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«No doubt this childhood disease on Vestmannö can be prevented» – neonatal tetanus on the Westman Islands

MEDICAL HISTORY

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At the beginning of the 1800s neonatal tetanus was a major health hazard on the Westman Islands, an archipelago immediately south of Iceland. Up to 60 – 70 % of newborn babies died in the course of the first two weeks of life, and Danish health authorities were almost helpless in the face of this mysterious disease.

In 1847 the young Danish doctor Peter Anton Schleisner (1818 – 1900) was sent to the islands to investigate the conditions there. He established a maternity hospital, gave advice on hygiene and encouraged breast-feeding and a number of changes in diet. Since there was no known treatment, Schleisner's only option was to resort to preventive measures. He dressed the umbilical stump with *balsamum copaivae* and tried well-established methods such as opium

tincture with saffron and mercurial ointment if there was any sign of infection. By the time he returned to Denmark after nine months, mortality had been halved.

In the summer of 1847, the 29-year old Danish doctor Peter Anton Schleisner (1818 – 1900) (1) (fig 1) sailed to the Westman Islands off the south coast of Iceland. He had received detailed instructions from the Danish authorities. The aim was to combat the epidemic of neonatal tetanus (referred to as *ginklofi*) that was ravaging the islands.

Figure 1 Peter Anton Schleisner (1818 – 1900). Reproduced from Læknablaðið, Reykjavik (5)

This article describes the background for Schleisner being shipped off to Iceland, what he did there, the outcome of the measures and how his efforts were assessed by his contemporaries and by posterity.

The challenge

Tetanus in newborn babies is caused by the bacterium *Clostridium tetani*. The infection is transmitted via open wounds and the disease occurs during the first days of life. The progress of the disease is rapid and begins clinically with lockjaw (*trismus*) and facial contractions *(risus sardonicus*) that mean that the child is unable to take nourishment. Later the jaw loosens, the chin drops and the child is no longer able to breastfeed. Death occurs shortly afterwards. Without treatment the disease is considered to be 100 % fatal.

Earlier generations were familiar with this condition under names such as *mundklemme* (Danish), *lockjaw* (English) and *ginklofi* (Icelandic). In Latin it was termed *tetanus* (or *trismus*) *neonatorum, nascentium* or *infantum*. What is unusual is that the disease is not transmitted from person to person and that each new case depends on direct contact with contaminated material. In most cases the cause is poor hygiene when dressing the umbilical stump immediately after delivery. In 1952 vaccination against tetanus became part of the Norwegian child vaccination programme, and today the incidence of tetanus is very small. But on a global basis it is still a dreaded disease. Every year 200 000 to 300 000 children die of the disease (2).

The disease was most persistent in western Europe and lasted longest in three remote islands in the western reaches of the Atlantic: the Westman Islands and Grimsey off Iceland, and St. Kilda in the Hebrides off Scotland (fig 2). In Scotland control of the disease was achieved around 1900, but only after the clostridium bacterium and the toxin had become known (3). Since the problem had been solved on the Westman Islands almost 50 years earlier, the story was already fading into oblivion at the beginning of the 20th century (4, 5).

Figure 2 Map of the North Sea showing St. Kilda, Grimsey and the Westman Islands (Vestmannaeyjar)

New interest in child mortality on Iceland

Child mortality on Iceland in the 19th century was surveyed once again from the start of the 1980s, not least thanks to the Icelandic doctor Baldur Johnsen (1910 – 2006), who rediscovered Schleisner's contribution. Johnsen's comprehensive report was published in the Icelandic medical journal *Læknablaðið* as a separate supplement in 1982 (5). In many ways that was the start of contemporary interest in Schleisner (4) – (7) (fig 3) – the literature on

neonatal tetanus was sparse prior to that (8). In recent years historians Ólöf Garðarsdóttir and Loftur Guttormsson have contributed new and extensive knowledge (9) – (11).

