Table 4. Non-comparative studies

Reference	Study design and methods	Study population	Findings
Bagshaw, 2018	Multi-center population-based cohort study in 9 adult ICUs in Alberta, Canada. Primary exposure was ICU strain, defined as instantaneous bed availability (≤1, ≤2 or ≤3 beds available at the time of patient admission) and as instantaneous bed occupancy (≥90%, ≥95% proportion of occupied beds at the time of patient admission). A path-analysis model was developed to estimate the magnitude and significance of hypothesized causal associations (direct, indirect and the total combined effect of both) between measures of strained capacity and outcomes (see Figure 1 in the article). A mixed-effects linear regression model was used, adjusting for co-variates (see section 2.4.1 in the article for more information).	All consecutive adults (age ≥ 15 yrs) admitted to any of the 9 ICUs were eligible for inclusion. There were 12,265 ICU admissions to all ICUs during the study period. Patient age, median (IQR): 59 years (46–70) Sex male: 58.3% Comorbidity, n (%): 10,485 (85.49) Admission APACHE II score, mean (SD): 20.2 (8.4) Surgery-related admissions: 26.7% ICU mortality: 14.7% (n = 1802).	<u>Effect of strained ICU capacity on ICU mortality</u> Direct effect Available beds ≤ 1: OR 1.116 (95%CI 0.995, 1.252) Available beds ≤ 2: OR 1.025 (95%CI 0.928, 1.133) Available beds ≤ 3: OR 0.948 (95% CI 0.856, 1.051) Occupancy ≥ 90%: OR 1.042 (95% CI 0.936, 1.160) Occupancy ≥ 95%: OR 1.095 (95% CI 0.962, 1.247) Indirect effect Available beds ≤ 1: OR 1.044 (95%CI 1.018, 1.070) Available beds ≤ 2: OR 1.037 (95%CI 1.016, 1.059) Available beds ≤ 3: OR 1.029 (95% CI 1.008, 1.052) Occupancy ≥ 90%: OR 1.047 (95% CI 1.024, 1.072) Occupancy ≥ 95%: OR 1.047 (95% CI 1.017, 1.077) Total (integrated) effect Available beds ≤ 1: OR 1.165 (95%CI 1.036, 1.310) Available beds ≤ 2: OR 1.063 (95%CI 0.960, 1.178) Available beds ≤ 3: OR 0.976 (95% CI 0.879, 1.084) Occupancy ≥ 90%: OR 1.091 (95% CI 0.978, 1.218) Occupancy ≥ 95%: OR 1.146 (95% CI 1.004, 1.309) <u>Effect of strained ICU capacity on hospital mortality</u> Direct effect Available beds ≤ 1: OR 1.05 (95% CI 0.955, 1.155) Available beds ≤ 2: OR 1.041 (95% CI 0.959, 1.13) Available beds ≤ 3: OR 0.961 (95% CI 0.883, 1.045) Occupancy ≥ 90%: OR 1.017 (95% CI 0.931, 1.11) Occupancy ≥95%: OR 1.033 (95% CI 0.928, 1.15) Indirect effect Available beds ≤ 1: OR 1.033 (95%CI 1.014, 1.053) Available beds ≤ 2: OR 1.028 (95%CI 1.012, 1.045)

			Available beds ≤ 3: OR 1.022 (95% CI 1.006, 1.039) Occupancy ≥ 90%: OR 1.036 (95% CI 1.018, 1.054) Occupancy ≥ 95%: OR 1.035 (95% CI 1.013, 1.058) Total (integrated) effect Available beds ≤ 1: OR 1.085 (95%CI 0.985, 1.195) Available beds ≤ 2: OR 1.070 (95%CI 0.985, 1.163) Available beds ≤ 3: OR 0.982 (95% CI 0.901, 1.07) Occupancy ≥ 90%: OR 1.053 (95% CI 0.963, 1.152) Occupancy ≥ 95%: OR 1.069 (95% CI 0.958, 1.193)
Blayney, 2020	Retrospective cohort study The exposure variable was daily occupancy, calculated as the sum of the proportion of the day each patient spent on the unit (derived from admission and discharge times), divided by the number of beds in that unit each day. For example, on a 4-bed unit, if three patients spent the entire day on the unit, a fourth patient was admitted at midday and there were no discharges, occupancy would be 3.5/4 = 0.875 (87.5%). Using this formula, it is possible that units may function at an occupancy exceeding 1. This is because some units in Scotland have spare physical (but not funded) beds to facilitate patient admission whilst another is prepared for discharge. Ultimate hospital mortality was reported for patients who experienced early discharge from ICU compared to those who did not, and for patients experiencing non clinical transfer (NCT) compared to patients who did not experience NCT. These were stratified by the occupancy level on the day of discharge (N70%, N80%, N90%), and by time of discharge (day-time vs night-time. Night-time was defined as after 22:00 and before 08:00, as per SICSAG definition. All readmissions to ICU were excluded from these analyses.	All patients admitted to every Scottish adult general ICU from 2006-2014. N total at baseline: Total: 77,209 patients Important prognostic factors: Age, median (QR) Total group: 62 (47 – 72) Sex, n male (%) Total group: 43,943 (56.9%)	Mortality 14.7% of patients experiencing early discharge died before ultimate hospital discharge compared with 7.4% of those not experiencing early discharge. Similarly, 30.0% of patients experiencing NCT died compared with 7.5% of those not experiencing NCT.
Gabler, 2013	Retrospective cohort study The primary exposures were three metrics	Patients admitted to U.S. ICUs included in the Project IMPACT database. Eligible patients were	The primary outcome was in-hospital death, which included patients dying during their initial ICU stay plus those dying after ICU discharge, including deaths in a step-down unit, on a general

