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*Occasional essay*

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# In the beginning. The 1952-1953 Danish epidemic of poliomyelitis and Bjørn Ibsen

"The modern specialty of intensive care medicine began with the poliomyelitis epidemic in Denmark". That quotation from the golden jubilee book of the Royal Australasian College of Physicians[1] is a characteristic statement found in the limited writings on the history of Intensive Care Medicine, because it was during the 1952-1953 Danish epidemic of poliomyelitis that the foundations of our specialty were laid. The epidemic was "unprecedented in the history of Denmark, in size as well as severity…..and by far the worst ever recorded in Europe".[2] Comprehensive and excellent accounts of it have been published.[2-5a]

Now that the 50th anniversary of the end of the epidemic has passed, at the variously given dates of March 2nd 1953,[6] or, it has been argued, May 1st 1953,[7] it seems an appropriate time to consider the epidemic's role in the development of our specialty. Further, the anniversary allows us to honour the innovative contributions made by the clinicians involved. They were principally the anaesthetist Bjørn Ibsen and his multi-disciplinary colleagues in H.C.A. Lassen's Department of Communicable Diseases at Copenhagen's Blegdams-hospitalet.

Ibsen's introduction of new treatment methods dramatically reduced mortality among those patients who needed artificial ventilation for acute respiratory failure arising out of breathing and/or swallowing deficits.[2,3,5] His ideas and practices during this time also started the development of the intensive care unit towards what it is today;[4] and, together with the collaborative enthusiasm of laboratory chief Poul Astrup, fostered the introduction of regular blood-gas and acid-base analyses into daily management of the intensive care patient.[8,9]

**The novel approach at Copenhagen[4,5,5a]**

Before Ibsen introduced his methods, infectious diseases departments often treated respiratory failure in polio patients with either a cabinet "respirator" or a body cuirass respirator, both providing negative pressure ventilation. Since 1948, tracheostomy had also been used at Blegdamshospitalet, where indicated, although Lassen found that did not improve mortality.[2]

At Copenhagen, for the month until Ibsen was recruited to the Blegdam treatment team, the death of 27 of the 31 epidemic patients treated by negative pressure ventilation (mostly by body-cuirass respirators) highlighted the limitations of this form of treatment.[10] With an inadequate number of machines to supply negative pressure ventilation (one Emerson cabinet and six cuirass respirators, probably Kifas, were available)[10] and because of the ineffectiveness of this form of treatment, on 27th August 1952 Ibsen demonstrated on an adolescent polio patient the benefits of an alternative approach. He showed that patients could be ventilated successfully by using a technique of manual intermittent positive pressure ventilation (m-IPPV).[4,10] The method used a rhythmical "bag-ventilation", through a Water's to-and-fro' carbon dioxide absorber connected to a cuffed endotracheal (tracheostomy) tube. The ventilation method was a known anaesthetic technique used in the operating theatre and the same anaesthetic system could be applied to critically ill patients.

To supply the labour for m-IPPV in the months ahead, Lassen organised shifts of approximately 1500 volunteer medical students,[5] (later joined by dental students[5]), 600 trained nurses and hundreds of auxiliary personnel,[2] student nurses and semi-retired nurses. They were supervised by anaesthetists and assisted by each patient's 'special' nurse. With these teams, "despite the unabating severity of the fresh cases",[2] the mortality among ventilated patients had decreased from 87% recorded prior to introduction of the new system, to 26% for the sixth cohort of 50 patients admitted after August 25 and treated by the "new methods"[11]. By the time of these patients, much of the mortality was obligatory (e.g. due to the severity of necrotising brain lesions caused by the polio virus).[12] For the group with the combination of "paralysis of respiratory muscles, pharynx and/or larynx and with cerebralia …mortality approaches 100 percent";[2] also many of the deaths occurred, with "catastrophic rapidity",[2] soon after admission.[11]

At the end of this Denmark-wide epidemic, the 1953 provincial Denmark epidemic followed,[7] and an out-break also occurred in Sweden,[13] where mechanical IPPV with tracheostomy was successfully employed in 54 patients, and the mortality among "55 cases of bulbo-spinal respiratory paralysis" was 27%.[13]

**Outcomes**

Multiple factors contributed to Ibsen's striking success. These included his clinical and laboratory acumen regarding the nature and origin of the clinical features in many of the patients treated by negative pressure ventilation, and his recognition of the essential nature of lethal problems, which were fully detailed in the accounts of the epidemic.[4,5] In addition, once Lassen was convinced of the efficacy of Ibsen's revolutionary ideas, he immediately accepted them.[10]

