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Myiasis in the intensive care unit: report from Switzerland and review of worldwide cases

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Summary

Nosocomial myiasis is seldom reported in Europe, and intensive care unit (ICU)-acquired myiasis is even rarer. Here, we describe the first report of hospital-acquired oral myiasis caused by *Lucilia sericata* occurring in a Swiss ICU. We provide a review of all European cases of oral ICU-acquired myiasis published since 1997 and discuss entomological aspects as well as treatment and prevention of this entity.

Introduction

Myiasis is a parasitic infestation of living vertebrates by dipteran larvae. Human myiasis is usually caused by flies belonging to the families Calliphoridae, Sarcophagidae, Oestridae and Muscidae [1, 2]. Some species require a host for complete larval development (obligatory or specific myiasis) and can cause severe damage to healthy tissues [2]. Facultative or semi-specific myiasis may infest living tissue but can also thrive on decaying organic matter or carrion [2, 3]. Most human myiases are related to the infestation of necrotic lesions or body cavities with accumulated secretions.

A 1997 review of worldwide nosocomial myiasis reported 23 cases of nosocomial myiasis from 1945–1996, involving *Lucilia sericata*, *Sarcophaga* spp, *Cochliomyia hominivorax* and *Musca domestica* [4]. Since 1997, according to Bernhardt et al., 54 cases of autochthonous European myiasis were published [1]. Nosocomial myiasis is seldom reported in Europe, and intensive care unit (ICU)-acquired myiasis is even rarer.

We describe the first report of hospital-acquired oropharyngeal myiasis caused by *Lucilia sericata* occurring in a Swiss ICU. We provide a review of worldwide cases of ICU-acquired myiasis and discuss entomological aspects as well as treatment and prevention of this infestation.

Case description

A 78-year-old patient was admitted to hospital for heart failure. He was hospitalized and investigated for 10 days on the internal medicine ward and diagnosed with severe valvular disease. He underwent cardiac surgery on day 11 and was intubated in the operating theatre and admitted to the ICU after surgery. Sixty hours after the intubation, 13 live centimetric larvae were found in his oral cavity during usual mouth care by an assistant nurse.

A careful otorhinolaryngological examination revealed no significant oral lesion but only a small erosion in the retromolar trigone. Nasogastric tube aspiration and a routine bronchoscopy excluded further larvae infestation. The treatment consisted of mechanical larvae removal and further enhancement of oral hygiene with antiseptics. No further larvae emission was observed over the following days. The clinical course was then uneven, and the patient was discharged from the ICU two weeks later.

After their removal from the patient's mouth, five larvae were placed in a small container by ICU staff and sent to the parasitology laboratory. Based on their morphological features, the maggots were identified as dipteran larvae in their third instar. The larvae were kept at room temperature but, lacking direct entomological supervision, only one pupated. The pupa was preserved in 90% ethanol and sent for further identification to the second author. The morphological characters of the pupa supported that the specimen belonged to *Lucilia sericata* (Calliphoridae; figure 1). This identification was confirmed by DNA barcoding of the mitochondrial cytochrome c oxidase subunit I (*COI*) gene using a novel primer, with the resulting sequence being identical to GenBank entry OQ611258 [5]. According to the data published by Grassberger et al.[6], it takes an average minimum of 30 hours after oviposition for *L. sericata* to reach the third instar at 34 °C. It stays in this stage for up to 57 hours, then reaches the post-feeding phase and starts to pupate 139 hours after oviposition at 34 °C. This is the approximate temperature assumed to be inside the patient's oral cavity, where the larvae were found. Maggots were identified 60 hours after intubation, suggesting that oviposition occurred either in the operating room or shortly after ICU admission.

Usually, in our ICU, mouth care is performed three to six times a day by swabbing the patient's oral cavity, but

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not the oropharynx, with an antiseptic solution. Selective oropharyngeal decontamination three times a day is also part of our ventilator-associated pneumonia (VAP) preventive bundle [7]. A staff and chart survey confirmed adherence to the mouth care protocol, whereas selective oropharyngeal decontamination, which may typically occur during the early ICU course, was not administered.

