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The Ventilator

In March 2020, a reality for much of the world—too few ventilators or none at all—came home as a major emergency to the United States. Physicists looking for dark matter pivoted to ventilator design. Hackers stayed up all night innovating on the bicycle pump. Elon Musk tweeted "Ventilators are not difficult" and sent 1,255 Chinese BiPAP machines (notably *not* a life support ventilator) to California. Ethicists held forth on lifeboats. The curator of Harvard's Warren Anatomical Museum, not often consulted on medical futures, received emails: Could the Iron Lungs that saved children in the polio epidemics of the early twentieth century help us now?[1]

As primal fears of suffocation became a nightmarish reality, time itself changed. For some, it slowed down ("March 2020 was quite a decade!"); for others, it lost meaning ("Monday isn't real"). Supply chains had broken and so had our position at the center of time. Was it this peculiar timelessness that made the possibility of past solutions for urgent problems seem possible? In crumpled "Corona Time," as distant moments stretched and met, could the Iron Lung belong to both past and future? Folded pandemic time did not necessarily mean reinstating a benighted past. Instead, what if seeing distant points in time as *adjacent* could reveal otherwise invisible and genuinely novel solutions?[2]

Experts were consulted and quickly confirmed: no. The Iron Lung was developed to treat polio's neurological interference with the movements of breathing, referred to as *ventilation*. But COVID-19 destroyed lung tissue,

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1. Dominic Hall, e-mail correspondence with author, 19 Mar 2020.

2. On historical time as folded, see Michel Serres, *Conversations on Science, Culture, and Time* (Ann Arbor: University of Michigan Press, 1990).

Historical Studies in the Natural Sciences, Vol. 51, Number 1, pps. 165–168. ISSN 1939-1811, electronic ISSN 1939-182X. DOI: https://doi.org/10.1525/hsns.2021.51.1.165.

interfering with *gas exchange*, the delicate dissolving of a gas in liquid that depends on an impossibly tiny and fragile one-micron-wide gap between lung and blood. Even in the best academic medical centers, with the most advanced ventilators, treating lung damage like that of COVID-19 is hard and often hopeless.[3] The experts said: Only state of the art ventilators forcing precisely calculated gases through a tube. . . . would be of any use. Direct delivery of air into unbreathing bodies had become natural, obvious, the only solution. Today's ventilators were timeless now, present and future enshrined in the machine. Iron Lungs would be left in the museum.

But breathing was not always a matter of pushing oxygen into the body. In 1667, before a meeting of the Royal Society, Robert Hooke asked if the "beating of the lungs" or "springiness" in the air gave respiration its "true use." Before breathing was chemistry, Hooke wanted to know: could a creature live if it did not *move* as it breathed? It was warmth, motion, and expressiveness that were characteristic of vibrant creatures, not occult interactions between yet-to-be-identified substances. The next three centuries saw resuscitation and, eventually, ventilator design centered not on pushing air into the lungs but rather on warming or moving the body. Though technically feasible early in the twentieth century, positive pressure ventilators of the kind on which today's medicine depends were not in common use until the end of the 1950s.[4] It had been simply unimaginable that forcing air into the body was a complete representation of, much less a safe proxy for, breathing.

Positive pressure finally became thinkable when WWII presented an urgent need for altitude supremacy. Airplane cabins could not yet be pressurized, and the day after the US entered the war a team was assembled to learn the physiological viability of forcing air into pilots' lungs instead. The team's graphical representations of breathing as it mediated the subtle and ever-changing boundary between organism and environment became an ideal object for postwar control engineering and cybernetics. The resulting mathematical models of breathing control were almost ready-made for emerging positive pressure ventilators. In early experimental psychology, on the other hand breathing traces had been probed for all kinds of mental content, from attention and aesthetic experience to the unconscious itself. But in spite of

3. See Sujith V. Cherian et al., "Salvage Therapies for Refractory Hypoxemia in ARDS," *Respiratory Medicine* 141 (Aug 2018): 150–58.

