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Case report

Death by lice? – A case of fatal secondary anaemia following severe lice infestation

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ABSTRACT

Head lice are generally considered harmless but in rare cases, a prolonged infestation can lead to severe consequences even resulting in the individuals' death. This article presents the case of a 56-year-old man who died from severe secondary anaemia most probably caused by prolonged and pronounced lice infestation. The man, who lived in poor hygienic conditions and suffered from schizophrenia and alcohol addiction, was found breathing heavily on the floor of his apartment and later died during the emergency measures. His body was covered in thousands of lice, even affecting his respiratory openings and the oesophagus. Autopsy and histopathological results revealed iron deficiency anaemia and signs of a long-term lice infestation. While other contributing factors such as hypothermia and alcohol withdrawal syndrome had to be discussed as contributory factors, the findings suggested that lice-induced anaemia was the primary cause of death. The case highlights the need for awareness about the potentially fatal consequences of untreated lice infestations, particularly in vulnerable populations. To our knowledge, it is the first death case due to lice infestation in the European Union.

1. Introduction

Humans can be infested by two species of lice: Pthirus pubis, also known as pubic lice or crab lice, and the species Pediculus humanus with two ecotypes, head lice (P. humanus capitis) and body lice (P. humanus corporis) [1–5]. Even though head and body lice differ slightly in size and distribution on the human body, they have almost identical transcriptomes and are therefore considered to be different subtypes of the same species [3]. It is difficult to give an exact incidence for lice infestations, as not all cases are being recorded, but according to Hatam-Nahavandi et al. (2020), the overall prevalence of head lice infestations in school age students worldwide was 19 % in the past five decades varying greatly between different regions, population groups and between the sexes [6]. Furthermore, their incidence is influenced by external factors like the weather with a peak during the winter months [1]. However, lice infestations do not only accumulate in children, but also occur in adults, especially in people with lower social status and poor hygiene and/or with a history of mental illness [1,3,7–9]. Infection with head lice is mostly seen as a harmless and annoying condition, whereas body lice can transmit diseases such as epidemic typhus, relapsing fever and trench fever, especially in populations living under poor-hygiene circumstances (e. g. due to war or poverty) [1,5,10]. Since lice feed on the blood of their hosts, they can cause severe secondary anaemia if the lice infestation is not (sufficiently) treated for months or even years by the people affected or their guardians [1,7,8,11–13]. Several cases of secondary anaemia (sometimes requiring transfusion) due to prolonged lice infestations have been reported in the literature [2,4,7,8,12,14–19]. Nevertheless, death cases due to lice induced anaemia seem to be rare. Nara et al. (2016) published the case of a lethal hypothermia associated with iron deficiency anaemia aggravated by severe body lice infestation [20]. Another case of death secondary to lice infestation was reported by Lowenstein et al. (2022) [21]. They describe the case of a girl who had suffered from on and off lice infestations for three years preceding her death at the age of twelve. At the autopsy, signs of a prolonged lice infestation as well as a severe anaemia were obtained. The cause of death was found to be an apparent cardiac arrest due to severe iron deficiency anaemia secondary to the girl's prolonged lice infestation [21]. In this article we present the case of a 56-year-old man whose most probable cause of death was anaemia caused by prolonged lice infestation.

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2. Case report

A 56-year-old man lived alone in his small apartment located in the centre of a big city in Germany. The apartment was found to be in a neglected and dirty state. The rooms and floors were covered with garbage and personal belongings. A large number of different types of vermin were found in all rooms.

There was only sparse information about the man's medical history: Relatives stated, that he had suffered from paranoid schizophrenia, alcohol addiction and was in a poor nutritional state. Furthermore it was reported that he had a kidney disease which could not be specified. They stated that he had suffered from psychological distress following the death of his wife which had led him to neglect his personal hygiene for years.

The day before the man died, an ambulance had been called to his home because neighbours had noticed that he appeared confused. However, he refused to be taken to a hospital. On the day he died, his mother tried to contact him, but was unable to reach him. When she went to his apartment, she found him lying on the floor. When the emergency services arrived, they found him moaning and breathing heavily. They pulled him out into the hallway outside the flat as there was not enough space inside. Once there, the man had a cardiac arrest. He was resuscitated for 45 min before the emergency physician pronounced him dead.