The ICU and infection and prevention control team conducted an environmental investigation. No specific environmental factors favouring fly entry in the ICU were identified, and no other patient cases were identified. This case was discussed during a multidisciplinary meeting to ensure adequate staff education and awareness. Mouth care and organic waste management education were reinforced.

Literature review

Search strategy

We performed a literature search in PubMed using the following MeSH terms: "myiasis" combined with "intubation intratracheal", "intensive care unit" or "nosocomial infection" (37 results). A second search was conducted using the following keywords: "myiasis" combined with "ICU", "intensive care" or "intubat*" (39 results). The initial search yielded 69 papers. A selection was made using the following criteria: cases describing myiasis that occurred either during ICU stay (≥48 hours after admission) or within 48 hours of ICU discharge. We selected only papers with at least an abstract available in English.

Results

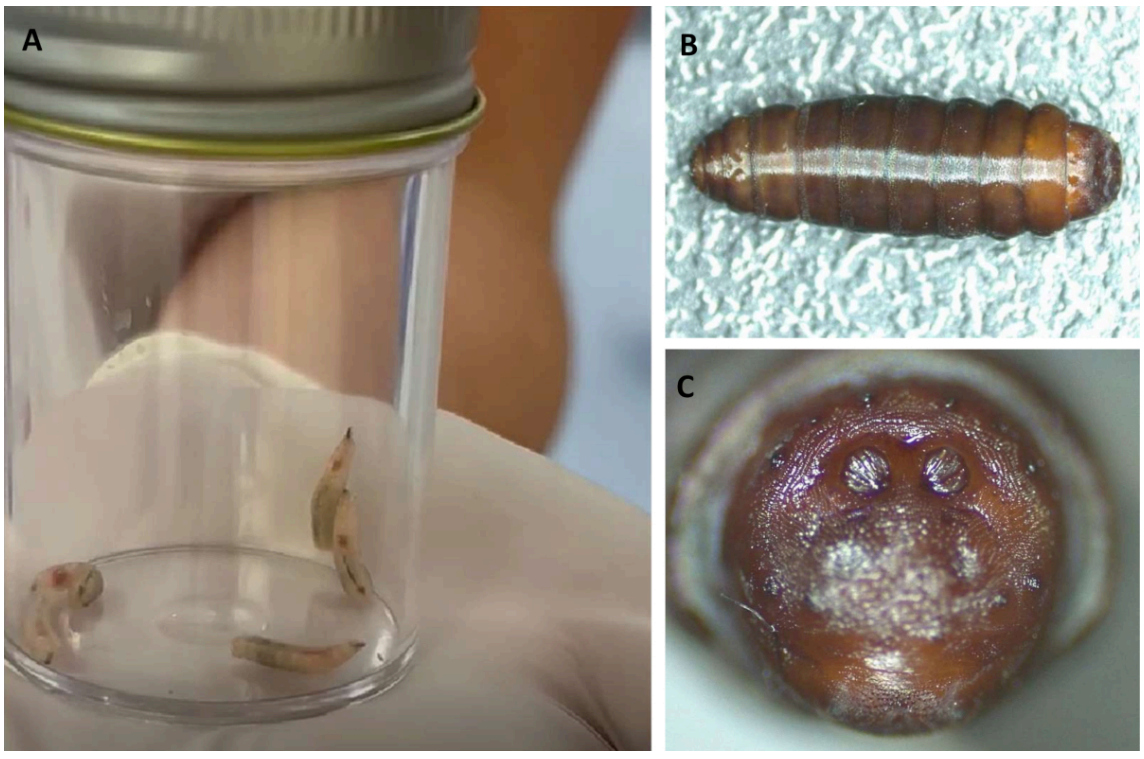
Thirty-eight case reports of ICU-acquired myiasis were identified worldwide (figure 2). Among these, 14 were reported from high-income countries, and eight were from Europe. Ninety-two per cent of reports of ICU-acquired myiasis presented as oro- or nasopharyngeal. In rare instances, infections were also reported at tracheostomy sites, in the vagina or in wounds. The most frequently involved species was *Lucilia sericata* (45% of cases; figure 3). Mechanical ventilation was a common feature of all cases. Nasogastric tube insertion and the presence of periodontal disease also appeared as predisposing factors. The Appendix offers an overview of these selected cases.

