

Supplementary Materials

Intensive Care Unit Caseload and Workload and their Association with Outcomes in Critically Unwell Patients: A Large Registry-Based Cohort Analysis

Paul ZAJIC, MD PhD¹

Teresa ENGELBRECHT, BSc²

Alexandra GRAF, PhD²

Barbara METNITZ, PhD³

Rui MORENO, MD PhD⁴

Martin POSCH, PhD²

Andrew RHODES, MD⁵

Philipp METNITZ, MD PhD^{1,3}

¹ Department of Anaesthesiology and Intensive Care Medicine, Medical University of Graz, Graz, Austria

² Center for Medical Data Science, Medical University of Vienna, Vienna, Austria

³ Austrian Center for Documentation and Quality Assurance in Intensive Care, Vienna, Austria

⁴ Hospital de São José, Unidade Local de Saúde São José, Lisbon, Portugal; Centro Clínico Académico de Lisboa, Lisbon, Portugal; Faculdade de Ciências da Saúde, Universidade da Beira Interior, Lisbon, Portugal

⁵ Adult Critical Care, St. George's University Hospitals NHS Foundation Trust, St. George's University of London, London, United Kingdom

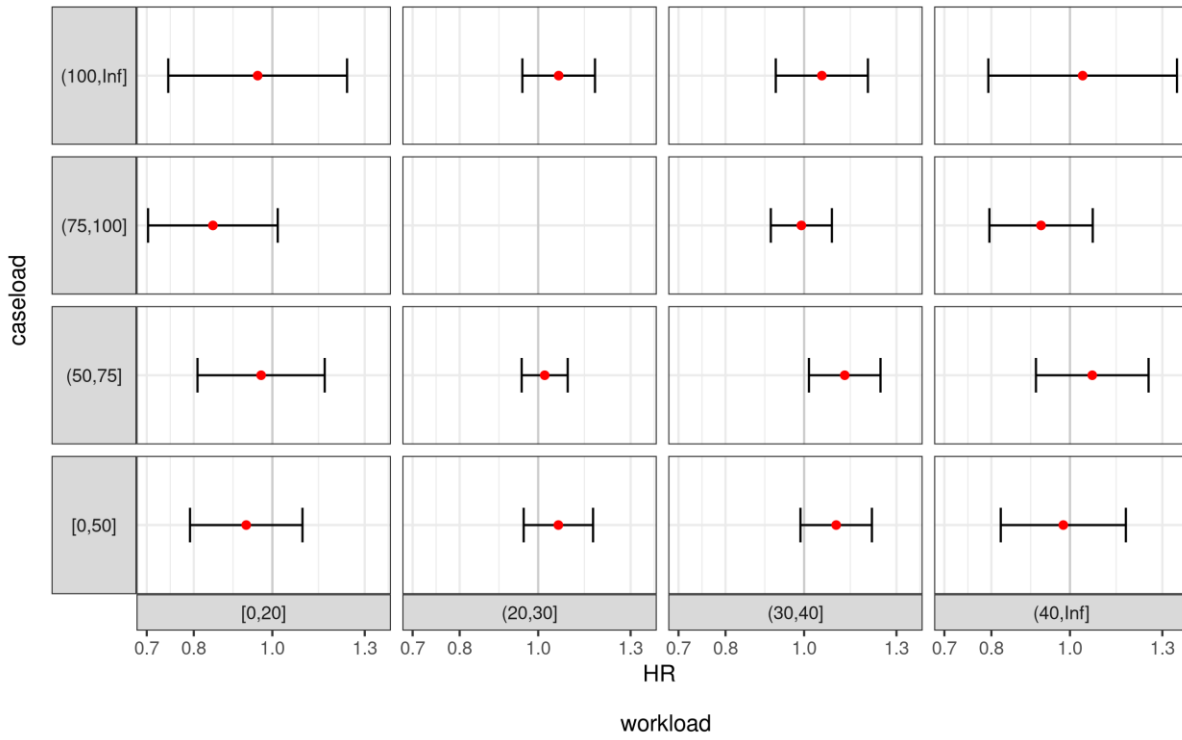
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Sensitivity Analysis: Interaction Term between Workload and Caseload

Table S 1 Cox proportional hazards regression with ICU mortality as endpoint. The main variable of interest, an interaction between workload based on the TISS-28-Score and caseload based on bed occupancy was modelled as a time-dependent covariable. SAPS3, sex, year of discharge, type of ICU, time of day, and calendar day were also included in the model and ICUID serves as a cluster variable

