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Morning Brief : Scientific Review

29 May 2020

The purpose of the Morning Brief is to **summarize** and present key information, research articles and other relevant publications pertaining to critical care and COVID-19. We aim to prioritise information, articles and publications released in the preceding 24-48hours.

STELLENBOSCH UNIVERSITY PULMONOLOGY

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Content of the brief

- Global Statistics
- South African Statistics
- Topics:
  - Respiratory physiology

Source: https://coronavirus.jhu.edu/map.html

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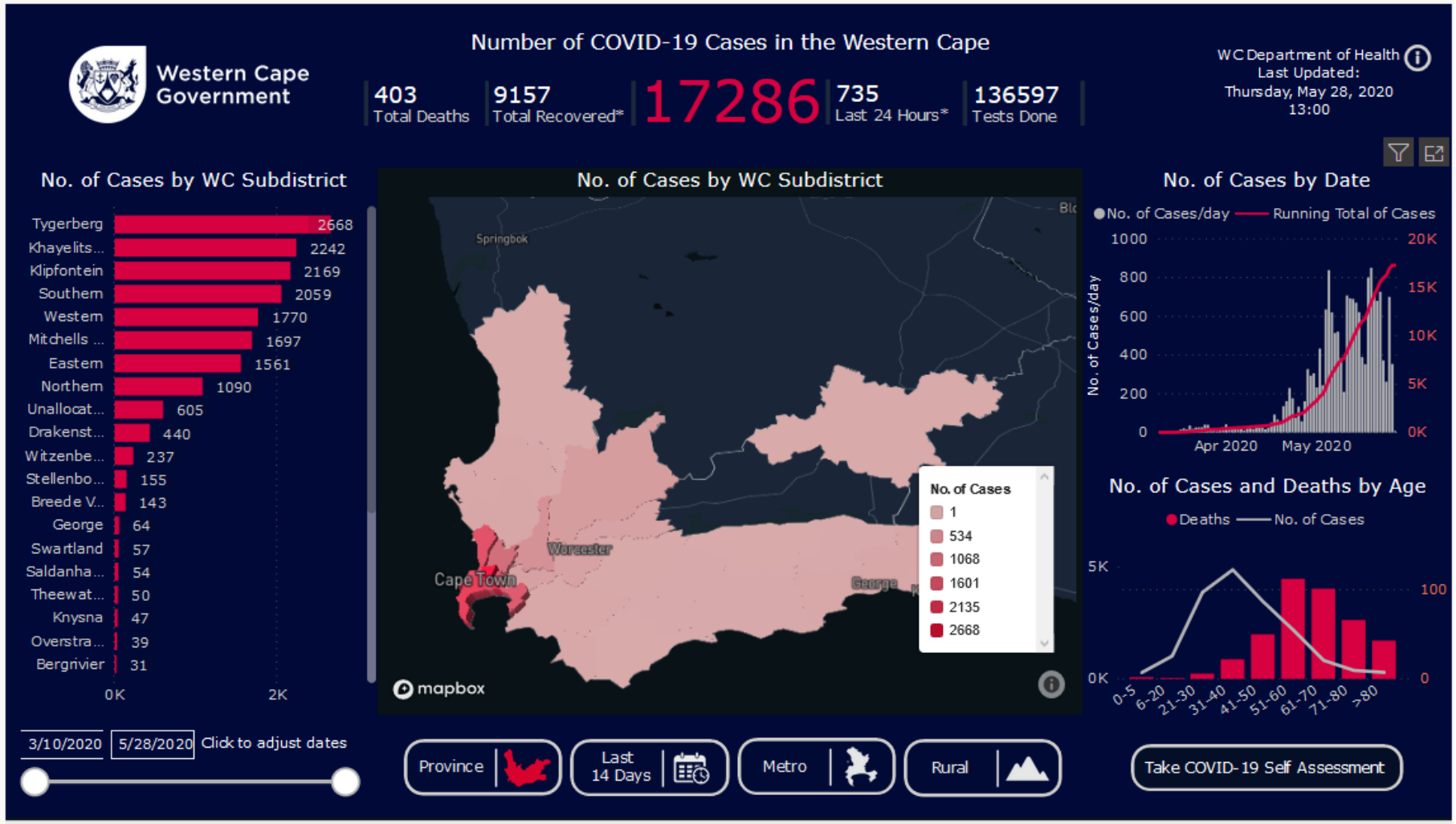
South African Statistics