Besides saving many lives, the achievements of that time produced important outcomes in three major respects:

**1. Intermittent positive pressure ventilation**

The successful use of m-IPPV resulted in a changeover from manual to mechanical, longer-term intermittent positive pressure ventilation (IPPV), a concept that spread through Scandinavia, the United Kingdom[14,15] and elsewhere in Europe.[5a,14] That change was accomplished by the rapid development and production of a range of new IPPV machines, dubbed "mechanical students",[16] reliable for the task of providing long-term artificial ventilation. Apart from the Engström prototype, the European IPPV machines, which were available before the time of the epidemic, were primarily anaesthetic ventilators, and had not been tried outside the operating theatre or for long term use.[14,18] These machines included the Blease Pulmoflator, the Frenckner, the Aga and the original Mørch-1 respirator (i.e. E. Trier Mørch's original World War II Danish modification of the Swedish Aga). The Bang ventilator, which was developed provincially during the epidemic and also used at the Blegdam from 1953,[3] could not compare with the Engström. The Gullberg positive pressure attachment for the Kifa cuirass also became available later in the epidemic, although it was not used in the acute phase of the illness and was only used for weaning.[3]

The sophisticated Engström volume-controlled ventilator[18] was foremost among these machines and had been developed in 1950 after Dr Carl-Gunner Engström realised that it was underventilation which caused many of the polio deaths in Stockholm.[18] His ventilator was carefully evaluated at the Blegdam, and was found to be the only one of several types of IPPV machines that were tested, that functioned satisfactorily.[8] Its merits were also evident in Sweden's 1953 polio epidemic.[13]

Further valuable developments from the epidemic included humidifying systems,[2,4] and non-rebreathing valves[19,20] enabling the soda-lime canister to be dispensed with.

After the Danish epidemic, IPPV was not taken up generally in polio units in the United States, despite new designs from Mørch (the 1954 Morch-3 Piston Ventilator) and from Van Bergen et al.[14] Negative pressure ventilation still reigned supreme for polio patients for the rest of the decade in most of North America as well as in Australia and New Zealand. In the latter two countries this was largely due to the ubiquity of a useful local product (the cabinet respirator of the Both brothers of Adelaide), which was freely donated by Lord Nuffield before World War II to hospitals of the British Commonwealth.[15]

**2. Intensive care units**

When polio patients were concentrated into "a special department"[5] for best management (at the Blegdam the large number required three floors), impetus was given to the development of these as specific units. Because Ibsen could see the benefits in always having an area with its own trained staff and multi-disciplinary team, he was foremost in advocating a separate location to be established in hospitals where intensive care management could be supplied to the critically ill.[4,9] These dedicated areas became known as intensive care units.

By demonstrating the success of a team approach for such patients (the team at Blegdam had anaesthetic, epidemiological/medical, "otolaryngeal", student, nursing, laboratory, and physiotherapy components), the organisation needed to run such a unit came to be determined.[2,8] Ibsen established his own intensive care unit, a general one and Denmark's first, at (Copenhagen's) Kommune-hospital in 1954.[4] Though this lead was soon followed in the United Kingdom,[15] and in the mid to late 1950s the United States, it was not until the end of the decade that any kind of formal intensive care unit was established in Australasia.[21]

**3. Intensive Care Medicine**

When serviced by staff trained and certified in the specialty, the practice and success of what rapidly expanded into early Intensive Care Medicine opened the way for evolution to its present state. For their polio patients, anaesthetists had to go beyond applying just the basic principles of anaesthetic[4] and respiratory care for the preservation of vital functions (airway, ventilatory, circulatory and acid-base balance). With guidance from their epidemiologist and physician colleagues they became acquainted with, and involved in, management of other complications (e.g. "cerebralia,"[2] sepsis, azotaemia, paralytic ileus, myocarditis[22]) and saw how to extend their particular skills to areas involving prolonged, whole-body support. This started with an expanded role for IPPV, exemplified by its use in "vasomotor shock" and pulmonary oedema.[3] Anaesthetists became intensivists and were now involved in systems of treatment tailored to relieve the physiological disturbances from spino-bulbar-cerebral complications. For those 345 victims of the epidemic who fitted the Blegdam criteria for having "Life-threatening poliomyelitis"[3] their clinicians had devised a "mixed anatomico-clinical classification" into six patient groups from A to F.[2] Specific treatments were determined and applied to the needs of each group.