	HR	lower	upper	p-value
SAPS3 [per point]	1.05	1.05	1.06	< 0.0001
Hospital level: Reference: PRIM				
Secondary care hospital	1.03	0.91	1.17	0.664
Specialised care hospital	0.74	0.62	0.87	< 0.0001
Tertiary care hospital	0.91	0.74	1.12	0.366
Time of the day: Reference: 8:00-15:59				
16:00-23:59	0.90	0.86	0.94	< 0.0001
00:00-7:59	0.49	0.47	0.52	< 0.0001
Type of ICU: Surgical vs Medical				
	0.73	0.65	0.83	< 0.0001
Year of discharge: Reference: 2013				
2014	0.92	0.86	0.99	0.028
2015	0.88	0.79	0.98	0.016
2016	0.98	0.86	1.11	0.699
2017	0.97	0.87	1.08	0.571
2018	1.00	0.89	1.13	0.943
2019	0.93	0.82	1.05	0.255
2020	1.12	0.99	1.26	0.080
2021	1.13	0.99	1.28	0.066
2022	1.03	0.92	1.15	0.590
Current load based on current workload (TISS-28) & current caseload [%]: Reference: 21-30 & 76-100				
≤ 20 ; 76-100	0.84	0.70	1.02	0.072
31 to 40 ; 76-100	0.99	0.91	1.08	0.861
> 40 ; 76-100	0.92	0.80	1.07	0.273
21 to 30 ; ≤ 50	1.06	0.96	1.17	0.255
≤ 20 ; ≤ 50	0.93	0.79	1.09	0.363
31 to 40 ; ≤ 50	1.10	0.99	1.21	0.078
> 40 ; ≤ 50	0.98	0.82	1.17	0.835
21 to 30 ; 51-75	1.02	0.95	1.09	0.581
≤ 20 ; 51-75	0.97	0.81	1.16	0.729
31 to 40 ; 51-75	1.12	1.01	1.24	0.026
> 40 ; 51-75	1.07	0.91	1.25	0.438
21 to 30 ; > 100	1.06	0.96	1.17	0.270
≤ 20 ; > 100	0.96	0.74	1.24	0.747
31 to 40 ; > 100	1.05	0.92	1.20	0.450
> 40 ; > 100	1.04	0.79	1.36	0.792
Sex: Male vs. Female				
	0.91	0.89	0.93	< 0.0001
Non-working day vs. working day				
	0.89	0.86	0.91	< 0.0001

Figure S 1 Results of a Cox proportional hazards regression with ICU mortality as endpoint. The main variable of interest, an interaction between workload based on the TISS-28-Score and caseload based on bed occupancy was modelled as a time-dependent covariable and is depicted here. SAPS3, sex, year of discharge, type of ICU, time of day, and calendar day were also included in the model and ICUID serves as a cluster variable



Sensitivity Analysis: “Moving Median” Up to Three Days

Table S 2 Cox proportional hazards regression with ICU mortality as endpoint. The main variables of interest, workload based on median TISS-28-Score over up to 3 days and caseload based on median bed occupancy up to 3 days were modelled as time-dependent covariables. SAPS3, sex, year of discharge, hospital level, type of ICU, time of day, and calendar day were also included in the model and ICUID serves as a cluster variable.

	HR	lower	upper	p-value
SAPS3 [per point]	1.05	1.05	1.06	< 0.0001
Hospital level (Reference: Primary care hospital)				
Secondary care hospital	1.02	0.90	1.15	0.794
Specialised care hospital	0.73	0.62	0.87	< 0.0001
Tertiary care hospital	0.89	0.73	1.09	0.259
Time of day (Reference: 08:00-15:59)				
16:00-23:59	0.91	0.87	0.94	< 0.0001
00:00-07:59	0.50	0.47	0.52	< 0.0001
ICU type (Surgical vs. Medical)				
	0.73	0.64	0.83	< 0.0001
Year of discharge (Reference: 2013)				
2014	0.92	0.85	0.99	0.026
2015	0.87	0.79	0.97	0.013
2016	0.97	0.86	1.10	0.675
2017	0.97	0.87	1.08	0.551
2018	1.00	0.89	1.13	0.936
2019	0.93	0.82	1.06	0.259
2020	1.12	0.99	1.27	0.065
2021	1.12	0.99	1.27	0.072
2022	1.04	0.93	1.16	0.469
Moving median (3 days) of caseload (bed occupancy) [%]: Reference: 76-100				
≤ 50	1.01	0.95	1.07	0.810
51-75	1.03	0.98	1.08	0.262
> 100	1.09	0.99	1.19	0.069
Moving median (3 days) of workload of the others (TISS-28): (Reference: 21 to 30)				
≤ 20	0.90	0.78	1.04	0.149
31 to 40	1.05	0.97	1.14	0.219
> 40	1.01	0.89	1.15	0.893
Patient gender (Male vs. Female)				
	0.91	0.89	0.94	< 0.0001
Calendar day (Non-working day vs. working day)				
	0.89	0.86	0.92	< 0.0001