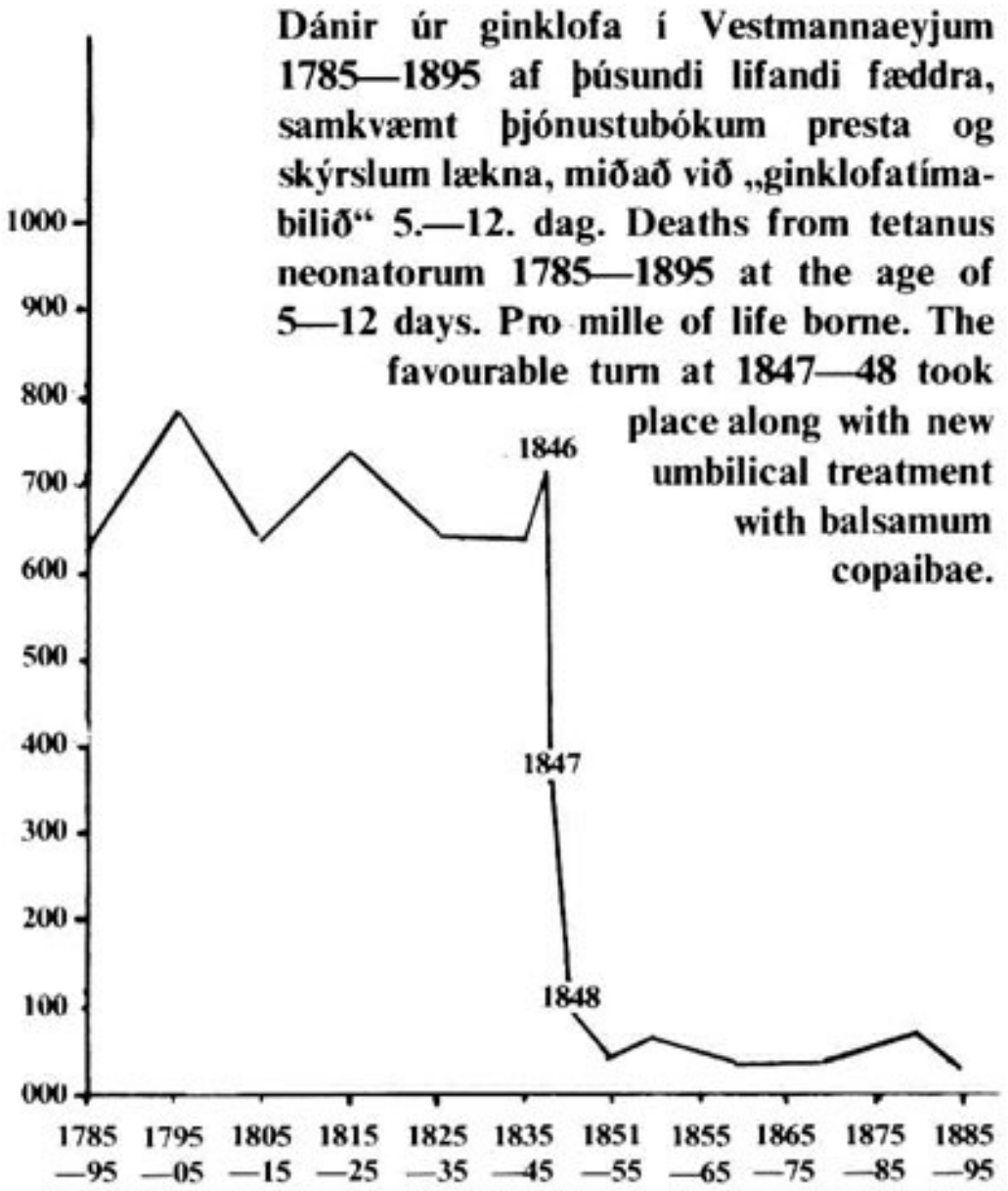


Figure 3 Mortality from ***trismus neonatorum*** on the Westman Islands for ten year intervals in the period from 1785 – 1895 (5, p. 10). Reproduced from Læknablaðið, Reykjavik

Tetanus neonatorum was a mysterious disease which gave rise to many speculations. Doctors groped in the dark for the causes: bowel irritation due to the retention of meconium, purgatives given immediately after delivery, the salinity of the sea air and an inflammation of the nerve vessels were among the suggested explanations (12, 13). One pediatrician wrote in the 1860s that there were few diseases about which opinions as to the cause were so diverse (14), and a contemporary colleague asserted that knowledge of the disease was no greater than it had been a hundred years earlier (13).

