

Supplementary Information

Driving pressure, simplified elastic mechanical power, and time to liberation from mechanical ventilation:

a competing-risks and time-anchored observational study

Supplementary Methods

Ventilator-data construction

In MIMIC-IV, ventilation episodes were obtained from the derived ventilation table and settings from `mimiciv_derived.ventilator_setting`. The fields used were `charttime`, `ventilator_mode`, `ventilator_mode_hamilton`, `plateau_pressure`, `peep`, `tidal_volume_set`, `tidal_volume_observed`, `respiratory_rate_set` and `respiratory_rate_total`. Controlled-mode labels were CMV/ASSIST (including AutoFlow variants), CMV, VOL/AC, VOL/AF, PRES/AC, PRES/AF, PCV variants, PRVC variants, SIMV variants, MMV variants, APRV, DuoPaP and Biphasic; corresponding Hamilton labels included APV (cmv), APV (simv), P-CMV, P-SIMV, (S) CMV, ASV, APRV, DuoPaP and SIMV. Spontaneous/support labels included SPONT, CPAP variants, PSV variants, VS, Ambient and Standby. Unmapped labels were classified as unknown and were not used in exposure windows. No additional physiological range filter was applied to the MIMIC-IV derived ventilator-setting fields beyond requiring the contemporaneous non-missing components specified below. This mode-based classification cannot verify absence of patient triggering or inspiratory effort.

For the landmark analysis, the anchor was the final controlled-mode record before the end of the first invasive-ventilation episode. Records from the preceding 6 h were retained. Driving pressure was calculated when plateau pressure and PEEP were available at the same charted time. Simplified elastic mechanical power (MP_{el}) was calculated only when plateau pressure, PEEP, tidal volume and respiratory rate were all available at that time; record-level values were then averaged within the window. Tidal volume used the set value when available and otherwise the observed value; respiratory rate used the set value when available and otherwise total respiratory rate.

In eICU-CRD, plateau pressure and PEEP were paired by `patientunitstayid` and `respchartoffset`. Values outside 5–60 cmH₂O for plateau pressure or 0–30 cmH₂O for PEEP were excluded. Because a reliable extubation timestamp was unavailable, exposure was summarized during the final 6 h of recorded invasive-ventilation settings. The external analysis was consequently restricted to replication of the binary 48-h association.

Table S1. Target-trial-inspired protocol for the time-zero-aligned weighted comparison.

Component	Operational specification
Eligibility	Adult, first ICU stay, invasive ventilation for at least 24 h, not chronically tracheostomised; first controlled-mode record with $\text{FiO}_2 \leq 50\%$ and $\text{PEEP} \leq 8 \text{ cmH}_2\text{O}$. These criteria indicate low respiratory support but not clinical SBT readiness.
Treatment strategies	Comparison of observed ΔP states (≤ 14 vs $> 14 \text{ cmH}_2\text{O}$); these are not uniquely specified ventilator interventions.
Assignment	Observational; entropy balancing on measured baseline covariates.
Time zero	First qualifying operational low-support record after 24 h of invasive ventilation.
Exposure assessment	Mean ΔP during the 6 h ending at time zero.
Follow-up	Time zero to successful liberation, death or 28 days.
Outcome	Successful liberation, with death as a competing event.
Estimand	Difference between observed groups in the 28-day area under the successful-liberation cumulative-incidence curve.
Key assumptions	Conditional exchangeability, positivity, consistency of the observed-state contrast and correct measurement/model specification. The intervention-consistency assumption is limited because ΔP is not directly assigned.

Table S2. Landmark sensitivity and component analyses in MIMIC-IV.

Analysis (per SD)	Cause-specific HR (95% CI)	Fine-Gray sHR (95% CI)
ΔP , 72-h outcome definition	0.921 (0.889–0.953)	0.868 (0.841–0.897)
MP_{el} , 72-h outcome definition	0.782 (0.746–0.821)	0.693 (0.664–0.725)
ΔP , excluding NIV-only failures	0.908 (0.878–0.939)	0.856 (0.829–0.883)
MP_{el} , excluding NIV-only failures	0.766 (0.731–0.803)	0.677 (0.649–0.708)
Respiratory rate	0.847 (0.815–0.881)	0.760 (0.732–0.788)
Tidal volume/PBW	1.019 (0.991–1.048)	1.022 (1.013–1.031)
PEEP	0.811 (0.778–0.846)	0.749 (0.719–0.779)

Table S3. Comparison of patients with and without measurable driving pressure. Dashes indicate that directly comparable eICU-CRD measures were not available in the analysis dataset.