Sensitivity Analysis: ICU Identifier as Covariate

Table S 3 Cox proportional hazards regression with ICU mortality as endpoint. The main variables of interest, workload based on median TISS-28-Score of up to 3 days and caseload based on median bed occupancy of up to 3 days were modelled as time-dependent covariables. SAPS3, sex, year of discharge, time of day, and calendar day were also included in the model. ICUID serves as a covariate, but is not depicted.

	HR	lower	upper	p-value
SAPS3 score	1.06			< 0.0001
Time of the day (Reference: 8:00-15:59)				
16:00-23:59	0.90	0.88	0.92	< 0.0001
00:00-7:59	0.49	0.48	0.51	< 0.0001
Year of discharge (Reference: 2013)				
2014	0.92	0.88	0.97	0.002
2015	0.88	0.84	0.93	< 0.0001
2016	0.91	0.87	0.96	< 0.0001
2017	0.90	0.85	0.94	< 0.0001
2018	0.92	0.88	0.97	0.001
2019	0.90	0.86	0.95	< 0.0001
2020	1.03	0.98	1.08	0.186
2021	1.08	1.03	1.13	0.002
2022	1.00	0.95	1.06	0.883
Current ICU Caseload (bed occupancy) [%]: Reference: 76-100				
≤ 50	1.09	1.05	1.13	< 0.0001
51-75	1.08	1.05	1.10	< 0.0001
> 100	1.01	0.97	1.05	0.610
Patient gender (Male vs. Female)				
	0.90	0.88	0.92	< 0.0001
Current ICU workload (TISS-28): Reference: 21 to 30				
≤ 20	0.92	0.86	0.99	0.022
31 to 40	1.00	0.98	1.03	0.739
> 40	0.95	0.89	1.01	0.085
Calendar day (Non-working day vs. working day)				
	0.88	0.86	0.90	< 0.0001

Subgroup Analysis: Years 2013-2019

Table S 4 Cox proportional hazards regression with ICU mortality as endpoint. The main variables of interest, workload based on the TISS-28-Score and case-load based on bed occupancy were modelled as time-dependent covariables. SAPS3, sex, year of discharge, hospital level, type of ICU, time of day, and calendar day were also included in the model and ICUID serves as a cluster variable.

	HR	lower	upper	p-value
SAPS3 [per point]	1.05	1.05	1.06	< 0.0001
Hospital level (Reference: Primary care hospital)				
Secondary care hospital	1.06	0.93	1.21	0.412
Specialised care hospital	0.84	0.74	0.95	0.006
Tertiary care hospital	0.93	0.77	1.13	0.485
Time of day (Reference: 08:00-15:59)				
16:00-23:59	0.91	0.87	0.96	< 0.0001
00:00-07:59	0.51	0.48	0.54	< 0.0001
ICU type (Surgical vs. Medical)				
	0.74	0.65	0.85	< 0.0001
Year of discharge (Reference: 2013)				
2014	0.92	0.86	0.99	0.031
2015	0.88	0.79	0.98	0.017
2016	0.98	0.86	1.11	0.733
2017	0.97	0.87	1.08	0.599
2018	1.01	0.89	1.13	0.924
2019	0.93	0.82	1.05	0.240
Current ICU caseload (bed occupancy) [%] (Reference: 76 to 100)				
≤ 50	1.05	0.98	1.14	0.170
51-75	1.08	1.02	1.15	0.006
> 100	0.99	0.91	1.08	0.846
Patient gender (Male vs. Female)				
	0.91	0.88	0.94	< 0.0001
Current ICU workload (TISS-28) [points] (Reference: 21 to 30)				
≤ 20	0.87	0.76	1.00	0.050
31 to 40	1.02	0.94	1.11	0.632
> 40	0.93	0.81	1.06	0.279
Calendar day (Non-working day vs. working day)				
	0.89	0.86	0.92	< 0.0001

Subgroup Analysis: Years 2020-2022

Table S 5 Cox proportional hazards regression with ICU mortality as endpoint. The main variables of interest, workload based on the TISS-28-Score and case-load based on bed occupancy were modelled as time-dependent covariables. SAPS3, sex, year of discharge, hospital level, type of ICU, time of day, and calendar day were also included in the model and ICUID serves as a cluster variable.