Discussion

Cases of nosocomial myiasis are constantly reported worldwide but only occasionally reported in intensive care patients because safeguards prevent fly entry in ICUs compared to other locations in the hospital [8–12]. Our case involving *Lucilia sericata* is the first nosocomial myiasis reported in Switzerland.

Lucilia sericata, a common blowfly known as the green bottle fly, is a cosmopolitan species with immense veterinary, medical and forensic importance. It is known for causing serious myiasis in sheep ("blowfly strikes"), which causes huge economic impacts to affected regions (mainly Northern Europe). However, in human medicine, *Lucilia sericata* larvae have displayed therapeutic benefits and are used as larva therapy to help heal some chronic wounds because they can feed on necrotic tissues, display antimicrobial activity and produce enzymes that promote healing [13]. *Lucilia sericata* also plays a role in forensic science to estimate the minimum postmortem interval because it is

Figure 1: (A) Third instar larvae just after collection; (B) one of the larvae after pupation; (C) detail of the anal plate of the pupa for species identification.



one of the most common necrophagous species recorded from dead human bodies [14]. The life cycle of the fly goes through four developmental stages: egg, larva, pupa and adult fly. Larvae will moult twice to reach the third stage (instar) of larval development. After the third stage of the larval period, larvae leave their host to find a place to pupate. The length of the life cycle can last from 10.79 days at 34 °C to 35.08 days at 17 °C [6]. The duration of the particular developmental stages depends on many external factors, of which the most important is temperature [6]. Blowflies usually lay their eggs in batches directly onto food sources (decaying animal or vegetable matter). However, they can also occasionally deposit them onto human necrotic tissues or open neglected wounds (traumatic myiasis) or in various human body cavities – but not onto intact mucous membranes, unlike obligatory parasitic fly species [1].

Flies are present all year round but can proliferate during summer months with higher temperatures due to a shortened life cycle. In our case, the infestation happened during a mid-summer heat wave. As noted by Bernhardt et al. [1], it is not unlikely that future global warming might change the incidence of this condition in Switzerland. Additionally, though the vast majority of fly species in Europe are facultative parasites, some obligatory species have also emerged [1]. According to a recent review, obligatory oral myiasis is most frequently caused by *Cochliomyia hominivorax* and *Chrysomya bezziana*, with higher reporting rates in India and Brazil [15]. Neurological diseases associated with clinical conditions such as lip incompetence or mouth breathing can increase an individual's risk of developing oral myiasis [15]. Unlike the present case of facultative oral myiasis caused by *Lucilia sericata*, these infestations can cause significant tissue damage and require aggressive treatment such as surgical extraction, necrotic tissue debridement and antiparasitic therapy [15].

ICU-acquired myiasis is predominantly oro- or nasopharyngeal. Mechanically ventilated patients, while sedated and paralysed, are defenceless against flies entering the pharyngeal sphere and are therefore at risk of infestation. Most cases of myiasis described in the ICU involve facultative parasites, such as *Lucilia* species, and are thus self-limited (figure 3). In rare instances, the infection is caused by obligatory parasites such as *Chrysomya bezziana* (figure 3). Due to the concern of local invasion and tissue destruction reported in nasal myiasis caused by obligatory species, some facultative ICU-acquired nasal myiases have been treated with invasive approaches such as sinus surgery [16].

Clinicians should differentiate between facultative and obligatory oral myiasis because this can change their approach to treating the condition. In facultative cases, antiparasitic or antibiotic treatments are unlikely to add benefits after mechanical larvae removal. Liaising with an entomologist is invaluable for identifying species and establishing the timing of infection. Additionally, since myiasis can occur as an outbreak, any case of nosocomial myiasis should prompt consultation with infection prevention and control to evaluate environmental factors favouring fly entry and identify potential concurrent cases.

Unlike operating theatres, ICUs are usually devoid of airlock systems, and flies can therefore occasionally be observed within their closure despite sealed windows. Flies can enter the ICU via staff and visitor movements or imported resources such as food. One ICU nosocomial case has been described in a patient with a private windowless room [17]. ICU staff should be aware of the possibility of myiasis occurring in mechanically ventilated patients and should not overlook the presence of flies.

Fly prevention is part of a comprehensive strategy to minimise the risk of healthcare-associated infections, not only in operating theatres but also in ICUs and on the ward. In

Figure 2: World distribution of published cases of ICU myiases.

