Evidence Table C-2. Findings of included primary studies addressing fatigue and sleepiness of clinicians related to hours of service

| Author, year | Comparison | Outcome findings |
| --- | --- | --- |
| Denson, 201560 | **Resident pre-duty hour change (2010-2011)****Control:** Patient discharged the following 3 weeks of each 4-week rotation before resident service change.**Handoff group:** Patient discharged within 7 days following a change in resident physician team.Resident **post ACGME duty hour change (2011-2012)****Control:** Patient discharged the 3 weeks of each 4-week rotation before resident service change.**Handoff group:** Patient discharged within 7 days following a change in resident physician team. | **Mortality**Pre-duty hour handoff group vs control group showed a statistically significant association with adjusted mortality (OR 1.5 (95% CI: 1.11 to 1.86)), however in the post-duty hour change, the association lost statistical significance (OR 1.18 (95% CI: 0.89 to 1.56)). Before duty hour restrictions, team handoff group vs. no team handoff group was associated with a statistically significant higher mortality (OR 1.5 [95% CI: 1.11 to 1.86]), however after duty hour changes, the association lost statistical significance (OR 1.18 [95% CI: 0.89 to 1.56])  |
| Desai, 201359 | **Control:** Overnight on-call shift every fourth night, beginning at 12 pm and concluding no later than 6 pm the next day, with a maximal continuous duty of 30 hours.**Q5:** Overnight call every fifth night beginning at 9 pm and concluding no later than 1 pm the next day, for a maximal continuous duty of 16 hours.**NF:** Day and night shifts with an intern working for approximately 6 consecutive nights, each with maximal continuous duty of 14 hours and with day shifts. | **Complications**No significant difference in operations outcomes between groups (30 day readmissions). No significant difference in 30-day readmission rates between groups  |
| Rajaram, 201461 | **Control:** before ACGME reform (2009-2011)**Intervention:** after ACGME reform (2011-2013) | **Mortality**No significant change in death or serious morbidity post-reform (OR, 1.06 [95% CI: 0.93] to 1.20]).**Incidence of medical errors or adverse events**No association between reform and any postoperative adverse events. |
| Weaver, 202362 | **2002-2007:** Resident physicians who contributed data from 2002-2007 when the 16-hour ACGME restriction was not yet implemented**2014-2017:** Resident physicians who contributed data from 2014-2017 (after the implementation of the 16-hour shift restriction) | **Incidence of medical errors or adverse events**Statistically significant reduction in risk of significant medical errors (RR 0.66 [95% CI 0.59 to 0.74])Statistically significant reduced risk of medical errors leading to patient death (RR 0.37 [95% CI 0.28 to 0.49]) |
| Wen, 201758 | **Pre-2003:** Hospital admissions which occurred prior to 2003 ACGME reform**Post-2003:** Hospital admissions which occurred after 2003 ACGME reform | **Complications**Patients were more likely to incur a hospital-acquired condition in the post-2003 group compared to the pre-2003 group (OR 1.10 [95% CI: 1.06 to 1.14]) |
| Bilimoria, 201666 | **Standard policy:** Adhere to existing ACGME duty-hour policies.**Flexible policy:** Limiting work to 80 hours per week, 1 day off in 7 days, and on-call duty no more frequently than every third night. Residents were granted a waiver to waive four duty-hour requirements concerning maximum shift length and minimum time off between shifts. | **Mortality and complications**The risk of death or serious complications did not differ significantly between patients who underwent surgery in hospital affiliated with the flexible policy and those in the standard policy hospitals (adjusted OR [0.96; 92% CI, 0.90 to 1.04]; p= 0.38). |
| Mirmehdi, 201665 | **National resident cases:** Operations performed by surgery residents with a traditional duty-hour work schedule**Institution Resident Cases:** Operations performed by surgery residents in a hospital which implemented a flexible work hour schedule | **Mortality**No statistically significant difference in patient mortality after operation (1.58% institution resident cases vs 1.30% national resident cases p=0.629). |