	HR	lower	upper	p-value
SAPS3 [per point]	1.05	1.05	1.06	< 0.0001
Hospital level (Reference: Primary care hospital)				
Secondary care hospital	0.97	0.83	1.13	0.690
Specialised care hospital	0.61	0.45	0.82	0.001
Tertiary care hospital	0.87	0.66	1.15	0.336
Time of day (Reference: 08:00-15:59)				
16:00-23:59	0.88	0.83	0.93	< 0.0001
00:00-07:59	0.47	0.44	0.50	< 0.0001
ICU type (Surgical vs. Medical)				
	0.72	0.62	0.84	< 0.0001
Year of discharge: Reference: 2020				
2021	1.01	0.95	1.08	0.764
2022	0.93	0.85	1.03	0.157
Current ICU caseload (bed occupancy) [%] (Reference: 76 to 100)				
≤ 50	1.16	1.07	1.27	< 0.0001
51-75	1.14	1.08	1.21	< 0.0001
> 100	1.18	1.06	1.30	0.001
Patient gender (Male vs. Female)				
	0.91	0.88	0.95	< 0.0001
Current ICU workload (TISS-28) [points] (Reference: 21 to 30)				
≤ 20	0.91	0.77	1.07	0.262
31 to 40	1.04	0.95	1.14	0.409
> 40	1.01	0.84	1.20	0.952
Calendar day (Non-working day vs. working day)				
	0.88	0.84	0.92	< 0.0001

Sensitivity Analysis: Interaction Terms for Years with Caseload and Workload

Table S 6 Cox proportional hazards regression with ICU mortality as endpoint. The main variables of interest, workload based on the TISS-28-Score and caseload based on bed occupancy were modelled as time-dependent covariables. Interaction terms between years 2013-2019 and 2020-2022 with caseload and workload were also included. SAPS3, sex, year of discharge, type of ICU, time of day, and calendar day were also included in the model and ICUID serves as a cluster variable

	HR	lower	upper	p-value
SAPS3 [per point]	1.05	1.05	1.06	< 0.0001
Hospital level (Reference: Primary care hospital)				
Secondary care hospital	1.02	0.90	1.16	0.776
Specialised care hospital	0.72	0.61	0.86	< 0.0001
Tertiary care hospital	0.90	0.73	1.11	0.336
Time of day (Reference: 08:00-15:59)				
16:00-23:59	0.90	0.86	0.94	< 0.0001
00:00-7:59	0.49	0.47	0.52	< 0.0001
ICU type (Surgical vs. Medical)	0.73	0.64	0.83	< 0.0001
Years 2020 to 2022 vs. 2013 to 2019	1.09	0.98	1.20	0.098
Years 2013 to 2019 : Current ICU caseload (bed occupancy) [%] 76-100				
2020-2022 ; ≤ 50	1.08	0.97	1.21	0.176
2020-2022 ; 51-75	1.04	0.96	1.13	0.305
2020-2022 ; > 100	1.19	1.06	1.34	0.003
Current ICU caseload (bed occupancy) [%] (Reference: 76 to 100)				
≤ 50	1.05	0.98	1.14	0.183
51-75	1.09	1.02	1.15	0.006
> 100	0.99	0.90	1.09	0.863
Patient gender (Male vs. Female)	0.91	0.89	0.94	< 0.0001
Current ICU workload (TISS-28) [points] (Reference: 21 to 30)				
≤ 20	0.88	0.76	1.01	0.062
31 to 40	1.02	0.94	1.11	0.582
> 40	0.92	0.81	1.05	0.234
Current ICU workload (TISS-28) [points] 21 to 30 : Years 2013 to 2019				
≤ 20 ; 2020-2022	1.04	0.88	1.23	0.679
31 to 40 ; 2020-2022	1.01	0.93	1.11	0.757
>40 ; 2020-2022	1.09	0.91	1.32	0.335
Calendar day (Non-working day vs. working day)	0.89	0.86	0.92	< 0.0001

Subgroup Analysis: ICU Type “Surgical”

Table S 7 Cox proportional hazards regression with ICU mortality as endpoint. The main variables of interest, workload based on the TISS-28-Score and case-load based on bed occupancy were modelled as time-dependent covariables. SAPS3, sex, year of discharge, hospital level, time of day, and calendar day were also included in the model and ICUID serves as a cluster variable.