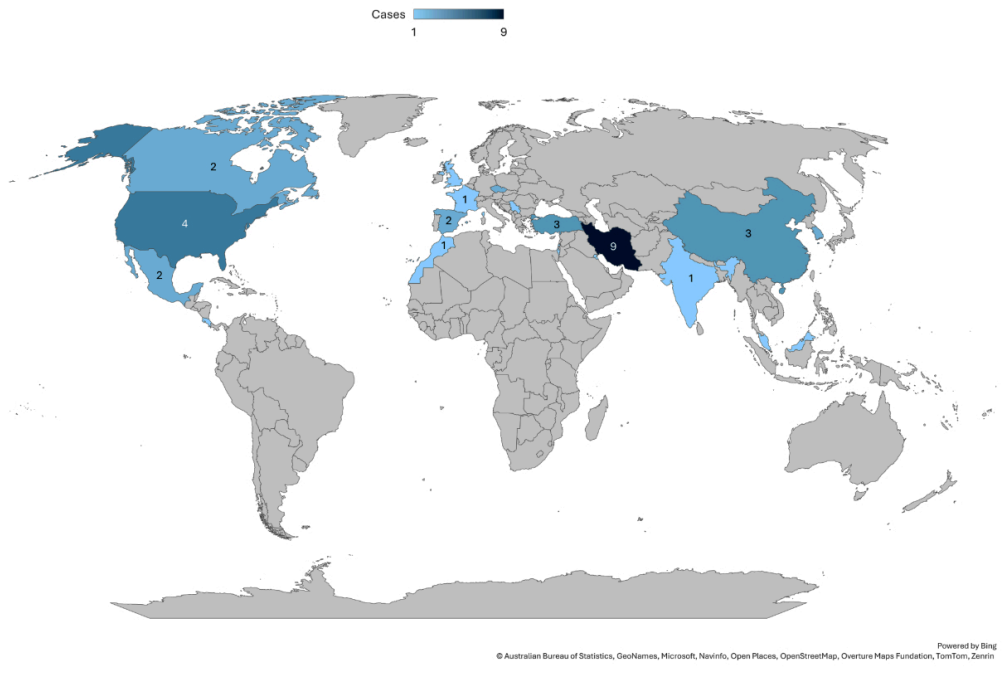
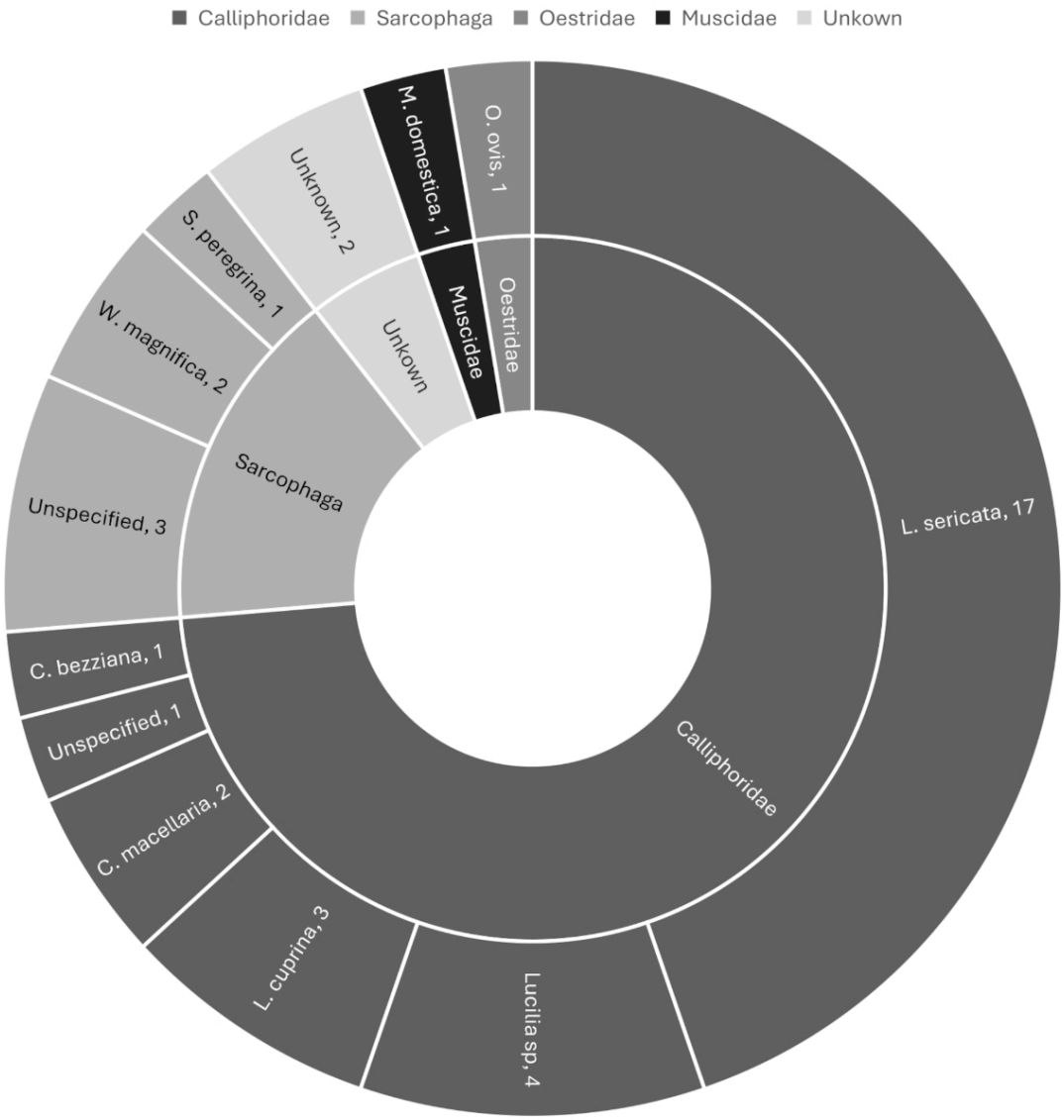