Hospital epidemics of neonatal tetanus were well known. The obstetrician Carl Edvard Marius Levy (1808 – 65) in Copenhagen reported on one in 1840 (12, 15). However, in contrast to puerperal fever which still raged in maternity hospitals throughout Europe, tetanus had become less common in the process

of time. Frans Chr. Faye (1806 – 90), professor at the maternity hospital in Christiania, wrote in 1861 that he had only seen one case in the preceding 15 years (16). But it was only in the 1880s that the cause of the disease was finally discovered.

The Westman Islands before Schleisner

The health authorities in Copenhagen were well aware that neonatal tetanus annually took the lives of over 60 % of liveborn babies on the Westman Islands (10). After his arrival Schleisner also ascertained this on the basis of observations back to 1785 (17).

As early as 1827 a separate regional doctor's post was established for the approximately 200 islanders to combat this state of affairs (18). Perhaps it was not exactly an attractive post. As an inducement the authorities promised that when the term was over, the doctor would be transferred to a position of higher standing in «our kingdom of Denmark».

From around 1800 and up to 1847 a number of doctors were sent one after the other to the Westman Islands to solve the problems. In comparison Iceland had five posts for physicians to serve the rest of the 60 000 inhabitants. In light of this imbalance and also the fact that none of the doctors had succeeded in combating the disease, in 1838 the *Landfysikus* (the chief medical officer for Iceland) Jón Thorstensen (1794 – 1855) criticised the *Sundhedscollegiet*'s (Health Board) continuing desire to maintain the post on the Westman Islands. Thorstensen was of the opinion that the disease was deeply rooted in the natural conditions and way of life of the islanders (10). Schleisner too pointed out that there were 187 clergymen and 294 churches on Iceland, but only a few doctors and not even a single hospital (19).

Schleisner's predecessor was district medical officer Andreas Steener Iversen Haalland (1814 – 55) who was posted to the Westman Islands in the period from 1840 to 1845. Mortality from tetanus was particularly high during these years even though it has been suggested that perhaps the most extreme figures might have been due to over-reporting (10). In the period from 1841 to August 1847 the figures showed that 95 % of all infant mortality was due to *ginklofi*. In many cases the deaths were reported to the parish minister at a later date, without any medical information being provided. The result may well have been that the most likely diagnosis was entered in the parish records (fig 4).

Figure 4 ***Ministerial Bok fyrir Vestmannaeija prestekall*** (Parish record for the Westman Islands) (1840). Deaths of males, with the cause of death and the child's age in days (column 1 and 3 from the right). The cause of death in almost all cases was given as ***ginklofi,*** or ***the same***. Reproduced from Þjoðskjalasafn Íslands (Iceland's national archives), Reykjavik

Even though Haalland did not complete his mission successfully either, he established a sound foundation that was essential for Schleisner's success. He applied for and received funding to conduct scientific investigations (18). As early as 1840 he wrote that the cause of *ginklofi* did not lie in the atmosphere

or water but in the «mean, damp and dirty houses» (18). He also believed that diet might be of significance, since it consisted almost solely of food of animal origin as well as considerable quantities of spirits and strong coffee. The treatment of newborn babies was unsuitable because the umbilical cord «is neither clamped nor tied in the proper manner». Mothers should start to breastfeed their infants instead of giving them cow's milk and water (18).

