colorado: Angela S. Czaja, MD; Ann C. Halbower, MD; Adam Rosenberg, MD; and Kenneth P. Wright Jr, PhD.

Iowa: Gretchen Cress, RN, MPH; Gwen E. Erkonen, MD, MEd; and Jeffrey L. Segar, MD.

Massachusetts: Lindsey B. Armstrong, MD; Ben D. Albert, MD; Erin A. Bressler, MD; Dennis Daniel, MD; Christopher P. Landrigan, MD, MPH*; Bradley S. Podd, MD, PhD; Amy L. Sanderson, MD; Theodore C. Sectish, MD; Patrick A. Upchurch, MD; and Traci A. Wolbrink, MD, MPH.

Ohio: Sue E. Poynter, MD, MEd

Virginia: Jeannean Carver, MD and Pearl L. Yu, MD.

Washington: Maneesh Batra, MD, MPH; Reid W.D. Farris, MD, MS; Horacio O. de la Iglesia, PhD; John K. McGuire, MD; and Michael V. Vitiello, PhD.

Other: Phyllis C. Zee, MD, PhD

*Dr. Christopher Landrigan fulfilled two roles: ROSTERS Study Multiple Principal Investigator (with Dr. Charles Czeisler) of the Clinical Coordinating Center and Site Principal Investigator at Boston Children's Hospital.

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Colorado: Bradley Brainard, MBA, MHA, PMP; Tristan Bakke Dear, MS, MD; Tondeleyo Gonzalez, MA, BSN, RN; Jonathan D. Haywood, MD, MPH; Heather Hoch, MD, MSCS; Brian M. Jackson, MD, MA; Ayoub Lahlou, MD, MBA; Kathryn J. Yucha, MSN, BSN; Karen Meyer, RN, BSN, CPN; Tolulope Oyewumi, MD, MPH; Kimberly Ralston, MPH, BSN, RN; Nabeel Sawaged, MD; Beth E. Smith, MSN, RN, WHNP-BC; and Vanitha K. Varre, MBBS, MPH, MPS.

Iowa: Safa Abukhalil, MD; Ihab Ahmed, MBBS, MPH; Safa Abdelwahid Mohamed Ahmed, MBBS; Shilpa C. Balikai, DO; Maria Ana C. Canaya-Voskov, MD; Janice M. Jeter, RN, CCRC; Sameer Kamath, MBBS; Crystal Tuley, RN; Jessica G. Moreland, MD; Vani C. Movva, MBBS; Geoffrey Ounda Obel, MPH, MD; Angie Platt, BSN, RN; Thomas D. Scholz, MD; Ruthann Schrock, BSN, RN; Amy Stier, MD, MME; Alexandra Paige Davis Volk, MD; and Jin Zhou, RN, MNHP.

Massachusetts: Oluwafunmilola Alabi, MD; Joseph Asemota, MD, MPH; Abimbola Chris-Olaiya, MD, MPH; Virginia Leon, BSN, MEd, CCRN; Alexandra Male, MPH; Siyu Ma, MS; Adeolu O. Oladunjoye, MBChB, MPH; Olunmi O. Oladunjoye, MBBS, MPH; Saki Onda, MD, MPH; Kimberly Ralston, MPH, BSN, RN; Bhavya Atul Shah, MBBS; Lisa Tse, MPH; and Sandra Wooldridge, BSN, RN.

Ohio: Juanita Dudley, BSN, RN; Tatiana Elson, BS; Narinderpal Kaur, MD; Samuel Lee, MD, MBA; Najima Mwase, MD; Narissa Puran, MD, MS, MPH; Ndidi Unaka, MD, MEd; Andrew M. Warner, MD; Robin Widing, RN, MSN, CCRP; and Hector R. Wong, MD.

Virginia: Indu Aggarwal, MD; Fatimah Begom, MBBS; Kateryna Bilanovych, MD, ND, PhD, BCMAS; Ashley C. Eason, MD; Nasir Farhat, MD; Nicole M. Frank, PA-C; Robin L. Kelly, BSN, RN; Evan B. Kudron, MD; Abigail V.W. Kumral, MD; Brock D. Libby, MD; Jules Mukunde Katotola, MD; Trevor Pollock, MD; Justin Rizer, MD; Isaac A. Shields, MD; Terrell D. Smith, BS; Carolyn Spilman, MS, RN, CPNP; Albert T. Tang, MD; Linlin Wang, MD, PhD; Weonpo Yarl, MD; Hong Zhu, RN, CCRC; and Jenna V. Zschaebitz, BS.

Washington: Mouammar M. Abouagila, MBBS; Ibrahim K. Abukenda, MBChB, MPH; Canan Akture, MD, CCRC; Jennifer Jane Gile, BS; Carol Mendivil, MD; Anas L. Najjar, MS; Gowri Rajendran, MBBS; Shahar Robinzon, MD, MSc; Erin M. Sullivan, MPH; and Nastassya West, BS.