Sources: https://sacoronavirus.co.za

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Articles of Interest

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Lung Recruitability in COVID-19–associated Acute Respiratory Distress Syndrome: A Single-Center Observational Study

Online 23 March 2020

12 patients mechanically ventilated in an ICU in Wuhan, during the week of 18 February 2020.
7 ptients received at least one session of proning; 3 received both proning and ECMO
Met Berlin definition for ARDS

Measured recruitability by the recruitment-to-inflation ratio (RI)

10 of 12 patients were poorly recruitable by this measurement
those who were proned had better recruitability than those who were not (p=0.02)

Pan C, Chen L, Lu C, Zhang W, Xia JA, Sklar MC, et al. Lung Recruitability in SARS-CoV-2 associated acute respiratory distress syndrome: a single-center, observational study. Am J Respir Crit Care Med. 2020.

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Low compliance
High driving pressures
Poor recruitability
But some improvement with change in position

Table 1. Worst Gas Exchange and Respiratory Mechanics during Observation Days

Patient No.	NIV/NHF Days*	IMV Days†	ARF Days‡	$F_{I_{O_2}}$	$Pa_{O_2}/F_{I_{O_2}}$ (*mm Hg*)	Pa_{CO_2} (*mm Hg*)	Pplat (*cm H_2O*)	ΔP§ (*cm H_2O*)	Crs‖ (*ml/cm H_2O*)	Prone¶	ECMO	Outcome
1	5	3	8	0.55	163.6	62	24	14	30	No	No	Dead
2	0	2	2	0.45	165	54	32	28	12	No	No	Alive
3	0	21	21	0.5	180	74	29	14	32	No	No	Alive
4	10	0	10	0.5	136	97	25	15	24	No	No	Dead
5	4	0	4	0.5	178	54	25	17	21	No	No	Alive
6	8	4	12	0.7	55	64	23	18	18	Yes	No	Alive
7	0	1	1	0.65	106	70	48**	43**	10	Yes	No	Dead
8	5	0	5	0.7	209	>115	27	23	17	Yes	No	Alive
9	5	4	9	0.55	128	70	22	12	30	Yes	No	Alive
10	4	8	12	1.0	90	69	35	25	9	Yes	Yes	Alive
11	2	1	3	1.0	57	49	35	25	18	Yes	Yes	Alive
12	7	9	16	1.0	68	58	38	30	14	Yes	Yes	Alive
Mean	4	4	9	0.7	128	66	30	22	20	—	—	—
SD	3	6	6	0.21	53	13	8	9	8	—	—	—
Total	—	—	—	—	—	—	—	—	—	7Y/5N	3Y/9N	9A/3D

Definition of abbreviations: ARF = acute respiratory failure; Crs = respiratory system compliance; ΔP = driving pressure; ECMO = extracorporeal membrane oxygenation; IMV = invasive mechanical ventilation; NHF = nasal high flow; NIV = noninvasive ventilation; PEEP = positive end-expiratory pressure; Pplat = plateau pressure.

*Days receiving NIV or NHF before intubation.

†Days on IMV before enrollment in the study.

‡ARF days were defined as days from the onset of respiratory failure with any form of ventilatory support until enrollment in the study.

§Driving pressure was the difference between the plateau pressure and total PEEP, measured at 6 ml/kg of V_T.

‖Crs was calculated as V_T divided by the difference between the plateau pressure and total PEEP.

¶Received at least one session of prone positioning.

**Suspected tension pneumothorax.

Pan C, Chen L, Lu C, Zhang W, Xia JA, Sklar MC, et al. Lung Recruitability in SARS-CoV-2 associated acute respiratory distress syndrome: a single-center, observational study. Am J Respir Crit Care Med. 2020.