	HR	lower	upper	p-value
SAPS3 [per point]	1.06	1.06	1.06	< 0.0001
Hospital level (Reference: Primary care hospital)				
Secondary care hospital	1.05	0.91	1.21	0.479
Specialised care hospital	0.72	0.57	0.91	0.005
Tertiary care hospital	0.96	0.78	1.17	0.656
Time of day (Reference: 08:00-15:59)				
16:00-23:59	0.89	0.84	0.94	< 0.0001
00:00-07:59	0.46	0.43	0.50	< 0.0001
Year of discharge (Reference: 2013)				
2014	0.91	0.84	0.99	0.033
2015	0.92	0.84	1.01	0.066
2016	1.01	0.90	1.13	0.924
2017	0.95	0.84	1.07	0.402
2018	0.98	0.84	1.14	0.766
2019	0.90	0.76	1.07	0.231
2020	1.12	0.96	1.31	0.139
2021	1.12	0.95	1.33	0.190
2022	1.04	0.91	1.20	0.544
Current ICU caseload (bed occupancy) [%] (Reference: 76 to 100)				
≤ 50	1.10	1.02	1.19	0.012
51-75	1.09	1.04	1.13	< 0.0001
> 100	1.02	0.92	1.13	0.658
Patient gender (Male vs. Female)				
	0.90	0.88	0.93	< 0.0001
Current ICU workload (TISS-28) [points] (Reference: 21 to 30)				
≤ 20	0.99	0.86	1.13	0.828
31 to 40	0.99	0.93	1.06	0.837
> 40	0.96	0.83	1.11	0.571
Calendar day (Non-working day vs. working day)				
	0.89	0.85	0.94	< 0.0001

Subgroup Analysis: ICU Type “Medical”

Table S 8 Cox proportional hazards regression with ICU mortality as endpoint. The main variables of interest, workload based on the TISS-28-Score and case-load based on bed occupancy were modelled as time-dependent covariables. SAPS3, sex, year of discharge, hospital level, time of day, and calendar day were also included in the model and ICUID serves as a cluster variable.

	HR	lower	upper	p-value
SAPS3 [per point]	1.05	1.04	1.05	< 0.0001
Hospital level (Reference: Primary care hospital)				
Secondary care hospital	1.03	0.83	1.27	0.818
Specialised care hospital	0.78	0.65	0.93	0.006
Tertiary care hospital	0.90	0.61	1.32	0.596
Time of day (Reference: 08:00-15:59)				
16:00-23:59	0.91	0.86	0.97	0.006
00:00-07:59	0.53	0.50	0.57	< 0.0001
Year of discharge (Reference: 2013)				
2014	0.93	0.83	1.04	0.210
2015	0.84	0.70	1.00	0.055
2016	0.94	0.76	1.16	0.569
2017	0.99	0.84	1.16	0.867
2018	1.02	0.86	1.22	0.800
2019	0.96	0.80	1.15	0.648
2020	1.10	0.92	1.31	0.320
2021	1.11	0.92	1.33	0.270
2022	1.01	0.85	1.20	0.886
Current ICU caseload (bed occupancy) [%] (Reference: 76 to 100)				
≤ 50	1.05	0.96	1.16	0.292
51-75	1.11	1.02	1.20	0.011
> 100	1.10	0.99	1.23	0.090
Patient gender (Male vs. Female)	0.92	0.89	0.96	< 0.0001
Current ICU workload (TISS-28) [points] (Reference: 21 to 30)				
≤ 20	0.80	0.68	0.95	0.010
31 to 40	1.09	0.96	1.23	0.190
> 40	0.94	0.79	1.12	0.497
Calendar day (Non-working day vs. working day)	0.87	0.84	0.91	< 0.0001

Sensitivity Analysis: Interaction Terms for ICU Type with Caseload and Workload

Table S 9 Cox proportional hazards regression with ICU mortality as endpoint. The main variables of interest, workload based on the TISS-28-Score and caseload based on bed occupancy were modelled as time-dependent covariables. Interaction terms between ICU Types with caseload and workload were also included. SAPS3, sex, year of discharge, type of ICU, time of day, and calendar day were also included in the model and ICUID serves as a cluster variable