Characteristic	MIMIC-IV		eICU-CRD	
	Measurable	Not measurable	Measurable	Not measurable
N	7,126	3,088	1,260	4,154
Age, years	63.3	63.4	61.9	60.4
Male, %	57.7	56.2	57.1	56.8
Day-1 SOFA	7.19	6.71	—	—
$\text{PaO}_2/\text{FiO}_2$	171	181	—	—
Ventilation duration, h	107.3	127.1	—	—
Hospital mortality, %	30.5	26.3	41.8	21.9
28-day death, %	29.0	24.7	—	—
48-h failure/death, %	36.5	31.8	33.3	14.1

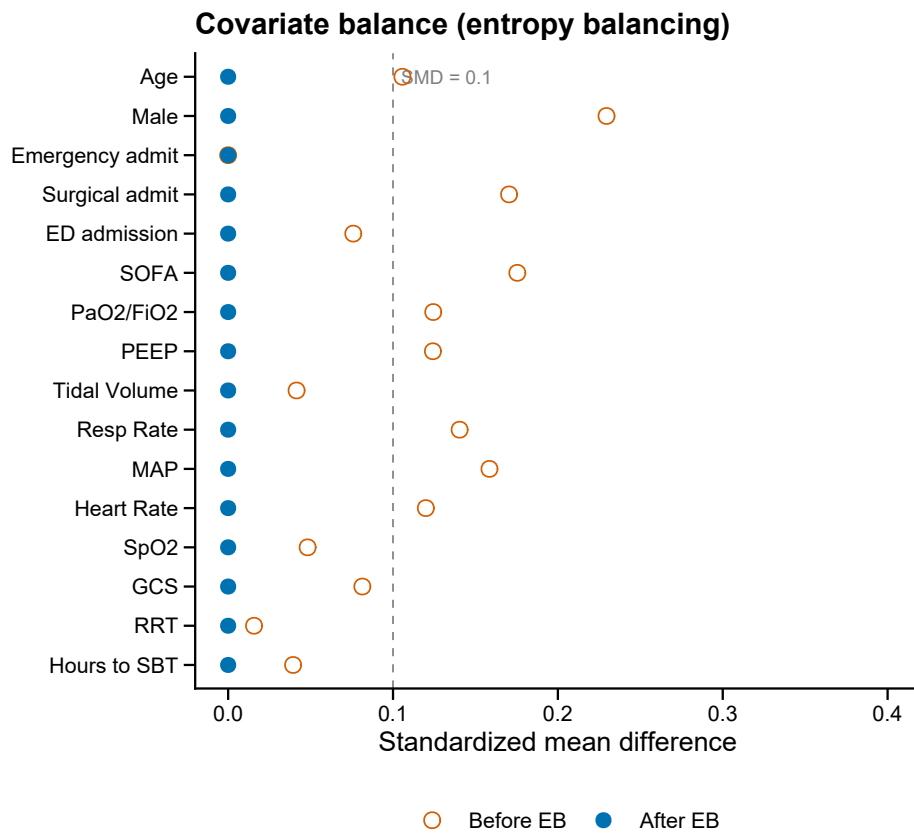


Figure S1. Covariate balance (love plot). Standardised mean differences of covariates before and after entropy balancing; dashed line, the 0.1 threshold.