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SUPPLEMENTAL TABLE 1. Evening Handoff Procedures by Site

Site	Systems or problem-based approach?	Consistent use of any organizing framework?	Supervised by fellow or attending?	Any change with intervention schedule?
A	systems-based	no	yes	no
B	systems-based	I-PASS*	yes	no
C	systems-based	no	yes	yes, PM handoff staggered to occur in two parts to accommodate fellow and resident schedules
D	systems-based	no	yes	no
E	systems-based	I-PASS*	yes	no
F	systems-based	I-PASS*	yes	no

**Illness severity; Patient summary: Action List; Situational awareness and contingency planning; Synthesis by receiver*

SUPPLEMENTAL TABLE 2. Summary of Shifts on Control Schedule vs. Intervention

	Control Schedule*	Intervention Schedule†
Day shift	6-7am through 3-7pm (8-14 hours)	6-7am through 5-9pm (11-14 hours)
Night shift	n/a	6-8pm through 8am-12pm (16 hours)
Extended shift	6-11am through 8-10am (24-28 hours)	n/a

*on the Control Schedule, 2-3 day shifts typically preceded an extended shift, with occasional days off built into the schedule

†on the Intervention Schedule, 2-3 day shifts typically preceded a night shift, with occasional days off built into the schedule

SUPPLEMENTAL TABLE 3. Patient Population and Unit Characteristics by Site and Schedule

Characteristic (site difference comparison)	Site A		Site B		Site C	
	Control	Intervention	Control	Intervention	Control	Intervention
Number of patients	545	754	382	353	586	537
Number of unit admissions	547	754	395	386	627	579
Number of patient-days	2674	3480	2195	2096	3451	3323
age, yr, mean \pm SD	7.1 \pm 6.0	6.5 \pm 6.3	9.2 \pm 7.4	8.8 \pm 7.1	7.1 \pm 6.4	7.1 \pm 6.3
Male sex, n (%)	305 (55.8)	425 (56.4)	216 (54.7)	215 (55.7)	316 (50.4)	297 (51.3)
Length of unit stay, days, median (IQR)	2 (1, 5)	3 (2, 5)	3 (2, 5)	2 (2, 4)	3 (2, 5)	3 (2, 5)
Median Chronic Condition Indicator (IQR)	2 (1, 3)	2 (1, 3)	3 (2, 5)	3 (2, 5)	3 (1, 5)	3 (2, 5)
ICU patients per resident physician [†]	3.9	4.8	4.4	7.3	7.3	8.0
Characteristic (site difference comparison)	Site D		Site E		Site F	
	Control	Intervention	Control	Intervention	Control	Intervention
Number of patients	432	392	617	601	705	673
Number of unit admissions	487	421	684	661	768	790
Number of patient-days	2884	2776	3659	3892	3886	4505
age, yr, mean \pm SD	5.9 \pm 6.0	5.6 \pm 5.9	7.3 \pm 6.7	6.5 \pm 6.3	7.6 \pm 7.3	8.1 \pm 7.1
Male sex, n (%)	244 (50.1)	239 (56.8)	373 (54.5)	362 (54.8)	399 (51.9)	405 (51.3)
Length of unit stay, days, median (IQR)	2 (1, 5)	2 (1, 5)	2 (2, 4)	3 (2, 4)	3 (2, 4)	2 (2, 4)
Median Chronic Condition Indicator (IQR)	2 (1, 3)	2 (1, 3)	2 (1, 4)	2 (1, 4)	2 (1, 3)	2 (1, 3)
ICU patients per resident physician [†]	7.1	9.1	7.9	10.2	9.8	13.2

[†]ICU patients per resident-physician (IPRP) calculated as average census at each site, per schedule, over average number of resident-physicians present daily at each site, per schedule