He also suggested that a maternity hospital should be established but the authorities were opposed to this. They believed that it would suffice to send a midwife to the islands and one of the local women was trained as a midwife in Copenhagen. Sólveig Pálsdóttir (1821 – 86), daughter of Gudrun Jónsdóttir (1791 – 1850), was chosen. Gudrun worked as a midwife on the islands even though she had no formal training. There was a pressing need for skilled midwifery. Doctors complained about untrained «midwives» who were totally incompetent and who lacked insight «into the most basic midwifery» (19). Sólveig was sent to the maternity hospital in Copenhagen where Carl Levy was now a professor and head of midwifery training (10). Levy himself pushed for mothers to breastfeed their babies. Since he was also engaged in the situation on the Westman Islands, he regarded the initiative favourably and helped Sólveig during her training (10). After Sólveig returned to the islands in 1843, she and her mother worked side by side but mortality did not decrease during the first few years (fig 5) (17). The authorities resorted to yet another measure. In 1846 an Icelandic version of Levy's textbook for midwives, *Kennslubók handa Yfirsetukonum*, was published and distributed to midwives on Iceland and the Westman Islands (20). In this Levy stressed the importance of meticulous care of the umbilical stump (21).

Schleisner's trip to Iceland

District medical officer Haalland had repeatedly requested the authorities to found a maternity hospital but this was not established until 1847. It was perhaps Professor Levy's recommendation that was the decisive factor. At the same time he asked the authorities to seize the opportunity to «enrich science» by allowing a young physician to travel to the islands in order to conduct a thorough investigation of the situation (20). The authorities agreed, believing that the assignment was of such great importance that it should be given to a man «of exceptional ability». Schleisner had written a monograph on puerperal fever only four years after graduating as a doctor in 1842 (22). Since the thesis clearly showed him to be a man of «considerable scientific abilities» (1), the decision had probably already been made as to who would be sent (10).

Schleisner arrived on the Westman Islands in September 1847 as the sixth in the succession of doctors to be sent there. Together with his housekeeper Guðfinna J. Austmann (1822 – 97) he set up and ran a maternity hospital. His expressed wish was to take responsibility for the deliveries himself and to keep the mother and child in hospital for the first two or three weeks. The most important step was to keep the children away from the adverse living conditions under which the majority of the inhabitants existed, and his aim was

to instruct mothers in better hygiene and a healthier diet (23, 24). Like Haalland, he was of the opinion that mothers should breastfeed their babies, but only partly succeeded in persuading them to agree to this and other changes in diet. He also recommended that they should eat less bird meat and more vegetables (17, 24).

Aarstal.	Dödeligheds-forholdet imellem 5te og 12te Dag, begge inclusive.	Dödeligheds-forholdet i 1ste Maaned.	Dödeligheds-forholdet i 1ste Aar.
1785—1794	0,637	0,804	0,818
1794—1804	0,785	0,862	0,862
1804—1814	0,632	0,730	0,753
1814—1824	0,730	0,801	0,817
1824—1834	0,643	0,757	0,772
1834—1844	0,643	5,728	0,772

Figure 5 Mortality from ***trismus neonatorum*** on the Westman Islands for ten year intervals in the period from 1785 – 1844, reproduced from Schleisner 1849 (17, p. 24). There is a printing error in the bottom line of column 3. According to the report in German from 1855 the figure should be 0.722

Schleisner as an obstetrician

During the nine months Schleisner spent on the Westman Islands and up to the time he returned to Denmark in June 1848, altogether 23 children were born. Eight of the mothers agreed to stay on in the maternity hospital and the remainder went home immediately after the birth. Nevertheless, he managed to keep all the children in hospital as planned. Five children died. Schleisner stated that three died of tetanus, one of diarrhoea and one of so-called *barnaveiki* (childhood weakness), probably as a result of premature birth or asphyxia. The earlier suspicion of erroneous classification turns up again in the form of a discrepancy between Schleisner's own information and what was entered in the parish records. Here *ginklofi* is given as the cause of death in all five cases (10).