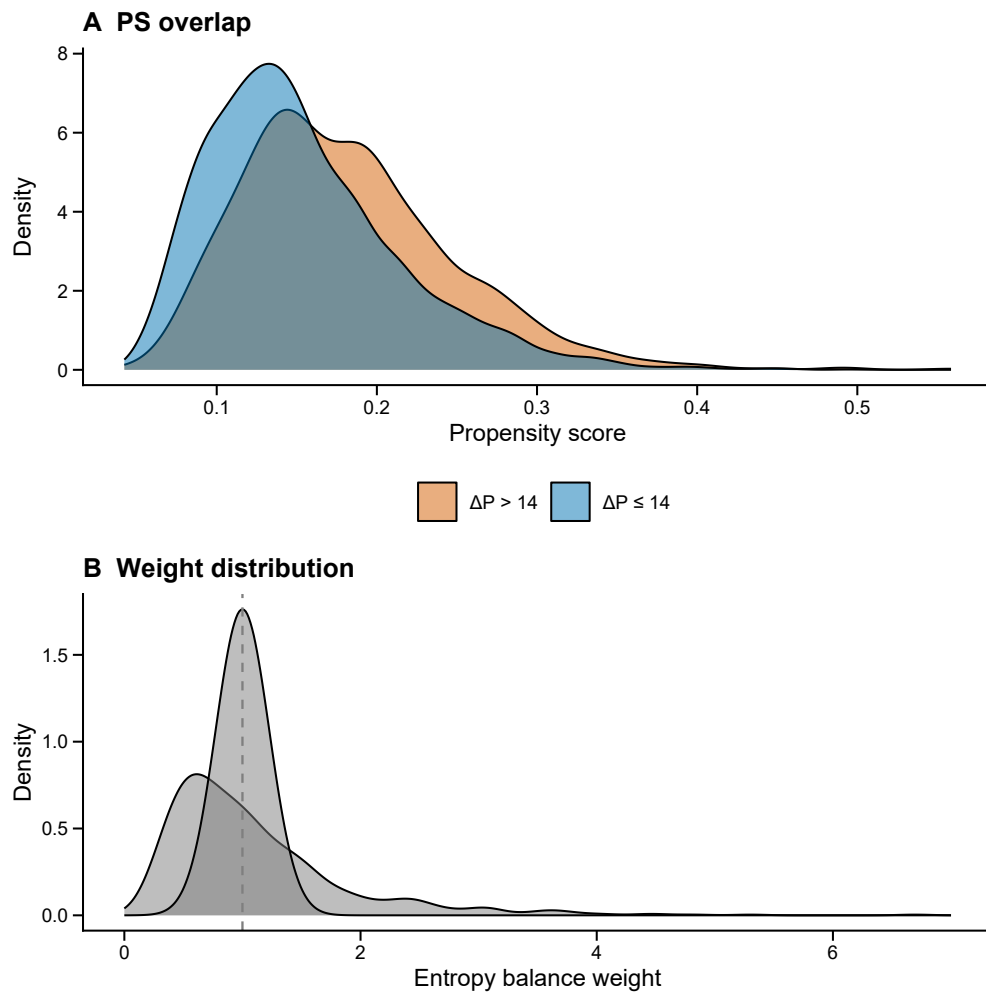


Figure S2. Propensity-score overlap (A) and distribution of entropy-balancing weights (B).