Figure 3: Distribution of species in published cases of ICU-acquired myiasis.



addition to causing incidental nosocomial myiasis, flies are also potential vectors of alert pathogens [18–20].

Though myiasis remains rare, reporting bias may be responsible for the lack of literature available, particularly in countries with high economic status, due to the poor image and risk of negative press it may lead to because this entity still carries the image of neglect and poor hygiene [21]. Our case is a reminder that myiasis is possible in high-income countries and is not invariably associated with neglect in care.

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Author contributions: MM and VD conceived the idea and wrote the manuscript. JH and JMS identified the species and established the nosocomial nature of the infection. All the authors critically reviewed the manuscript and contributed substantially to its final form.

Informed consent

Written informed consent was obtained from the patient for the publication of this article.

Potential competing interests

All authors have completed and submitted the International Committee of Medical Journal Editors form for disclosure of potential conflicts of interest. No potential conflict of interest related to the content of this manuscript was disclosed.

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Appendix

	Year	Country	Body location	Case description	Family/ Species	Tissue damage	Season	Environmental factors	Author and ref
1	1980	USA	Pharyngeal and wound	Description of two non concurrent cases of myiasis likely contracted in the same cardiac operating theatre in 1977 and 1979. 1) 73 year old woman CABG surgery. 2 days after surgery in ICU, larvae found in nose (and around sternal incision and subclavian catheters). 2) 67 year old redo for prosthetic aortic valve. Maggots found 42 hours after start of operating theatre in nasal cavity.	*Lucilia sericata*	Case 1: no damage. Case 2, after myasis identification nasal bleeding and septal perforation is described but ENT consult attributed to previous nasal surgery	Summer (August)	Infection control identified several possible routes for flies' entry in the OR (unscreened window in the dressing room). Intervention: large use of insecticide and sealing of the window.	Jacobson et al. [1]
2	1993	Canada	Pharyngeal and tracheostomy sites	Maggots found from nose and tracheostomy site of an 82 year old women in coma state.	*Cochliomyia macellaria*	no access to full text			Josephson et al. [2]
3	1994	Czech republic	Pharyngeal or traumatic wound	Polytrauma with facial and skull involvement. Tracheostomized du to inability to intubate. 50 larvae in the oral, nose and paranasal sinuses and enucleated eye socket found 7 days after ICU admission.	*Lucilia sericata*	prior (trauma). Secondary wound infection	Summer	Room with opening window without netting. Summer heat wave	Daniel et al. [3]