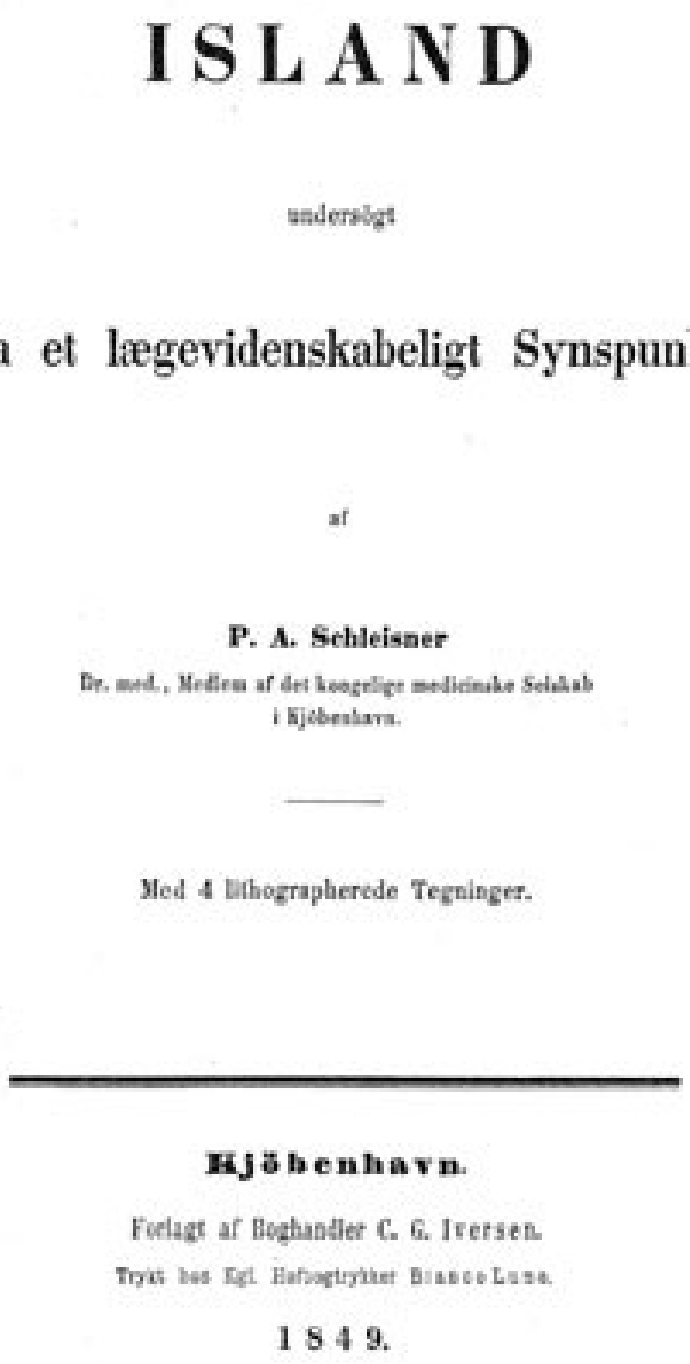
While eight of the ten children born on the Westman Islands from January to August 1847 died, Schleisner's figures showed a total neonatal mortality of 22 % (5/23). The figure for neonatal tetanus was 13 % (3/23). Three more children died of other causes after they had been discharged. Schleisner himself declared that a total infant mortality of 35 % was «twice as favourable» as in the preceding 20 years (24) (fig 5).

Report to the authorities

When Schleisner returned to Denmark in the summer of 1848, he first of all delivered a report on the tetanus situation to the Health Board. Unfortunately the original Danish version of the report is unobtainable, as Baldur Johnsen has also explained (4, 5). However, a summary of the report has been preserved (24). This makes it clear that Schleisner, like Haalland, put strong emphasis on the indoor climate in dwellings, which were mainly overcrowded. The indoor climate was particularly poor in the wintertime especially for the poorest in the community. It was at this time of year that neonatal mortality was at its highest. Schleisner believed that the «foul air» affected the unhealed umbilical stump by causing a «suppurating infection in the inner umbilical vessels». This infection irritated the spinal cord and produced spasms. The local inhabitants blamed the «foul water and the constant diet of bird meat» (17, 24). Even though the experts had very differing opinions, nevertheless the majority agreed that hygiene was a decisive factor. According to Schleisner *ginklofi*, like scurvy and leprosy, was a cultural disease (17).