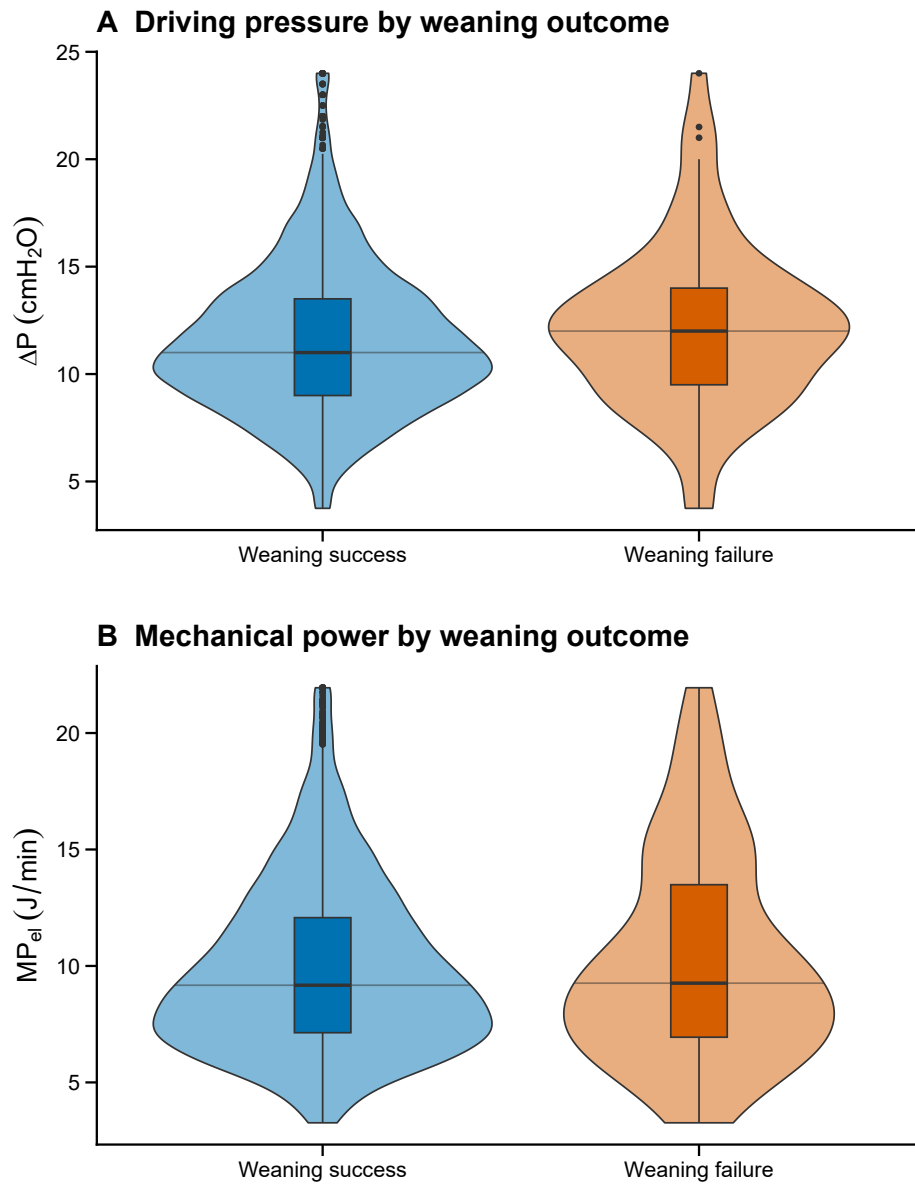


Figure S3. Distribution of exposures by weaning outcome: driving pressure (A) and simplified elastic mechanical power (B), shown as violin plots.

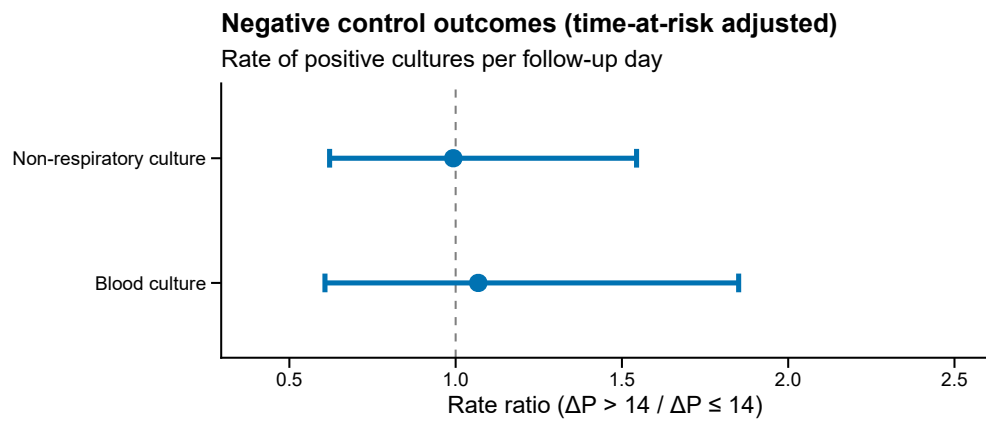


Figure S4. Negative-control outcomes (adjusted for time at risk). Rate ratios for non-respiratory and blood cultures ($\Delta P > 14$ vs ≤ 14 cmH₂O); reference line at 1.