	HR	lower	upper	p-value
SAPS3 [per point]	1.05	1.05	1.06	< 0.0001
Hospital level (Reference: Primary care hospital)				
Secondary care hospital	1.03	0.91	1.17	0.672
Specialised care hospital	0.73	0.62	0.86	< 0.0001
Tertiary care hospital	0.91	0.74	1.12	0.356
Time of day (Reference: 08:00-15:59)				
16:00-23:59	0.90	0.86	0.94	< 0.0001
00:00-7:59	0.49	0.47	0.52	< 0.0001
ICU type (Surgical vs. Medical)	0.74	0.63	0.88	< 0.0001
ICU Type Medical : Current ICU caseload (bed occupancy) [%] 76-100				
Surgical ; ≤ 50	1.05	0.92	1.20	0.472
Surgical ; 51-75	0.98	0.90	1.08	0.705
Surgical ; > 100	0.88	0.75	1.04	0.140
Year of discharge (Reference: 2013)				
2014	0.92	0.86	0.99	0.031
2015	0.88	0.79	0.98	0.016
2016	0.98	0.86	1.11	0.724
2017	0.97	0.87	1.08	0.579
2018	1.00	0.89	1.13	0.946
2019	0.93	0.82	1.06	0.260
2020	1.12	0.99	1.26	0.071
2021	1.13	1.00	1.28	0.060
2022	1.03	0.92	1.16	0.563
Current ICU caseload (bed occupancy) [%] (Reference: 76 to 100)				
≤ 50	1.05	0.95	1.17	0.311
51-75	1.11	1.02	1.20	0.011
> 100	1.15	1.01	1.30	0.031
Patient gender (Male vs. Female)	0.91	0.89	0.93	< 0.0001
Current ICU workload (TISS-28) [points] (Reference: 21 to 30)				
≤ 20	0.85	0.72	1.00	0.048
31 to 40	1.04	0.92	1.17	0.541
> 40	0.89	0.74	1.08	0.239
Current ICU workload (TISS-28) (20,30) : ICU Type Medical				
≤ 20 ; Surgical	1.12	0.91	1.39	0.273
31 to 40 ; Surgical	0.99	0.86	1.13	0.837
> 40 ; Surgical	1.11	0.88	1.41	0.366
Calendar day (Non-working day vs. working day)	0.89	0.86	0.91	< 0.0001

Subgroup Analysis: Hospital Level “Primary Care Hospital”

Table S 10 Cox proportional hazards regression with ICU mortality as endpoint. The main variables of interest, workload based on the TISS-28-Score and caseload based on bed occupancy were modelled as time-dependent covariables. SAPS3, sex, year of discharge, type of ICU, time of day, and calendar day were also included in the model and ICUID serves as a cluster variable.

	HR	lower	upper	p-value
SAPS3 [per point]	1.06	1.06	1.06	< 0.0001
Time of day (Reference: 08:00-15:59)				
16:00-23:59	0.92	0.87	0.97	0.002
00:00-07:59	0.60	0.53	0.69	< 0.0001
ICU type (Surgical vs. Medical)				
	0.65	0.53	0.79	< 0.0001
Year of discharge (Reference: 2013)				
2014	0.92	0.75	1.14	0.455
2015	1.02	0.80	1.32	0.847
2016	1.06	0.84	1.34	0.638
2017	1.11	0.89	1.39	0.354
2018	1.13	0.92	1.39	0.240
2019	0.99	0.80	1.21	0.903
2020	1.26	1.00	1.58	0.052
2021	1.35	1.08	1.70	0.009
2022	1.31	1.05	1.64	0.019
Current ICU caseload (bed occupancy) [%] (Reference: 76 to 100)				
≤ 50	1.06	0.99	1.14	0.074
51-75	1.03	0.97	1.10	0.334
> 100	1.08	0.97	1.20	0.160
Patient gender (Male vs. Female)				
	0.98	0.92	1.04	0.494
Current ICU workload (TISS-28) [points] (Reference: 21 to 30)				
≤ 20	0.93	0.81	1.06	0.250
31 to 40	1.09	1.01	1.19	0.035
> 40	1.28	1.02	1.60	0.033
Calendar day (Non-working day vs. working day)				
	0.96	0.88	1.04	0.273

Subgroup Analysis: Hospital Level “Secondary Care Hospital”

Table S 11 Cox proportional hazards regression with ICU mortality as endpoint. The main variables of interest, workload based on the TISS-28-Score and caseload based on bed occupancy were modelled as time-dependent covariables. SAPS3, sex, year of discharge, type of ICU, time of day, and calendar day were also included in the model and ICUID serves as a cluster variable.