Schleisner after the Westman Islands

In June 1849, one year after returning to Denmark, Schleisner published two works. The first was called *Forsøg til en Nosographie af Island* (Attempt to provide a systematic description of diseases on Iceland) (17), which he defended as his doctoral thesis on 22 June 1849 (25). For that matter this was the first doctoral degree in Danish at the Faculty of Medicine in Copenhagen – even though the dissertation defence still had to be conducted in Latin (26). Schleisner writes in the preface that he intends to write a separate treatise on *ginklofi* at a later date. The other work had the title *Island undersøgt fra et lægevidenskabeligt Synspunkt* (Investigation of Iceland from the point of view of medical science) (27) (fig 6). This work aroused great interest, not least in Norway where schoolmaster Wilhelm Boeck (1808 – 73) wrote an enthusiastic 45-page review in the *Norsk Magazin for Lægevidenskaben* (19).



ISLAND

undersøgt

fra et lægevidenskabeligt Synspunkt

af

P. A. Schleisner

Dr. med., Medlem af det kongelige medicinske Selskab i Kjöbenhavn.

Med 4 lithographerede Tegninger.

Kjöbenhavn.

Forlagt af Boghandler C. G. Iversen.

Trykt hos Kgl. Hofbogtrykker Bianco Luno.

1849.

Figure 6 Facsimile of ***Island undersøgt fra et lægevidenskabeligt Synspunkt*** (27)

Schleisner's expedition proved to be more expensive than anticipated, especially in the case of the maternity hospital. However the minister of justice at the time pointed out that Schleisner's journey had led to «most fortunate results». There was no doubt that the decline in mortality was due to his efforts, according to the minister. So the costs were covered (28).

Schleisner left Denmark the same year as he took his doctoral degree, travelling abroad to learn more. In autumn 1849 he gave lectures in London on conditions in Iceland (29, 30). After spending two consecutive years in England and France during which he mainly studied statistics and the public health service, he returned to Denmark in 1851 and was appointed regional medical officer in Copenhagen. In 1853 he was appointed to the influential position of medical inspector of Slesvig but returned to Copenhagen as municipal medical officer when the duchy was ceded to Germany after the war in 1864.

Schleisner practised for many years as a prominent public health physician in Denmark (31). He was responsible *inter alia* for the proposals to establish Øresundshospitalet (1875 – 76) and Blegdamshospitalet (1878 – 80) as epidemic hospitals (1). He was also familiar with conditions in Norway, and he was admitted to membership of the Norwegian Medical Society in 1874 (32).

Schleisner's treatment

We know quite a lot about Schleisner's treatment of newborn babies. The main sources are the Health Board's records for the period from 1847 – 48 (23, 24, 33, 34) which we have compared with a fuller report published by Schleisner in German in 1855 (35). Schleisner focused particularly on the umbilicus «insisting – in accordance with the advice of American physicians – that the umbilical stump be dressed with *balsamum copaivae* as a preventive measure until it fell off» (24, 35). The copaiba balsam was obtained by making incisions in the trunk of different species of the *Copaiba* genus which belongs to the *Fabaceae* family that grows in South and Central America (36) (fig 7). The preparation had been used medicinally from the 17th century onwards and is found in all Norwegian pharmacopoeias. In Europe it was originally used as a remedy to heal wounds but later good effects were also attained for a number of other conditions such as coughs, scurvy, venereal diseases and diarrhoea (37). It was said to be particularly effective against urinary tract diseases, especially gonorrhoea (38, 39). We have not found other descriptions of the use of copaiba balsam in the preventive treatment of neonatal tetanus, but Schleisner apparently knew of the preparation's wound healing properties (40). Until the first half of the 20th century, copaiba balsam was described in pharmacology textbooks as a possible remedy but became superfluous with the introduction of anti-bacterial preparations such as sulfonamides in the 1930s (41, 42). Some more recent studies suggest that the preparation may in fact have anti-inflammatory and antiseptic properties (43, 44).