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Respiratory Pathophysiology of Mechanically Ventilated Patients with COVID-19: A Cohort Study

David R. Ziehr*, MD[1,2], Jehan Alladina*, MD[1], Camille R. Petri, MD[1,2], Jason H. Maley, MD[1,2], Ari Moskowitz, MD[2], Benjamin D. Medoff, MD[1], Kathryn A. Hibbert, MD[1], B. Taylor Thompson, MD[1], C. Corey Hardin, MD, PhD[1]

Online 29 April 2020

All COVID-19 mechanically ventilated patients at Mass Gen and Beth Israel during the period 11 to 30 March 2020.
Various methods of titrating PEEP (oesophageal manometry, ARDSnetwork table, best compliance); Vte 6ml/kg
Clinical management at the discretion of the treating physician.

66 patients, median age 58 years (23 – 87), 43 (65%) male, 8 (12%) had preexisting pulmonary disease, 22 (34%) were current or ex-smokers, median BMI 30 (27 – 35).

56 (85%) met Berlin criteria for ARDS on ICU admission

Ziehr et al. AJRCCM online 29 April 2020. 10.1164/rccm.202004-1163LE

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Median patient follow-up (days, range)	34 (30-49)	66/66
Successful extubation	62.1%	41/66
Median duration of mechanical ventilation (days, IQR)*	16.0 (10.0-21.0)	
Tracheostomy	21.2%	14/66
Median time to tracheostomy (days, IQR)	22.5 (18.0-27.0)	
Thrombotic event	22.7%	15/66
ICU discharge	75.8%	50/66
Median ICU length of stay (days, IQR)**	17.5 (13.0-25.0)	
Death	16.7%	11/66

Abbreviations: interquartile range (IQR), angiotensin-converting enzyme

ICU Therapies		
High-flow nasal cannula	2%	(1/66)
Non-invasive positive pressure ventilation	2%	(1/66)
Invasive mechanical ventilation	100%	(66/66)
Invasive mechanical ventilation, median HD initiated (IQR)	1 (1-2)	
Prone position	47%	(31/66)
Prone position, median HD initiated (IQR)	3 (2-5)	
Neuromuscular blockade	42%	(28/66)
Neuromuscular blockade, median HD initiated (IQR)	2 (1-2)	
Inhaled pulmonary vasodilator	27%	(18/66)
Inhaled pulmonary vasodilator, median HD initiated (IQR)	3 (1-3)	
Extracorporeal membrane oxygenation	5%	(3/66)
Extracorporeal membrane oxygenation, median HD initiated (range)	2 (2-5)	
Renal replacement therapy	20%	(13/66)
Renal replacement therapy, median HD initiated (IQR)	9 (5-13)	
Vasopressors	95%	(63/66)

Ziehr et al. AJRCCM online 29 April 2020. 10.1164/rccm.202004-1163LE

Bilateral infiltrates on chest x-ray	97 %	6)
PaO_2:FiO_2	182 (135-245)	(65/66)
Estimated physiological dead space fraction	0.45 (0.38-0.58)	(65/66)
Ventilatory ratio	1.25 (1.06-1.44)	(65/66)
Ventilator parameters on intubation		
Positive end-expiratory pressure, cm H_2O	10 (8-12)	(66/66)
Plateau pressure, cm H_2O	21 (19-26)	(48/66)
Driving pressure, cm H_2O	11 (9-12)	(48/66)
Static compliance, ml per cm H_2O	35 (30-43)	(48/66)
Resistance, cm H_2O per liters per second	5 (4-7)	(48/66)

Vd/Vt normal <0.3

Ventilatory ratio = [minute **ventilation** (ml/min) × Pa_{CO2} (mm Hg)]/(predicted body weight × 100 × 37.5) = 1 ideally

Ziehr et al. AJRCCM online 29 April 2020. 10.1164/rccm.202004-1163LE

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"Patients with COVID-19 respiratory failure in our series exhibit similar gas exchange, respiratory system mechanics, and response to prone ventilation as prior large cohorts of patients with ARDS. While further study is needed to elucidate the biology and unique features of this disease, our findings **provide a pathophysiologic justification for the use of established ARDS therapies**, including low tidal volume and early prone ventilation, for COVID-19 respiratory failure"

Ziehr et al. AJRCCM online 29 April 2020. 10.1164/rccm.202004-1163LE

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RESEARCH LETTER Open Access

Advanced respiratory monitoring in COVID-19 patients: use less PEEP!