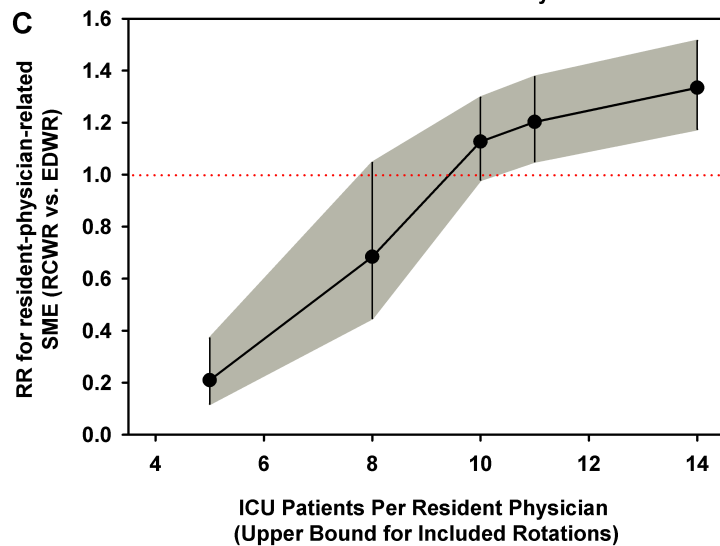
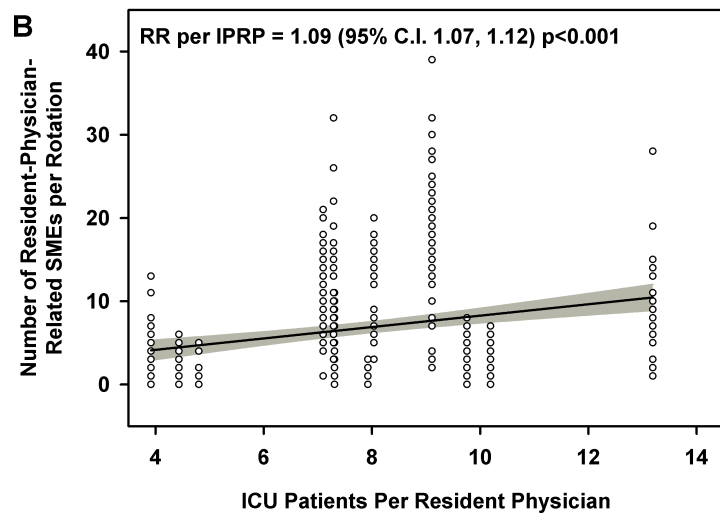
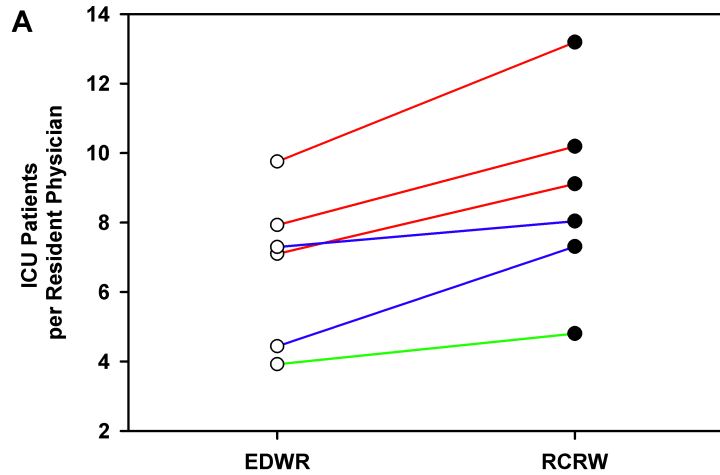
P-values from a chi-square test or Wilcoxon rank-sum test for within site comparisons.

P-values from a chi-square test for homogeneity or a Kruskal Wallis test for site difference comparisons.

SUPPLEMENTAL TABLE 4. Number of Serious Medical Errors, by Site

	Overall		Site A		Site B		Site C		Site D		Site E		Site F	
	control	intervention	control	intervention	control	intervention	control	intervention	control	intervention	control	intervention	control	intervention
Resident-physician related	1268	1723	129	42	93	117	490	435	419	678	18	111	119	340
Unit-wide	2112	3217	304	179	200	213	673	781	600	1046	74	313	261	685

SUPPLEMENTAL FIGURE 1. Effect of workload on serious medical error rates



(A) Number of ICU patients per resident-physician (IPRP), a measure of resident-physician workload, under the extended duration work roster (EDWR; control schedule) vs. the rapid cycle work roster (RCWR; intervention schedule). Sites in red experienced a worsening in rates of resident-physician-related serious medical errors (SMEs) with implementation of the RCWR schedule; sites in blue experienced no significant change; the site in green experienced an improvement. (B) We used a Poisson model with robust standard errors to estimate the unadjusted dependence of the number of resident-physician SMEs on IPRP. Site- and schedule-level average resident-physician workload was correlated with resident-physician-related serious medical errors (SME). (C) On the basis of an initial Poisson model showing modification of the effect of schedule by IPRP, we assessed its effects allowing for dependence in IPRP, again using log-link Poisson models, but with resident-rotation as the unit of analysis instead of admissions to the unit as the unit of analysis, and with site and schedule as fixed effects, robust standard errors, and the log of the duration of resident rotation as an offset. Separate Poisson models were run, restricting each model to rotations with IPRP at discrete thresholds from 5 to 14 to estimate the rate ratio of resident-physician-related SMEs under RCWR and EDWR at each of these thresholds. The rate ratio estimates from these separate Poisson models showed that the effectiveness of the RCWR on the rate of resident-physician-related SMEs across sites depended on IPRP. In these exploratory analyses, the rate ratio of resident-physician-associated SMEs on the RCWR vs. EDWR was significantly <1.0 in analyses including rotations below the IPRP inflection point [RR 0.21 (95% CI: 0.12 – 0.37)], but detrimental [RR 1.46 (95% CI: 1.27 – 1.67)] when IPRP was above the inflection point.

Covariate-adjusted rate ratio estimates of resident-physician-related SMEs are shown with corresponding 95% confidence intervals.