	HR	lower	upper	p-value
SAPS3 [per point]	1.05	1.05	1.06	< 0.0001
Time of day (Reference: 08:00-15:59)				
16:00-23:59	0.91	0.86	0.97	0.004
00:00-07:59	0.48	0.46	0.51	< 0.0001
ICU type (Surgical vs. Medical)				
	0.75	0.65	0.88	< 0.0001
Year of discharge (Reference: 2013)				
2014	0.96	0.88	1.04	0.324
2015	0.87	0.76	0.99	0.042
2016	0.93	0.79	1.10	0.394
2017	0.92	0.81	1.05	0.203
2018	0.96	0.83	1.12	0.622
2019	0.92	0.79	1.08	0.313
2020	1.05	0.91	1.20	0.512
2021	1.12	0.96	1.32	0.149
2022	1.03	0.90	1.18	0.683
Current ICU caseload (bed occupancy) [%] (Reference: 76 to 100)				
≤ 50	1.09	1.00	1.19	0.056
51-75	1.13	1.06	1.20	< 0.0001
> 100	1.05	0.96	1.15	0.300
Patient gender (Male vs. Female)				
	0.90	0.87	0.92	< 0.0001
Current ICU workload (TISS-28) [points] (Reference: 21 to 30)				
≤ 20	0.75	0.54	1.03	0.073
31 to 40	0.98	0.89	1.08	0.685
> 40	0.90	0.78	1.04	0.143
Calendar day (Non-working day vs. working day)				
	0.88	0.84	0.91	< 0.0001

Subgroup Analysis: Hospital Level “Specialised Care Hospital”

Table S 12 Cox proportional hazards regression with ICU mortality as endpoint. The main variables of interest, workload based on the TISS-28-Score and caseload based on bed occupancy were modelled as time-dependent covariables. SAPS3, sex, year of discharge, type of ICU, time of day, and calendar day were also included in the model and ICUID serves as a cluster variable.

	HR	lower	upper	p-value
SAPS3 [per point]	1.06	1.05	1.06	< 0.0001
Time of day (Reference: 08:00-15:59)				
16:00-23:59	1.01	0.91	1.11	0.919
00:00-07:59	0.35	0.25	0.48	< 0.0001
ICU type (Surgical vs. Medical)	0.71	0.56	0.90	0.005
Year of discharge (Reference: 2013)				
2014	1.09	0.95	1.25	0.239
2015	0.83	0.66	1.05	0.120
2016	1.03	0.90	1.18	0.703
2017	0.99	0.85	1.16	0.913
2018	0.98	0.83	1.16	0.842
2019	0.92	0.60	1.39	0.680
2020	0.89	0.41	1.93	0.763
2021	0.80	0.55	1.17	0.245
2022	0.99	0.75	1.31	0.948
Current ICU caseload (bed occupancy) [%] (Reference: 76 to 100)				
≤ 50	1.01	0.82	1.26	0.911
51-75	1.00	0.85	1.19	0.964
> 100	1.03	0.77	1.38	0.855
Patient gender (Male vs. Female)	0.84	0.78	0.90	< 0.0001
Current ICU workload (TISS-28) [points] (Reference: 21 to 30)				
≤ 20	0.95	0.75	1.19	0.626
31 to 40	0.84	0.68	1.04	0.105
> 40	0.78	0.56	1.08	0.131
Calendar day (Non-working day vs. working day)	0.82	0.70	0.97	0.017

Subgroup Analysis: Hospital Level “Tertiary Care Hospital”

Table S 13 Cox proportional hazards regression with ICU mortality as endpoint. The main variables of interest, workload based on the TISS-28-Score and caseload based on bed occupancy were modelled as time-dependent covariables. SAPS3, sex, year of discharge, type of ICU, time of day, and calendar day were also included in the model and ICUID serves as a cluster variable.

	HR	lower	upper	p-value
SAPS3 [per point]	1.05	1.04	1.06	< 0.0001
Time of day (Reference: 08:00-15:59)				
16:00-23:59	0.78	0.70	0.86	< 0.0001
00:00-07:59	0.45	0.39	0.52	< 0.0001
ICU type (Surgical vs. Medical)	0.69	0.42	1.13	0.140
Year of discharge (Reference: 2013)				
2014	0.77	0.63	0.93	0.006
2015	0.84	0.64	1.08	0.176
2016	1.18	0.82	1.71	0.366
2017	1.11	0.77	1.62	0.572
2018	1.16	0.77	1.76	0.471
2019	0.98	0.58	1.64	0.932
2020	1.45	0.97	2.18	0.072
2021	1.24	0.80	1.91	0.336
2022	0.75	0.55	1.03	0.073
Current ICU caseload (bed occupancy) [%] (Reference: 76 to 100)				
≤ 50	1.11	0.91	1.35	0.310
51-75	1.12	1.03	1.21	0.006
> 100	1.05	0.85	1.29	0.678
Patient gender (Male vs. Female)	0.88	0.83	0.94	< 0.0001
Current ICU workload (TISS-28) [points] (Reference: 21 to 30)				
≤ 20	1.12	0.79	1.59	0.519
31 to 40	1.16	0.87	1.54	0.307
> 40	1.04	0.73	1.48	0.817
Calendar day (Non-working day vs. working day)	0.84	0.78	0.90	< 0.0001