4	1995	Czech republic	Pharyngeal	Head trauma, intubated. Maggots found in nasal and oral cavity on the 4th day of ICU stay.	*Lucilia sericata*	no access to full text			Minar et al [4]
5	1997	Turkey	Pharyngeal	80 year old intubated and in ICU. 1 week following ICU admission 20 maggots found coming from the mouth and intubation tube.	*Wohlfahrtia magnifica*	no tissue damage at rhinoscopy	Summer (August)	Not described	Ciftçioğlu et al [5]
6	1998	Israel	Vaginal	Vaginal myiasis in an extremely premature infant intubated after deliver. The myiasis noted at 48hours after delivery and NICU admission.	*Lucilia sericata*	no tissue damage	Summer	Ground floor location of NICU as a favouring factor	Amitay et al. [6]
7	2002	USA	Pharyngeal	Description of 2 non concomitant cases with temporal proximity. 1) 45 year old man admitted for cardiomyopathy in ICU. Nasogastric tube then orogastric tube placed. Maggots found on day 10. 2) 49 year old cardiogenic shock. Nasotracheal intubation, nasogastric tube showing purulent drainage. maggots found on day 8.	*Lucilia sericata*	No tissue damage	Summer (case 1: July, case 2: September)	Fly observed within ICU. Mouse infestation in the hospital building present for months preceding the myiasis. Improper management of food storage in the kitchen Windows opening to the outside.	Beckendorf et al. [7]
8	2004	Kuwait	Pharyngeal	2 concurrent cases in a hospital. 1) 10 year old boy intubated due to MVA. nasal myiasis found on the 4 days after ICU admission. 2) occurred in orthopaedic ward (wound dressing after 14 days).	*Lucilia sericata* (case 1), *Megaselia scalaris* (case 2)	Unreported	Unreported	Fifty flies caught in the kitchen belonging to several species of fly.	Hira et al. [8]

9	2005	Turkey	Pharyngeal	Oral myiasis in a 15-year-old boy intubated in ICU due to tuberculosis meningitis. Maggots found at 27 days of ICU stay.	*Sarcophaga spp*	Poor oral hygiene but no tissue damage reported to be directly related to the infection	Unreported	Poor oral hygiene	Yazar et al. [9]
10	2006	Turkey	Pharyngeal	16 year old after MVA. Maggots found on day 4 of ICU stay.	*Sarcophaga spp*	No access to full text			Türk et al [10]
11	2007	Canada	Pharyngeal	Nasal myasis. 65 year old women intubated for in the ER for acute respiratory failure. Maggots found 3 days after intubation (2nd instar 6-7mmlong).	*Lucilia sp*	No tissue damage	Unreported	Private room windowless and open door.	Szakacs et al [11]
12	2009	South Korea	Pharyngeal	Nasal myasis in a 76 year old female, admitted after ruptured AA. Larvae found at day 4 of ICU admission.	*Lucilia sericata*	No pathological change by endoscopic examination	Summer (July)	Environmental factors not described.	Kim et al. [12]
13	2011	Iran	Pharyngeal	54 year old female underwent coronary artery bypass grafting. Intubated on day 2 (cardiogenic shock). Maggots found on day 22 after surgery (75 third instar larvae out of her nose), NGT	*Lucilia sericata*	No tissue damage reported	Summer	Contributing environmental factors not described.	Mowlavi et al. [13]
14	2011	China	Pharyngeal	74 year old admitted for SCA, CABG, intubated (nasotracheal tube due to difficult airways). Nasal myiasis. 7 maggots found after extubation on day 8	*Sarcophaga peregrina*	No pathological change found at nasal endoscopic examination	Summer (July)	No environmental factors described	Lee et al. [14]
15	2011	Malaysie	Pharyngeal	73 year old intubated at admission for respiratory failure. nasal myasis found on day 6 of ICU stay.	*Lucilia cuprina*	No tissue damage with nasal endoscopy	Unreported	Fly was observed within ICU enclosure on day 6. ICU is on first floor	Nazni et al. [15]