| Silber, 201967 | **Standard duty-hour rules:** Following the 2011 ACGME duty-hour regulations with its 16-hour limit on intern shift length.**Flexible duty hours:** Directors allowed to extend work-hour limits beyond the 16-hour limit. | **Mortality**Change in 30-day mortality among the patients in the flexible programs (12.5% in the trial year vs. 12.6% in the pretrial year) was noninferior to that in the standard programs (12.2% in the trial year vs. 12.7% in the pretrial year).  |
| Bae, 201352 | **Control groups:**Nurse overtime without regulationsNo overtimeNurses working ≤40 hours per week**Intervention groups:**Nurse overtime with regulationsNurse overtime (mandatory, voluntary, or on-call)Nurses working ≥40 hours per week | **Complications**No significant difference in number of any adverse events between comparisons. Only for nurses working ≥40 hours per week was there significantly higher adverse events in comparison to nurses working ≤40 hours per week (OR 14.36 [95% CI: 1.20 to 171.9]).Rates of patient falls were significantly higher among nurses with overtime regulations, and among voluntary overtime nurses. Rates of patient pressure ulcers were significantly higher among nurses with overtime regulations, voluntary overtime nurses, and nurses working ≥40 hours per week. Rates of patient nosocomial infection rates were significantly higher among nurses with overtime regulations, on-call nurses, and nurses working ≥40 hours per week. There were no statistically significant differences among comparison groups for failure to rescue.**Incidence of medical errors or adverse events** No significant difference in medication errors between comparisons of overtime vs no overtime, and nurses with overtime regulation vs without regulations. There was a significant increase in medication errors for nurses working ≥ 40 hours per week compared to nurses working ≤ 40 hours per week (OR 3.71 [95% CI: 1.16-11.84])  |
| Weaver, 201647 | **Day shift:** Shifts included: 7:00 am to 7:00 pm, 9:00 am to 9:00 pm, 11:00 am to 11:00 pm**Night shift:** Shifts included: 1:00 pm to 1:00 am, 3:00 pm to 3:00 am, and 7:00 pm to 7:00 am | **Incidence of medical errors or adverse events**Sleep quantity was not associated with minor, moderate or severe perceived errors. |
| Landrigan, 202063 | **Control:** Night shift followed by approximately 24 hours off duty, and then two or three consecutive day shifts.**Intervention:** Schedules that eliminated extended shifts and cycled resident physicians through day and night shifts of 16 hours or less. | **Incidence of medical errors or adverse events**Physicians made more serios errors during intervention schedules (RR 1.53 ;[95% CI: 1.37 to 1.72], p<0.001). Serious errors unit wide were also higher during intervention schedules (RR 1.56 [95% CI: 1.43 to 1.71]). |
| Rahman, 202164 | **Extended duration work roster (EDWR):** Shifts of 24 or more hours every third or fourth shift. 4 day rotation with 2 ∼12-hour day shifts followed by an on-call shift beginning in the morning and ending 24 to 28 hours later.**Rapid cycling work roster (RCWR**): Limit resident physicians’ scheduled continuous work to 16 hours maximum. 4 day rotation with 2 ∼11 to 15-hour day shifts followed by a 16-hour overnight shift that started in the evening and ended the next morning.**EDWR+RCWR:** Resident physicians' worked both times of shifts. | **Incidence of medical errors or adverse events**After adjustment, RCWR had a protective effect and lower rate of serious medical errors (rate ratio 0.48 (95% CI: 0.30 to 0.77)). |
| Abdalla, 202249 | **6-8 hours of total sleep on call:** Neurointerventional surgeons who reported 6-8 hours of total sleep while on call**4-6 hours of total sleep on call:** Neurointerventional surgeons who reported 4-6 hours of total sleep while on call**Less than four hours of total sleep on call:** neurointerventional surgeons who reported less than 4 hours of total sleep while on call | **Incidence of medical errors or adverse events**Risk of medical errors showed strong association in respondents reporting <4 hours of uninterrupted sleep (45.7% versus 25.5%, p=0.008).Statistically significant association of sleeping <6 hours and fatigue related medical errors (38.9% vs 18.4%, p=.02). |