Figure 7 ***Copaifera officinalis***, from which copaiba balsam is extracted, reproduced from ***Medical botany*** by John Stephenson and James Churchill, published 1834 – 36 (www.classicnatureprints.com)

It has been claimed that Schleisner did not use copaiba balsam but rather peru balsam (6, 7) but in all probability this is not correct. Schleisner writes to the Health Board and also in the German report that he used copaiba balsam.

However, these remedies were not very different from each other and the indications were fairly similar. Interestingly, several books published at the beginning of the 19th century discuss the good results achieved by using peru balsam against tetanus (39, 45). In 1831, it was asserted that «Lately [...] it has required some reputation in tetanus, on the authority of a most respectable practitioner» (46). This probably refers to the American physician Lemuel Kollock (1766 – 1823), who had practised as a doctor in Savannah, Georgia since the 1790s (47). Neonatal tetanus was known to be prevalent in warm regions such as America's southern states (13). According to one of the first American pharmacopoeias, Kollock had even cured several cases (48). But as early as the 1840s it seemed that the enthusiasm had subsided and some were of the opinion that peru balsam for this indication was obsolete (39).

In both reports Schleisner also gave an account of other medical initiatives vis-à-vis newborn babies (25, 35). At the slightest sign of symptoms, he wrote, he would apply a lukewarm preparation of herbs (*Kräuterbäder*) and dress the umbilical stump once or twice daily with a linen compress (Charpie) that was moistened in opium tincture with saffron. At the next phase he applied an oatmeal poultice with mercurial ointment on the lower part of the abdomen. These were well-established remedies. Opium tincture with saffron, which Schleisner referred to as «Laud. liq. Syd.», was an old preparation named after the famous English physician Thomas Sydenham (1624 – 89): *Laudanum liquidum Sydenhami*. These drops were originally made of opium, saffron, cloves, cinammon and Spanish wine, but both the recipe and the name varied over time (37). In Norwegian pharmacopeias the preparation was known as *tinctura* (or *essentia*) *opii crocata*.

Mercurial ointment was the last remedy Schleisner mentioned. He referred to it as «*Ugt. Neapolitanum»,* named after the town of Neapolis (Naples): *unguentum neapolitanum* otherwise known as Naples ointment, a reminder of the outbreak of syphilis there in 1495 (37). Mercurial ointment had been used as a remedy against syphilis for many centuries.

We can say with certainty that Schleisner did not approach the task lightly. He used all means at his disposition and there is little doubt that these succeeded. Some have asserted that the copaiba balsam was the decisive factor because this was the only remedy the midwife continued to use after Schleisner had returned to Copenhagen (5). In retrospect it is difficult to decide which remedy or remedies led to the gratifying development. Perhaps of greatest importance was that Schleisner improved hygiene in the postnatal period.

The Westman Islands after Schleisner

Schleisner regarded his mission as concluded and did not have any involvement later in conditions on the Westman Islands as far as we know. In 1854 the district medical officer wrote that the maternity hospital had not been used at all in recent years (49). According to him the reason was that «payment was now demanded from those who wanted to be admitted to the hospital». The authorities in Copenhagen felt that they had done everything in their power to

ensure that the hospital would run smoothly and complained that the Icelandic «authorities» had not given such an important matter «the attention and support that it deserves». They ordered the governor and the local minister to join the hospital board and to ensure that women made use of the hospital, but without «using any kind of external force». The district medical officer even suggested extending the work of the hospital so that «patients other than those giving birth could be admitted» but that proposal was rejected (49). Nothing helped in any case. Two years later the medical officer reported that the maternity hospital was still not in operation «but on the contrary it is being used by the governor himself». All in all, the doctor had experienced a great deal of «inconvenience and unpleasantness» on the islands. In the summer of 1858 the authorities also acknowledged that the battle had been lost. They decided that the activities of the hospital should be «suspended until further notice» (50).