16	2012	Spain	Pharyngeal	32 year old male with peritonitis intubated, requiring multiple abdominal surgeries. Maggots found 15 days after ICU admission in the nasopharynx and oropharynx	*Lucilia sericata*	no tissue damage reported	Unreported	Environmental factors not described	Pérez-Giraldo et al. [16]
17	2012	Costa Rica	Pharyngeal	91 year old patient with signs of immunosuppression, severe impairment of lung function, and mechanical ventilation presented larvae in both nostrils on the seventh day after ICU admission.	*Lucilia cuprina*	no access to full text			Quesada lobo et al. [17]
18	2013	Korea south	Pharyngeal	37 year old with history of muscular dystrophy. Intubated on the ED, on day 8 of hospitalisation transferred to ICU. 43 larvae found a few hours after ICU admission (time not well described but infection is likely to be ED acquired rather than ICU acquired)	*Lucilia sericata*	no tissue damage reported	Summer	No environmental factors described	Jang et al. [18]
19	2014	Iran	tracheostomy site	63 year old. Day 35 of ICU. 100 larvae in tracheostomy site at one month of ICU admission. Died a day later	*Lucilia sericata*	no access to full text			Najjari et al. [19]
20	2014	Iran	Pharyngeal	36 year old lady with TRALI requiring intubation. ICU acquired. Found at 1 month of ICU admission. (timing of intubation unclear)	*Lucilia sericata*	unreported	Unreported	No environmental factors described	Alizadeh et al. [20]
21	2015	USA	Pharyngeal	53 year old with CA, intubated prehospitally, died after 7 days of ICU stay. Maggots found postmortem when the patient was extubation	*Lucilia cuprina*	not reported	Unreported	No environmental factors described	Ahadizadeh et al. [21]

22	2015	UK	Pharyngeal	2 ICU concurrent cases (2 days apart). 1) 52 year old intubated due to hypoglycemia and seizure. Developed ARDS secondary to aspiration. Nasal maggots found on routine nasal suctioning in ICU 2): 44 year old intubated due to aspiration pneumoniae. maggots found on routine care .	unknown	Unreported	Unreported	Flies reported in the ICU by staff. specific environmental factors not described	White et al. [22]
23	2015	Iran	Pharyngeal	Concurrent cases. 1): 81 year old suffered from CA, intubated and admitted to ICU. Maggots found on day 5 after ICU admission. 2) 47 year old liver insufficiency, intubated. Maggots found on day 15. 3) 74 y o with respiratory distress intubated 5 days prior to admission. hours (not clearly reported) after ICU transfer maggots found (infection occurred likely outside of ICU)	*Calliphoridae*	Unreported	Summer (June)	3 cases from the same fly genus. No environmental factors described but inspection of hospital windows revealed many dead flies suggesting fly infestation in the hospital buildings	Leylabadlo et al. [23]
24	2016	Iran	Pharyngeal	74 year old CAP, transferred to ICU on the 4th day after hospital admission, intubated day 5. Maggots were found 4 day after ICU admission.	*Chrysomya bezziana*	No lesion observed	Not reported	Specific environmental factors not reported	Mircheraghi et al. [24]

25	2017	Iran	Pharyngeal	55 year old, intubated due to respiratory failure, pulmonary nodules. Larvae found in the ICU on the 30 day safter hospitalisation. Timing of ICU admission and intubation not clearly mentionned	*Oestrus ovis*	Unreported	Not reported	Specific environmental factors not reported	Hazratian et al. [25]
26	2018	Iran	Pharyngeal	35 year old admitted to ICU for respiratory failure in the setting of immunosuppression after chemotherapy. Nasal myasis found several days after intubation. Described as ICU acquired	*Lucilia sp*	Unreported	Unreported	Specific environmental factors not reported	Salmanzadeh et al. [26]
27	2019	China	Pharyngeal	89 year old with long term tracheostomy ICU ventilated for 5 months. Maggots found in the dental caries	*Lucilia sericata*	Unreported	Unreported	Specific environmental factors not reported	Sun et al. [27]
28	2019	Iran	Pharyngeal	78 year old, out of hospital cardiac arrest intubated to and admitted to ICU. Maggots found 5th day after ICU admission.	*Lucilia sericata*	Unreported	Unreported	Specific environmental factors not reported	Ahmadpour et al.[28]
29	2020	Mexico	Pharyngeal	13 year old patient admitted to ICU for congestive heart failure. Intubated for respiratory failure. Maggots found 10 days after admission	Lucilia *sericata*	Oral examination described with periodontal disease. no tissue damage directly related to the infection	Unreported	Specific environmental factors not reported	Martínez-Rojano, H et al. [29]
30	2020	USA	Pharyngeal	72 year old admitted to ICU for septic shock. Intubated on ICU admission + placement of NG tube trigger large epistaxis. Maggots found 3 days after ICU admission feeding on blood clot (nasal)	Unkown	Blood from previous epistaxis. No tissue damage on serial nasal endoscopy	Unreported	Specific environmental factors not reported	Katabi et al [30]