2.1. Autopsy results

The judicial autopsy was conducted five days after the man's death. His body length was 181 cm, the body weight 65.5 kg and the BMI 20.0 kg/m^2. The death spots were very sparse on the back of the body, barely delineated and not properly accessible due to a diffuse brownish discoloration of the skin, especially affecting the trunk and the upper parts of the extremities. Furthermore, there were numerous scratching marks on the man's body, particularly on the back as well as the extremities. In addition to that, we found similarly shaped scars in the same regions that were affected by scratching marks. The entire body was littered with thousands of lice up to about 0.3 cm in size. At the time of autopsy all lice on the man's body were dead. They were visible in the hair and on the skin surface as well as partially in the respiratory openings (Fig. 1). The oral cavity, the back of the trunk and the anal region were covered in lice. The lips and conjunctiva were pale.

The brain was free of haemorrhages or other abnormalities. When the inferior vena cava was opened, hardly any liquid blood came out, but a very small quantity of postmortal clots. The coronary arteries had singular fatty plaques, but the heart had no scars or signs of acute myocardial infarction. The tissue of the lungs was rich in air in the peripheral areas and otherwise rather rich in fluid. The pulmonary airways were lined with a very pale mucous membrane; there was little whitish mucus in the clearing. The oesophagus was lined by a pale mucosa, containing some whitish mucus as well as some lice. The liver and spleen appeared pale. The splenic capsule was tender and slightly puckered. The gastric mucosa showed a couple of blackish haemorrhages up to 0.3 cm in diameter, morphologically consistent with Wischnewski's spots. The adipose tissue around the kidneys was sparse, the kidney tissue appeared pale. There were regular contents in the small and large intestine and there was no evidence of bleeding or injury. Concerning the skeletal system, there were serial fractures of the ribs as well as a sternum fracture, consistent with the history of cardio-pulmonary resuscitation.

2.2. Histopathological examination

During histopathological examination, we noticed some diffusely distributed small areas of the heart muscle, showing coagulation necrosis with loss of cross striation. We assumed that these changes were a result of generalised hypoxia as there were no signs of relevant coronary artery sclerosis. The lung tissue showed focal haemorrhages as well as partially overinflated alveoli. These changes were interpreted as consequences of the resuscitation measures including intubation and mechanical ventilation. In the renal tissue we found glomerulosclerosis and mild signs of chronic inflammation naming lymphocyte infiltration and connective tissue remodelling. We also observed dilated renal tubules

Fig. 1. Close up view of the man's face demonstrating the severity of lice infestation. The picture was taken in the man`s home by the criminal police.

indicating a final circulatory shock. There was no histopathological evidence of fatty degeneration of the renal tubule cells as a possible sign for lethal hypothermia. The bone marrow (Fig. 2A, B) was found to be hypercellular, especially showing increased erythro- and granulopoiesis. These findings were consistent with the hypothesis of an iron deficiency underlined by the fact that the iron content of the bone marrow was found to be low (Fig. 2B). An increased haematopoiesis could also have been reinforced by vitamin B9 and B12 deficiency as a consequence of alcoholism. The proportion of eosinophil granulocytes was remarkably increased in the bone marrow which fit the finding of a prolonged parasite infestation. Interestingly, the liver (Fig. 2C) did not show any sign of steatosis or fibrosis, but leucostasis in the perivenular zone. Together with the findings in the spleen (Fig. 2D) and the bone marrow, this indicates an inflammatory condition. Overall, the organs appeared anaemic. The brain, pancreas and thyroid didn't show any additional pathological changes.

2.3. Toxicological examination and post-mortem blood testing

A blood alcohol concentration of < 10 mg/dl was measured in the blood. The toxicological screening showed no evidence of illegal drugs. However, drugs were found that can be attributed to the rescue operations (midazolam, rocuronium, amiodarone). The presence of 9-hydroxy risperidone (metabolite of paliperidone or risperidone) could be explained with the man having a history of schizophrenia. None of the drugs were found to be overdosed.

In post-mortem blood tests, we found a haemoglobin value of 5.5 g/dl (standard values 13.5–17.5 g/dl) consistent with anaemia. Although haemoglobin values can vary slightly in post-mortem blood samples, they can be used to diagnose anaemia [22] and were found to be stable in the post-mortem period except in bodies with a post-mortem interval of more than 168 h [23].

3. Discussion

The autopsy results, the histopathological findings as well as the laboratory values in the presented case showed signs of severe anaemia which might have had multiple causes. The poor nutritional status of the man and vitamin deficiency in the possible context of alcoholism are likely to have contributed to it. However, since there were no macroscopic or histological signs that would suggest a chronic liver disease due to alcoholism and the nutritional status of the man was only moderately reduced, we assume that predominantly a prolonged lice infestation with thousands of lice (at the time of autopsy even present in the respiratory openings and the oesophagus) had led to severe iron deficiency anaemia. The suspicion of a prolonged and pronounced lice infestation is underlined by the presence of eosinophilia in the bone marrow [8]. Unfortunately, we did not take any skin samples for histological examination to further support the assumption of a long-lasting lice infestation, but the observed brownish discoloration of the skin as well as numerous scratching marks and similarly shaped and located scars strongly speak for this hypothesis. We assume that bone marrow is an important tissue sample when it comes to diagnosing prolonged lice infestation with consecutive anaemia and recommend that forensic pathologists take skin samples when facing a similar case.