Thus, during the poliomyelitis epidemic and with a backing of "good clinical research" from Astrup and his team,[8] began the development of Intensive Care Medicine.[4] In anticipation of further, perhaps irretrievable, deterioration, the principle of preventive intervention was recognised and developed. To quote Ibsen: "keeping the patient out of the respirator [i.e. ventilator] as long as possible can let pulmonary complications develop".[4]

Management of patients during the epidemic included the development of safe methods of transportation to the Blegdam by road or air from other hospitals or locations, rather than waiting for the unsecured patient to arrive at the door of the intensive care unit. Clinicians travelled out in ambulances and aircraft to safeguard and stabilise the patient for safe transport.[4] Recognition of this need was made at a time when Australia's flying doctor system was well established, which Ibsen himself acknowledged.[4]

Intensivists were strategically placed to take advantage of rapid developments in blood gas and acid-base analysis, the value of which was exemplified by successful ventilatory and clinical practice during the epidemic.[5a,8] Such application gave a substantial boost towards further refinements.

**Other considerations**

Whatever innovative thinking Ibsen brought to existing Scandinavian practice, certain considerations should not be overlooked.

1. *Previous manual-IPPV*

   Within the confines of the operating theatre, anaesthetists were familiar with manual ventilatory support, to the extent of controlling the patient's breathing completely. Credit for initiating this technique is usually given to Arthur Guedel and David Treweek,[23] who in 1934 documented "four years of clinical observation" of rhythmic manual ventilation (with CO2 absorption) for ether-induced apnoea. However, Engström pointed out that "In Sweden, KH Giertz had, as early as 1916, advocated the use of rhythmic insufflation ventilation in intrathoracic operations and [at that time] had made a critical review of all previous publications".[18] Before 1952, occasional use of various forms of m-IPPV, often delivered through an external mask when not by tracheostomy, had also occurred outside the operating theatre for certain medical and surgical conditions.[21,24]

2. *Previous mechanical-IPPV for polio patients*

   A method of mechanical IPPV had already been developed outside Europe in 1948, by Ray Bennett for Albert Bower,[25,26] at Los Angeles County Hospital, for large-scale and successful use in a polio epidemic (e.g. "294 respirator cases" in 1948, with 1949 mortality figures at 17% of 130 respirator cases). Ibsen, as he has already written concerning the two papers of Bower et al,[4] confirms that he "saw it in the library" (personal communication). That was fortunate, because although he had been in the United States of America after the time the two relevant papers appeared, he was not aware of them while he was there. Also in North America, and prior to the Copenhagen achievements, it was recognised that "the all-important problem in life-threatening poliomyelitis is respiratory".[2] In 1949, Sjøberg introduced the treatment with tracheostomy and bronchoscopic drainage to "maintain free airways in these patients."[18] Nonetheless, Engström - an epidemiolgist at that time - later lamented that mortality figures still stayed high in the Stockholm Hospital for Contagious Diseases.[18] Before Bower and Bennett's work there had never been any long-term use of IPPV for artificial ventilation.[18] Prolonged artificial ventilation had been achieved in polio units only with intermittent negative pressure ventilation.[14]

3. *A team effort*

   It should be acknowledged that the results achieved could not have occurred without a team of colleagues and supporting staff. The logistics at the Blegdam were very impressive, coping with the 318[11] patients "treated according to the new therapeutic principles" (from the hospital's epidemic total of 2,241 verified polio cases).[3] Some of the advances described can appear to be attributable solely to Ibsen. Notwithstanding his inspired innovations, what was achieved came from a closely collaborative effort among many professionals.

The 50th anniversary of the Copenhagen poliomyelitis epidemic has recently passed. On considering the outstanding achievements towards the development of Intensive Care Medicine, the epidemic needs to be remembered for the influence it had on the establishment of our individual specialty. At the same time we acknowledge with gratitude our indebtedness to these pioneers, Bjørn Ibsen and his colleagues, whose fore-sight, dedication and application made the development of Intensive Care Medicine possible.

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***Regarding Reference 5a.***

The writer regrets that at the time this essay went to printing he was unaware of the admirable description of the Danish epidemic and the consequences arising from it, contained within the paper now given above as reference 5a. There are multiple sites in the essay where this paper should have been cited. However, Poul Astrup - despite being an active participant at Prof. Ibsen's demonstration with the test patient[5] – in collaboration with John Severinghaus, had earlier seemed to imply,[9] but now in this paper actually stated,[5a] that the date of Prof. Ibsen's initial demonstration was August 26. They wrote that date notwithstanding previous papers by HCA Lassen himself[2,10] (and later, the 1994 paper from Ger Wackers[5]), giving the August 1952 date for the Ibsen demonstration as the 27th. Which date is the one repeated here in this *Critical Care and Resuscitation* essay.