| Iverson, 201848 | **Sleep deprivation:** Patients who underwent PCI performed by a sleep deprived operator**No sleep deprivation:** Patients who underwent PCI performed by a non-sleep deprived operatorNon-sleep deprived defined as operators performing a case between 7 am and 11:59 pm as well as a case the preceding night, between 12 am and 6:59 am. | **Complications**Major procedural complication: no statistically significant difference (p=0.42)Bleeding event: no statistically significant difference (p=0.29)**Mortality**In-hospital mortality: no statistically significant difference (p=1.0) |
| Quan, 202350 | **Non-post call:** Surgery performed by surgeon who was non post-call status**Post-call:** Surgery case performed by a surgeon who was post-call status | **Incidence of medical errors or adverse events**No statistically significant difference in incidence of medical errors: IRR 3.16 comparing non-post call and post call error rate p=0.165 |
| Kalmbach, 202251 | **Sleep time > 6hours:** First year residents with sleep time greater than 6 hours**Work hours < 70 hours:** Less than 70 work hours per week**Sleep time < 6hours:** First year residents with sleep time less than 6 hours**Work hours ≥ 70 hours:** Equal or more than 70 work hours per week | **Incidence of medical errors or adverse events**Residents with less than 6 hours of sleep more likely to make medical errors (RR = 1.3, p=0.03) at 3 months.Error rates higher for residents who work more than 70 hours per week (RR = 1.5, p<0.01) at 3 months. |
| Barger, 202356 | **Control:** less than 48 weekly work hours**>48 and ≤60:** 48 to 60 weekly work hours**>60 and ≤70:** 60 to 70 weekly work hours**>70 and ≤80:** 70 to 80 weekly work hours**>80:** More than 80 weekly work hours | **Incidence of medical errors or adverse events**Working more than 48 hours per week was associated with an increased risk of self-reported medical errors, preventable adverse events, and fatal preventable adverse events (p<0.001 for call groups compared working less than 48 hours per week). |
| Ouyang, 201655 | **Control:** Residents who worked less than 80 hours that week.**Intervention:** Residents who worked more than 80 hours that week. | **Mortality**No statistical difference for rate of in-hospital mortality for patients in either group.**Complications**No statistical difference for rate of ICU and 30-day readmission rate for patients in either group. |
| Salgado, 202257 | **Extended duty hour call system:** 24-hour plus 4-hour shifts every 4 days from 7 am to 11 am the following day, with 4-hour protected off-pager for in-hospital rest in private call rooms from 2:00 to 6:00 am (extendedduty hours)**Limited duty hour call system:** “Long call” admitting shift every 3 days with a maximum single-day work hour limit of 16 hours. | **Complications**No statistically significant difference in patients who developed complications during admission (95% CI of -0.064 to 0.104) |
| Stimpfel, 201353 | 8-hour shift length12-hour shift lengthShift length longer than 13 hours | **Incidence of medical errors or adverse events**The likelihood of a nurse reporting poor quality or a poor safety grade on their unit was greater for nurses working > 13 hours compared to nurses working 8 hours (adjusted ORs 2.76 and 3.14, respectively). |
| Westley, 202054 | 60 hours or more work within 7 daysLess than 60 hours work within 7 days | **Incidence of medical errors or adverse events**Nurses working 60 hours or more in a week had an average near-miss rate of 4% compared to 3% (p <.001) for nurses who did not. Nurses working extended hours had a significantly increased risk of triggering a near-miss alert compared to those not working extended hours. |

ACGME = Accreditation Council for Graduate Medical Education; CI = confidence interval; EDWR = extended duration work rosters; ICU = intensive care unit; IRR = incident rate ratio; OR = odds ratio; PCI = percutaneous coronary intervention; RCWR = rapid cycling work rosters; RR = relative risk