Furthermore, in our case we found concrete indicators of iron deficiency anaemia: The bone marrow showed low iron content as well as an increased erythropoiesis. As pointed out above, a causal connection between prolonged lice infestation and iron deficiency anaemia is plausible and numerous cases of severe anaemia due to severe lice infestations have been published [2,4,7,8,12,14–19]. The haemoglobin value was very low at 5.5 g/dl, indicating an insufficient hematopoietic output despite a hypercellular bone marrow without signs of myelodysplasia. It can be assumed that lice infestation led to an inflammatory ground condition and lice induced anaemia.

Certainly, other (contributory) causes of death need to be discussed: On the one hand, an alcohol withdrawal syndrome must be considered regarding the peripheral blood alcohol concentration of < 10 mg/dl at the time of death and the man's reported history of alcoholism. However, the liver did not show relevant signs of alcoholic liver disease. On the other hand, lethal hypothermia must be discussed as we found a couple of blackish haemorrhages consistent with Wischnewski's spots in the gastric mucosa. However, these haemorrhages were sparse and no other evidence of hypothermia was found as there were no signs of haemorrhage in the psoas, pancreas or knee joint fluid and no histopathological evidence of fatty degeneration of the renal tubule cells. It is

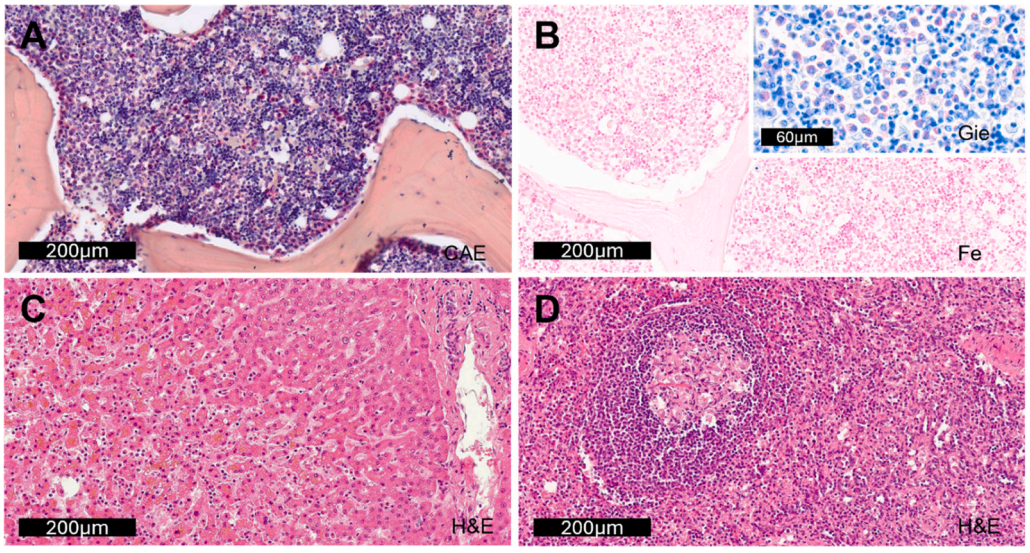

Fig. 2. Histology of bone marrow, liver and spleen. (A) displays a hypercellular bone marrow with leading granulo- and erythropoesis (granulopoesis stained in red, erythropoesis in blue). Note that the granulopoesis is layered peritrabecular, with physiologically increased maturation in central areas. Erythropoesis is regularly situated in small erythrons, without contact to the bone trabeculae. Megakaryocytes are regular. (B) shows iron depletion and eosinophilia in the inlet. (C) The liver displays some intrasinusoidal granulocytes in zone 3 (left side), no steatosis and no fibrosis (portal field on the right side). (D) Some secondary lymphoid follicles in the white pulp of the spleen (left side) indicate an inflammatory condition. There is no extramedullary hematopoiesis in the liver or spleen. Stainings: CAE: Chloracetate esterase, Fe: Prussian blue iron staining, Gie: Giemsa, H&E: hematoxylin and eosin. All pictures were taken with 40x original magnification and 0.25 µm resolution per pixel with a slide scanner (Leica Aperio, Nussloch, Germany). Magnifications are indicated by bars.

known that Wischnewski's spots are not pathognomonic for hypothermia and can be present in other causes of death. For not completely understood reasons, they are especially being observed, when the individual suffered from physiological or psychological distress before death [24].

