Since January 2020 Elsevier has created a COVID-19 resource centre with free information in English and Mandarin on the novel coronavirus COVID-19. The COVID-19 resource centre is hosted on Elsevier Connect, the company's public news and information website.

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Editorial

Invention of intensive care medicine by an anaesthesiologist: 70 years of progress from epidemics to resilience to exceptional healthcare crises

Seven decades before COVID-19, during the poliomyelitis epidemic in Copenhagen, the anaesthetist Dr Bjorn Ibsen revolutionised the management of acute respiratory failure by applying positive pressure ventilation (PPV) outside the operating theatre and invented intensive care medicine.

In 1952, Copenhagen was hit by an exceptionally bad polio epidemic. Between July and December, over 2722 patients admitted to Blegdam hospital with polio, 866 had paralysis including 316 patients with respiratory or/and pharyngeal paralysis [1]. At that time, Blegdam was the only hospital in Copenhagen offering ventilatory support and there was only one real iron lung ventilator and a few other negative pressure devices (“cuirass”). Clinicians and hospitals were overwhelmed by the epidemic with 87% mortality rate [2]. The anaesthetist Dr Bjorn Ibsen, who trained in Boston, then used the continuous PPV technique, regularly used in operating theatres, to rescue a 12-year girl dying of paralytic poliomyelitis in the Bledgam emergency room [3]. Over the next eight days, Blegdam Hospital leadership organised PPV for all patients with respiratory failure. Under the supervision of anaesthetists and dedicated nursing staff, two hundred medical students continuously and manually ventilated up to 70 patients simultaneously [1]. Ibsen’s techniques slashed mortality rates from 87% to less than 15% among patients with bulbar poliomyelitis. Spurred on by these results, Carl-Gunnar Engström invented a machine called a respirator capable of alternating inhalation and exhalation phases and hospital students were replaced by these “mechanical students”. The Blegdam hospital arranged for these methods to be applied to all patients with respiratory failure, and grouped them in three speciality wards: the first three ICUs in the world. Along with this therapeutic revolution, Bjorn Ibsen also profoundly improved the understanding of respiratory physiology. Indeed, at the beginning of the epidemic, the only routinely available measurement at Bledgam Hospital was the concentration of carbon dioxide in the blood, and the elevated values were initially misinterpreted as a mysterious “alkalosis” [4]. Bjorn Ibsen immediately suspected respiratory acidosis and a then-experimental pH electrode was clinically used for the first time to confirm Ibsen’s hypothesis. Technology for clinical measurements of pCO_2 and pO_2 developed rapidly in the next few years; thus, modern clinical acid-base respiratory physiology was born [4].

Modern intensive care medicine owes its origin to the demonstration that patients with vital organ failure can be kept alive by mechanical support with skilled round-the-clock nursing and medical care and then recover [1]. At a European conference sponsored by the National Foundation for Infantile Paralysis, Dr Bjorn Ibsen proposed that the expertise and equipment of polio ICUs be applied to the treatment of patients with other respiratory conditions. ICUs rapidly emerged around the world to treat severe forms of polio but also tetanus, barbiturate intoxication, drowning, myasthenia gravis, crushed chests, head injuries, shock or cardiac arrest.

The vision of what critical care is and how to implement it both medically and organisationally make this anaesthetist the founding father of intensive care medicine [5].

Finally, 70 years ago, Bjorn Ibsen invented 1) a life-saving technique, 2) an organisation for acute care within a hospital ward and 3) a new medical discipline: intensive care medicine. This highlights the historical link between anaesthesiology and intensive care medicine, two parts of the same speciality which crosstalk.

The COVID-19 pandemic has stressed healthcare systems all over the world, probably as never before the invention of intensive care medicine. The COVID-19 pandemic has not yet been accompanied by any major new inventions in the field of intensive care medicine, although it has required a major adaptation of the organisation and capacities of intensive care medicine and led to better knowledge of acute respiratory failure. Because COVID-19 results in an acute hypoxaemic respiratory failure that may culminate in acute respiratory distress syndrome, ICU beds, ventilators and even oxygen supplies have become invaluable resources [6]. As the number of ICU beds was enormously increased in France by upgrading step-down units and postoperative recovery rooms, some hospitals were faced with a shortage of ventilators [7], and led to stringent extracorporeal membrane oxygen support criteria, probably for the first time since intensive care medicine was born, giving rise to ethical issues. In many aspects, the COVID-19 pandemic has exacerbated and amplified the problems and fragilities of our healthcare systems. Beyond our healthcare systems, the pandemic has highlighted ethical issues related to the appropriateness of critical care, societal representations of death, and support for the dying and their relatives [8].