Sensitivity Analysis: Interaction Terms for Hospital Levels with Caseload and Workload

Table S 14 Cox proportional hazards regression with ICU mortality as endpoint. The main variables of interest, workload based on the TISS-28-Score and caseload based on bed occupancy were modelled as time-dependent covariables. Interaction terms between Hospital Levels with caseload and workload were also included. SAPS3, sex, year of discharge, type of ICU, time of day, and calendar day were also included in the model and ICUID serves as a cluster variable

	HR	lower	upper	p-value
SAPS3 [per point]	1.05	1.05	1.06	< 0.0001
Time of day (Reference: 08:00-15:59)				
Secondary care hospital	1.11	0.93	1.32	0.231
Specialised care hospital	0.92	0.75	1.13	0.425
Tertiary care hospital	0.88	0.71	1.09	0.251
Hospital level: Primary care hospital & Current ICU Caseload (bed occupancy) [%]: 76-100				
Secondary care hospital ; ≤ 50	0.99	0.88	1.11	0.808
Specialised care hospital ; ≤ 50	0.89	0.66	1.21	0.460
Tertiary care hospital ; ≤ 50	1.02	0.83	1.25	0.835
Secondary care hospital ; 51-75	1.08	0.99	1.17	0.101
Specialised care hospital ; 51-75	0.96	0.78	1.17	0.660
Tertiary care hospital ; 51-75	1.05	0.95	1.16	0.339
Secondary care hospital ; > 100	0.99	0.86	1.14	0.907
Specialised care hospital ; > 100	0.89	0.63	1.24	0.481
Tertiary care hospital ; > 100	0.96	0.73	1.26	0.753
Time of day (Reference: 08:00-15:59)				
16:00-23:59	0.90	0.86	0.94	< 0.0001
00:00-7:59	0.49	0.47	0.52	< 0.0001
ICU type (Surgical vs. Medical)				
	0.73	0.65	0.83	< 0.0001
Year of discharge: Reference: 2013				
2014	0.92	0.86	0.99	0.027
2015	0.88	0.79	0.98	0.017
2016	0.98	0.86	1.11	0.727
2017	0.97	0.88	1.08	0.621
2018	1.01	0.90	1.13	0.890
2019	0.93	0.82	1.06	0.269
2020	1.12	1.00	1.27	0.058
2021	1.14	1.00	1.29	0.046
2022	1.04	0.93	1.16	0.515
Current ICU caseload (bed occupancy) [%] (Reference: 76 to 100)				
≤ 50	1.09	1.01	1.18	0.020
51-75	1.04	0.98	1.11	0.194
> 100	1.07	0.97	1.19	0.185
Patient gender (Male vs. Female)				
	0.91	0.89	0.93	< 0.0001
Current ICU workload (TISS-28) [points] (Reference: 21 to 30)				
≤ 20	0.93	0.82	1.06	0.260
31 to 40	1.13	1.04	1.22	0.006
> 40	1.31	1.05	1.63	0.018

	HR	lower	upper	p-value
Hospital level: Primary Care Hospital & Current ICU Workload (TISS-28): 21 to 30				
Secondary care hospital ; ≤ 20	0.82	0.58	1.14	0.232
Secondary care hospital ; 31 to 40	0.86	0.76	0.99	0.031
Secondary care hospital ; >40	0.68	0.52	0.89	0.005
Specialised care hospital ; ≤ 20	1.00	0.76	1.32	0.976
Specialised care hospital ; 31 to 40	0.75	0.61	0.92	0.006
Specialised care hospital ; > 40	0.62	0.44	0.86	0.005
Tertiary care hospital ; ≤ 20	1.26	0.91	1.77	0.168
Tertiary care hospital ; 31 to 40	1.01	0.83	1.23	0.917
Tertiary care hospital ; > 40	0.74	0.54	1.03	0.071
Calendar day (Non-working day vs. working day)	0.89	0.86	0.91	< 0.0001