Unfortunately, no body temperature had been documented in the emergency service records. Therefore, hypothermia as the cause of death cannot be completely ruled out. However, hypothermia cannot be considered independently of anaemia caused by lice, but more likely as a consequence of it [20]. Hence, a contributory hypothermia would not speak against the hypothesis of a death due to lice infestation, but even strengthen it.

Against this background, the findings obtained in our case indicate that the man's death was primarily caused by prolonged lice infestation and an associated severe iron deficiency anaemia.

As mentioned above, there are two ecotypes of Pediculus humanus, including head lice (P. humanus capitis) and body lice (P. humanus corporis). In our case, the majority of lice were on the hairy scalp, moustache and the hairy genital and anal area. Some lice could also be found on body hair. We assume that the lice found in the oesophagus had been transferred from the moustache during intubation or had been swallowed by the man during lifetime. It can be assumed that the lice in our case were head lice. This is supported by the extensive infestation of the hairy scalp with countless nits at the hairline, the lack of nits in the man's clothing and the lice`s rather small body size of no more than 0.3 cm. The whole-body infestation does not contradict this, as in cases of severe head lice infestations, characteristics that would rather be attributed to body lice were also described in head lice [3].

The observed brownish discoloration or hyperpigmentation can also be explained by lice infestation. In the literature, this phenomenon is referred to as parasitic melanoderma or vagabond's skin / vagabond's disease [1,10,20,21,25,26]. The term vagabond's skin / disease is unfortunate, not only because of its discriminatory nature but also because of its inconsistent use in the literature. On the one hand, the term is defined as body lice infection, which is synonymous with the term pediculosis corporis, and on the other hand, it is defined as a typical hyperpigmentation caused by body lice [1,10,20,21,25,26]. The discoloration is caused by chronic infestation with ongoing parasite bites, scratching and thus excoriation of the host's skin [1,20,25,26]. We assume, that this phenomenon can also occur in head lice infestations if they're severe and the lice are not limited to the hairy scalp but expand to the rest of the body which was the case here. As stated above, the man had numerous scratching marks and – with regard to location and shape – matching scars. These findings support the assumption that the decedents lice infestation had been long-lasting.

According to Speare, Canyon and Welrose (2006), the average volumes of blood intake of the female louse, the male louse and nymphe are 0.0001579 ml, 0.0000657 ml, and 0.0000387 ml respectively [11]. In their paper, Speare et al. calculated rather conservatively with three feeds per lice per day and an extensive amount of 2657 lice, which can be transferred to this case, and came to a conclusion of 0.7 ml blood loss per day or 20 ml per month. In other publications, it is described that lice feed five [1,5,10] or even ten to twelve [13] times per day. Given these numbers, the assumed monthly blood loss could be as high as 33–80 ml. Although this figure may appear relatively modest, a substantial body of case studies has documented that severe lice infestations can lead to a profound iron deficiency anaemia even requiring transfusion of red blood cells [2,4,7,8,12,14–19]. It can be thus concluded that the associated external circumstances, such as the duration of the illness and the lack of physical, social as well as psychological resources, are of considerable importance and can (in combination) result in death if they are particularly severe [20,21].

In summary, in the present case, it must be assumed that a prolonged and pronounced lice infestation was the main factor that led to a severe iron deficiency anaemia and thus to the man's death. Other contributory factors may have been present, but as mentioned above, there were neither relevant visceral findings due to chronic alcoholism nor a severe reduction of the BMI that would strengthen a great contribution of alcoholism and malnutrition to the anaemia. Instead, there were findings that underline a prolonged lice infestation as the primary cause for anaemia. In vulnerable groups of people, especially children and adults from difficult social circumstances and with indications of a reduced state of care, the dangers of lice infestations should be aware to physicians as well as other responsible persons like teachers or social workers. In autopsies of deceased persons with lice infestation, iron deficiency anaemia should be considered as the cause of death or at least as a relevant contributing factor. We recommend forensic pathologists to take samples of the skin and bone marrow as they can provide important findings to strengthen the causal link between a lice infestation and a consecutive death due to anaemia.

CRediT authorship contribution statement

Lisa Küppers: Writing – review & editing, Writing – original draft, Visualization, Validation, Supervision, Project administration, Methodology, Investigation, Formal analysis, Data curation, Conceptualization. **Stefanie Ritz:** Writing – review & editing, Validation, Data curation. **Maximilian Seidl:** Writing – review & editing, Visualization, Validation, Data curation. **David Fabian Ast:** Writing – original draft, Writing – review & editing, Investigation, Formal analysis, Data curation, Conceptualization, Visualization, Validation, Supervision, Project administration, Methodology.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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