	of ICU capacity strain measured on the day of a patient's admission: (1) standardized census, (2) acuity, and (3) admissions. Primary and secondary outcomes were analyzed by hierarchical logistic regression in which ICU-year was modelled as a fixed effect to adjust for correlation of outcomes within ICUs and to prevent confounding by practice differences among ICUs or within ICUs over time. Before model building, used locally weighted scatterplot smoothing was used to determine whether variables required transformation or could be entered linearly. Log transformation was required for admitted patients' MPM0-III scores. Strain variables were entered as continuous variables and all three were included in each model. We explored two-way interactions between strain variables for each outcome.	admitted between April 1, 2001 and December 31, 2008 to U.S. ICUs included in IMPACT. Total at baseline: 264,401 patients admitted to 155 ICUs in 107 Hospitals Patients' mean age was 60 years (SD, 18), 54% were male, and 77% were white.	floor, or during an ICU readmission. The secondary outcome of ICU death included deaths occurring during the initial ICU admission plus patients discharged from the ICU in a moribund state. <u>Results</u> Quotes: "In adjusted analyses including patient-level covariates and all three strain variables without interaction terms, standardized ICU census on the day of admission was associated with increased odds that admitted patients would die in the hospital (OR for a standardized unit increase, 1.02; 95% CI: 1.00, 1.03). The proportion of ICU admissions was inversely associated with the odds of inhospital death (OR for a 10% increase in admissions, 0.98; 95% CI: 0.96, 0.99), and ICU acuity had no significant effect (OR for a 10% increase in acuity, 1.00; 95% CI: 0.97, 1.02)." "Similar results were observed for the secondary outcome of ICU death. There was a significant interaction between standardized census and acuity for both in-hospital death (P value for interaction < 0.01) and ICU death (P value for interaction = 0.04), such that standardized ICU census was more strongly associated with death when the standardized census comprised sicker patients. For example, the OR for in-hospital death for each standardized unit increase in ICU census is 1.06 (95% CI: 1.01, 1.11) for the highest decile of ICU acuity, and 0.98 (95% CI: 0.93, 1.03) for the lowest decile of ICU acuity." "The effect of standardized census on in-hospital death was greater among ICUs with closed physician staffing models (OR, 1.07; 95% CI: 1.02, 1.12) than among ICUs with open physician staffing models (OR, 1.01; 95% CI: 0.99, 1.03) (P value for interaction = 0.02). Similar effects were noted for ICU death. Corresponding interactions between ICU capacity strain measures and the ICU characteristics of annualized patient volume, nocturnal intensivist staffing, academic affiliation, and medical–surgical case mix were all nonsignificant."

Town, 2014	Observational cohort study Between January 1, 2009, and December 31, 2011, at a tertiary care academic medical center with 63 total adult ICU beds, including specialized medical, cardiac, surgical, and neurological ICUs, and 272 adult general inpatient ward beds. ICU bed availability was collected in a handwritten institutional log. At the start of each 7 am and 7 pm shift, the ICU manager or charge nurse recorded the census and capacity of each ICU. The “census” refers to the number of patients within the ICU at the start of the shift. The “capacity” refers to the total number of beds available to accommodate patients with the available nurses for the shift. Therefore, if there were 10 physical beds, but only enough nurses to care for eight patients, then the capacity would have been logged as eight. Bed availability represents the capacity minus the census. The final models were adjusted for potential confounders by adding the variables of calendar year (2008, 2009, etc.), season (Summer, Spring, etc.), day of week (Monday, Tuesday, etc.), and time of day (day vs night).	Over the study period, there were 60,355 admissions over 2,190 consecutive shifts, of which 2,086 (95.3%) had complete data. The mean age of all admitted patients was 54 ± 18 years, 43% were men, and 24% were surgical admissions.	The article reports ICU readmission rates by ICU bed availability in quartiles (see also Figure 1 in the article). Quote: “The odds of readmission to the ICU significantly increased with each unit decrease in total ICU bed availability after adjusting for potential confounders (odds ratio [OR] = 1.06; 95% CI, 1.00–1.12; p = 0.03).”