Even though the hospital was not a success, midwife Sólveig Pálsdottir continued to deliver babies in her own home, keeping them there and continuing treatment with copaiba balsam until the risk of tetanus had passed and the umbilical stump had fallen off. Since the results were so positive, she may have found it unnecessary to carry out other measures (10). This may well explain why she apparently attached less importance to Schleisner's advice on changes in diet and breastfeeding.

Another advantage of the midwife looking after the children following delivery was that registration of the cause of death became more accurate. It was quite unlikely that the minister failed to confer with Sólveig before registering the death in the parish record (10).

The long-term effect of Schleisner's work appears from data presented by Baldur Johnsen in 1982 (5). The dramatic decline in neonatal mortality, overall and as a result of tetanus, is documented by examining the parish records for the islands in the period towards the end of the 19th century (5, 10, 11) (fig 3). Similar data are available for the period from 1911 to 1980 (5).

How were newborn babies infected?

There has been a great deal of speculation about how infection was transmitted to newborn babies. Schleisner's own explanation was linked to overcrowding and the indoor climate, but this does not tally with the manner in which the tetanus bacterium is transmitted.

Animal husbandry entailed people and animals living together under the same roof. In the majority of cases the dwelling consisted of one room above the byre with an opening in the floor as the only entrance and source of air. It is possible that animal faeces might be the source of the infection. But this explanation is also unlikely since this design was common over the entire country. The difference, if any, was that the houses on the Westman Islands were built more closely together than in other places on Iceland (24).

The islands had poor access to fresh water. Cisterns were placed around and beside each house. Rainwater was collected and used as drinking water and for cooking, washing clothes and personal hygiene. The water was often contaminated with seepage from the domestic animals and from dead birds and other carcasses that lay rotting on the ground. There was also reason to suspect that the cloths used to dress the umbilicus of the newborn baby had been washed in contaminated water and then laid on the ground to dry. But even after people started to hang these up to dry in the wind, this had no effect on the disease.

The most likely explanation can be found in the treatment of dead seabirds. There were no trees on the islands and the carcasses of seabirds, mostly seagulls and puffins, were therefore used as fuel. The seabirds were quite fatty and saturated with fish oil. Collecting dead birds for fuel was the women's job. Therefore it is quite likely that the source of infection was the lack of hand hygiene when the child was tended after such work had been carried out. It is reasonable to assume that this mode of transmission was eliminated when the midwife took over responsibility for nursing and caring for all newborn babies until the end of the second or third week of life (9) – (11).

Conclusion

Schleisner's achievement can be assessed in different ways. First of all he did not know the real cause of the disease either, but tried out the remedies that were available. Nevertheless, as indicated in the title of this article, he had «no doubt this childhood disease on the Westman Islands can be prevented» (24, 34). Moreover, he described the situation as a «cultural disease» while at the same time recognising that you cannot change people's way of life and existence overnight. For that reason he was convinced of the justification for the hospital (34). We may perhaps wonder whether Schleisner's well-meaning advice and its rejection by the poor fishermen of the Westman Islands does not have a parallel in today's development assistance?

It is possible that the total mortality from *ginklofi* was in decline throughout the 19th century as part of a long-term trend, and was therefore less the result of Schleisner's clinical efforts than people were inclined to believe both then and today. First the situation on St. Kilda argues against this explanation. On the other hand Schleisner found a considerable difference in neonatal mortality between the highest (23 %) and the lowest (69 %) social classes (24, 34).
A combination of minor changes such as the relatively large number of mothers in better social circumstances and the favourable urban influence of Reykjavik may have had a positive effect (10). This should also be considered in addition to improvements in people's general living conditions, way of life, food and hygienic practices – what Schleisner called the «hygienic potencies» (24). Nevertheless there is much to indicate that Schleisner's efforts were of decisive importance (5).

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