31	2021	France	Pharyngeal	50 year old man intubated for SARS-CoV2 pneumonia. Maggots found 4 weeks after ICU admission. Patient found to have generalized periodontal disease.	*Lucilia sp*	No tissue damage reported	Summer (august 2021)	Specific environmental factors not reported	Dupont et al. [31]
32	2022	Morocco	Pharyngeal	72 year old with septic shock (peritonitis). Intubated. Maggots found a few days after admission	*Lucilia sp*	Full text in French			Bouikhif et al. [32]
33	2022	Spain	Pharyngeal	78 year old patient admitted to cardiac intensive care with cardiogenic shock, CA after 24h of CCU admission. PCI on day 3 with 3VD. Day 6 maggots found oral during routine care (50 maggots). Timing of intubation unclear	*Wohlfahrtia magnifica*	No tissue damage. Follow up endoscopy with biopsy. Mucosa was erythematous no perforation	Unreported	Specific environmental factors not reported	Ruiz-García et al [33]
34	2023	Iran	Pharyngeal	2 non concomitant cases, intubated ICU patients. 1) 18year old admitted to hospital in 2020 after car accident sustaining severe head trauma. Maggots found on 2 days after ICU admission from nasal/oral cavity 2) 32yo male after severe head trauma. Admitted to ICU. Maggots found on day 4 of ICU admission in oral cavity.	*Lucilia sericata*	No necrotic tissue at endoscopic evaluation	Summer	Specific environmental factors not reported	Zobairy et al.[34]
35	2023	Serbia	Pharyngeal	65 year old admitted to ICU for respiratory failure related to COVID. Intubated 5 days after ICU admission. On day 11 of ICU stay, 20 larvae found in the nostril. Nasogastric tube in place	*Sarcophaga spp*	No tissue damage at rhinoscopy	Spring (May)	Reallocated ICU is the setting of the COVID pandemic	Dolinaj et al [35]

36	2023	Mexico	Pharyngeal	outbreak of 5 cases in a hospital (from which 3 ICU acquired). 1) oral myiasis found 10 days after starting IMV. 2) oral myiasis observer at day 6 after ICU admission with IMV. 4) 50 y old intubated due to liver failure requiring IMV, oral myasis on the 8 days. Cases 3 and 5 not ICU acquired	*Cochliomyia macellaria*	No tissue damage	Summer (June and July)	No environmental factor is discussed, extensive fumigation and reviewing of screening of windows in all buildings was undertaken without new cases occuring.	Espinoza-Gómez et al. [36]
37	2024	India	Pharyngeal	Outbreak. Two concomitant cases of nosocomial ICU myiasis. 1) 73 year old intubated for respiratory failure due to terminal lung cancer. On day 21, 8 larvae removed from oral cavity .. 3 day later. 2) 93 year old intubated for nosocomial pneumoniae. Larvae found on day 24 of hospitalisation. 6 larvae found from nasal cavity (NGT)	*Lucilia sericata* (case 1). Not identified in case 2	No tissue damage	Summer (July)	Chronology between the two cases unclear. No infection prevention control described	Savas et al. [37]
38	2024	China	Pharyngal	55 year old admitted to ICU due to severe respiratory failure. Intubated on day 1 in another institution and transferred to ICU Maggots found on the 4 days of ICU admission.	*Musca domestica*	Tissue damage is not described but the authors mention debridement	Unreported	No infection prevention control described	Xu et al. [38]

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