4. See Adrian A. Matioc, "An Anesthesiologist's Perspective on the History of Basic Airway Management: The 'Progressive' Era, 1904 to 1960," *Anesthesiology* 128, no. 2 (Feb 2018): 254–71.

these explorations, from the postwar period through at least the early 1980s positive pressure ventilators were simple, treating the lungs as an unmoving box and breath as unfolding with an unchanging rhythm.[5]

When such ventilators replaced the Iron Lung, they also displaced the tradition of seeing breath in the body's surfaces, movements, and warmth: the breather in an Iron Lung could be expressive and wakeful. The device was a human-sized version of one that the inventor's brother, a physiologist, had been using to measure if and how much cats breathe through their skin. Transit across all body surfaces, skin breathing, was a persistent (if now utterly strange) remnant of presocratic and Galenic theory. The device enclosed a creature's entire body, save the head, which protruded through an air-tight cuff into the room air. Within its own miniature atmosphere, gases were measured and adjusted not inside the body but surrounding it, recreating the "natural" movements of breathing. When pressurized, the chamber compressed the body causing an exhalation, with inhalation following as air was pulled off the body. Iron Lungs expanded the skin boundary outward, while positive pressure ventilators would burrow within it.[6]

The breathing these devices produced could not have been more different. Calibration protocols embodied competing ideas not just of breathing, but of being. To treat polio emergencies, the Iron Lung was calibrated for sick children by tracing the chest movements of a healthy breather and simply recreating those patterns for an unhealthy one. Metabolic rate measurements, the respiration of the cell, a common early twentieth-century analog for "warmth," was another bedside monitor of breathing sufficiency. Mostly simply, breaths were increased in volume and frequency until a child could speak well enough to "ask for ice cream."[7]

Today, heavily sedated to dull the sense of continual suffocation, with an air tube down the throat and between vocal folds, mechanically ventilated patients don't speak.[8] There is evidence that many of those who survive a stay in intensive care thanks to mechanical ventilation will face another life-

5. See W. F. Fincham and F. T. Tehrani, "A Mathematical Model of the Human Respiratory System," *Journal of Biomedical Engineering* 5, no. 2 (Apr 1983): 125–33.

6. See Oriana Walker, *The Breathing Self: Toward a History of Respiration* (PhD dissertation, Harvard University, 2016).

7. See Philip Drinker and Louis A. Shaw, "An Apparatus for the Prolonged Administration of Artificial Respiration," *Journal of Clinical Investigation* 7, no. 2 (Jun 1929): 229–47, on 238.

8. See Veronika Karlsson, "The Lived Experiences of Adult Intensive Care Patients Who Were Conscious during Mechanical Ventilation: A Phenomenological-Hermeneutic Study,"

threatening condition on discharge: PTSD.[9] Was expert rejection of the Iron Lung too hasty? Pausing to reconsider need not entail romanticizing the Iron Lung on which we have definitively improved. Instead, taking the Iron Lung and its tradition seriously reveals the negative space of breathing, atmospheres around the body that we have forgotten, there for us to use if we could only see them.[10] The Iron Lung is also a reminder that the subtlety of breathing, negotiating an ever-changing boundary between inside and out, is constitutive of states of mind, even selves. More than a matter of just getting air in, breathing and its traditions are possibilities. If only we would humbly fold time to reveal them.

Intensive and Critical Care Nursing 28, no. 1 (Feb 2010): 6–15. See also Jill L. Guttormson, Karin Lindstrom Bremer, and Rachel M. Jones, "Not Being Able to Talk Was Horrid: A Descriptive, Correlational Study of Communication During Mechanical Ventilation," *Intensive & Critical Care Nursing* 31, no. 3 (Jun 2015): 179–86.

9. See Gautam Rawal et al., "Post-Intensive Care Syndrome: An Overview." *Journal of Translational Internal Medicine* 5, no. 2 (Jun 2017): 90–92.

10. Konstantinos Raymondos et al., "Combined Negative- and Positive-Pressure Ventilation for the Treatment of ARDS," *Case Reports in Critical Care* (2015): 714902. https://doi.org/10.1155/2015/714902.