Lisanne Roesthuis*, Maarten van den Berg and Hans van der Hoeven

Online 15 May 2020

14 patients with COVID-19 pneumonia from Radboud University Nijmegen, NL between 19 March and 2 April.
8 male, mean age 67, BMI 28.
Standardised approach to PEEP: after intubation, immediately prone positioning for at least 3 days, using the lowest possible PEEP to obtain adequate oxygenation with FiO2 of 50%..

They were interested in the change in respiratory mechanics with different PEEP levels

Roesthuis L, van den Berg M, van der Hoeven H. Critical Care. 2020: 24(230). https://doi.org/10.1186/s13054-020-02953-z

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Note prone positioning in all but 3 of the patients

Table 1 Respiratory mechanics

Patient no.	MV days	FiO_2	PaO_2/FiO_2 (mmHg)	$PaCO_2$ (mmHg)	$P_{plateau}$ (cmH_2O)	P_{drive} (cmH_2O)	$P_{L,e-i}$	$P_{L,drive}$ (cmH_2O)	C_{rs} (mL/cmH_2O)	C_L (mL/cmH_2O)	Enghoff (%)	Bohr (%)	Position
1	7	0.50	156	87	22	8	9	5	55	82	–	–	P
2	2	0.45	208	56	24	7	17	18	54	79	–	–	S
	3	0.55	124	57	26	8	–	–	48	–	66	47	S
3	0	0.50	228	44	23	9	17	16	47	62	66	56	S
4	1	0.60	123	44	–	–	–	–	–	–	71	58	P
5	0	0.40	214	48	23	13	9	9	40	54	55	42	P
	1	0.40	278	44	18	10	7	8	50	64	48	38	P
6	1	0.45	143	49	–	–	–	–	–	–	63	40	P
7	1	0.55	183	55	23	14	11	10	36	50	60	42	P
8	1	0.40	176	52	16	8	7	5	56	95	64	51	P
9	0	0.95	98	61	29	12	14	9	38	50	–	–	P
	5	0.60	143	89	27	12	14	9	35	45	72	60	P
10	1	0.80	125	53	21	10	11	7	36	49	66	52	P
11	2	0.55	147	49	21	12	11	10	40	51	69	47	P
12	2	0.75	113	59	25	11	11	8	26	37	69	57	P
	3	0.65	111	47	26	12	11	8	27	40	71	60	P
13	1	0.50	192	67	24	12	10	7	47	76	82	74	P
14	6	0.70	150	62	28	15	15	11	31	43	65	52	P

C_{rs} compliance of respiratory system, C_L lung compliance, *MV days* days of mechanical ventilation at the time of measurement, $P_{L,e-i}$ end-inspiratory transpulmonary pressure, $P_{L,drive}$ transpulmonary driving pressure, *P* prone position, *S* supine position

Roesthuis L, van den Berg M, van der Hoeven H. Critical Care. 2020: 24(230). https://doi.org/10.1186/s13054-020-02953-z

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Compliance of the respiratory system was low (42) – both lung compliance (61) and chest wall compliance were low (latter likely due to prone positioning of most of the patients)

BUT compared to traditional ARDS the compliance of the lungs was much higher than expected

So, end inspiratory transpulmonary pressures were low (12)

Measured dead space ventilation and gas exchange was impaired.

Changes with PEEP:

Lung compliance DECREASED if PEEP INCREASED in 8 of 9 patients where the PEEP was adjusted
Dead space mostly increased as PEEP was increased
This implies that the patients were not 'recruitable'
BUT they note that all patients responded well to proning. (?redistribution of blood flow?)

Roesthuis L, van den Berg M, van der Hoeven H. Critical Care. 2020: 24(230). https://doi.org/10.1186/s13054-020-02953-z

This summary was prepared by Dr Jane Shaw as part of the daily brief to the TBH ICU team.