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The COVID-19 crisis emphasised the importance of ICUs, but also their organisational weaknesses face to such an epidemic wave [9,10]. Thus, the COVID-19 pandemic has showcased the skills of anaesthetists as intensivists, team workers, medical managers, strategists, and leaders. During the first COVID-19 wave in France, ICU capacity increased in three weeks from 5415 to 7150 beds [9]. Importantly, Taccone et al. found no correlation between mortality and the ratio of newly created ICU beds to the total number of ICU beds [11]. Concurrently, many patients had to be transferred, within the same region, from one region to another or even to other countries [12]. This adaptation resulted in a focus of care on COVID-19, to the detriment of other pathologies considered less urgent.

Finally, in terms of the healthcare system, the main effort of adaptation has been supported by the health caregivers [9]. This effort and dedication have been widely praised and applauded, but it has unfortunately resulted in the exhaustion and attrition of health caregivers over the months. Following the first and second waves, many paramedical staff left their job, aggravating an already precarious situation in the ICU beds availability. The COVID-19 crisis accentuated pre-existing weaknesses of critical care in France. Moreover, successive epidemic waves, *i.e.* the perpetuation of the crisis over two years, highlight the necessity to refine the adaptability of our healthcare system, and most importantly, the focus of care on COVID-19 must not restrict other pathologies management, especially those requiring surgical intervention.

Which solutions could be proposed?

First, it is particularly important to maintain our capacity to deal with an epidemic peak or a massive influx of victims requiring intensive care (from terrorism attacks, to mass casualties, to acute infectious epidemics). The polyvalence of anaesthesia-intensive care medicine has shown its added value. This polyvalence must be further strengthened by creating an intensive care health reserve. Second, the number of nurses in the intensive care units must not only be guaranteed but should be increased. A figure of one nurse to take care of two intensive care beds seems to be the minimum desirable at present. For the most critically ill patients, this ratio should even be adapted day after day, according to patient severity.

Thus, the number of nurses trained should be increased, the attractiveness of ICUs improved and continuing education for all intensive care medicine staff pursued.

Finally, in order to anticipate potential future disasters while ensuring that access to care remains sustainable and realistic, it would seem useful to extend the "culture of adaptation" specific to our profession, as Bjorn Ipsen did 70 years ago.

Conflicts of interest

The authors have no conflicts of interest related to this editorial

References

[1] Gilbertson AA. Before intensive therapy? J R Soc Med 1995;88(8):459P–63P.
[2] Trubuhovich RV. Further commentary on Denmark's 1952-53 poliomyelitis epidemic, especially regarding mortality; with a correction. Acta Anaesthesiol Scand 2004;48(10):1310–5.
[3] Ibsen B. The anaesthetist's viewpoint on the treatment of respiratory complications in poliomyelitis during the epidemic in Copenhagen, 1952. Proc R Soc Med 1954;47(1):72–4.
[4] West JB. The physiological challenges of the 1952 Copenhagen poliomyelitis epidemic and a renaissance in clinical respiratory physiology. J Appl Physiol (1985) 2005;99(2):424–32.
[5] Pincock S. Bjørn Aage Ibsen. Lancet 2007;370(9598).
[6] Bonnet L, Carle A, Muret J. In the light of COVID-19 oxygen crisis, why should we optimise our oxygen use? Anaesth Crit Care Pain Med 2021;40(4):100932.
[7] Ranney ML, Griffeth V, Jha AK. Critical supply shortages - the need for ventilators and personal protective equipment during the Covid-19 pandemic. N Engl J Med 2020;382(18):e41.
[8] Sallnow L, Smith R, Ahmedzai SH, Bhadelia A, Chamberlain C, Cong YL, et al. Report of the Lancet Commission on the Value of Death: bringing death back into life. Lancet 2022;399(10327):837–84.
[9] Lefrant JY, Fischer MO, Potier H, Degryse C, Jaber S, Muller L, et al. A national healthcare response to intensive care bed requirements during the COVID-19 outbreak in France. Anaesth Crit Care Pain Med 2020;39(6):709–15.
[10] Roger C, Collange O, Mezzarobba M, Abou-Arab O, Teule L, Garnier M, et al. French multicentre observational study on SARS-CoV-2 infections intensive care initial management: the FRENCH CORONA study. Anaesth Crit Care Pain Med 2021;40(4):100931.
[11] Taccone FS, Van Goethem N, De Pauw R, Wittebole X, Blot K, Van Oyen H, et al. The role of organizational characteristics on the outcome of COVID-19 patients admitted to the ICU in Belgium. Lancet Reg Health Eur 2021;2100019.
[12] Collange O, Sammour Y, Soulié R, Castelain V, Mertes PM. ICU re-organisation to face the first COVID-19 epidemic wave in a tertiary hospital. Anaesth Crit Care Pain Med 2020;39(6):731–2.

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