# Case Report

## INDOOR AIR POLLUTION AS A RISK FACTOR FOR FATAL ANTHRACOSIS AND COPD IN SUB-SAHARAN AFRICA – THE CASE OF AN UNIDENTIFIED RWANDAN MALE OF ABOUT 50 YEARS

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**ABSTRACT**

**Background:** The deposition of particles of coal dust into the lung tissue, particularly due to high exhaust pollution levels in large cities, smoking, or in the coal mining sector, is generally considered as less harmful than the deposition of other kinds of dust that lead to unspecific clinical pictures of the lung tissue (e.g. asbestosis, silicosis, silicatosis). However, anthracosis, a more or less intensive deposition of coal dust into the pulmonary interstitium and lymphatic system connected with a blackish pigmentation is a common macroscopic and microscopic finding especially in cities and greatly contributes to the development of chronic obstructive lung disease (COPD). The present case report aims at highlighting the high relevance of indoor pollution to the development of COPD and other lung diseases.

**Methods:** We review a case of a 50-year-old Rwandan male autopsied at the Kacyiru Police Hospital as part of an inter-disciplinary Forensic Summer School with the theme" A holistic approach towards a safer society" in the Conference held in Kigali-Rwanda from 24th -27th August 2015.

**Results:** The autopsy revealed severe chronic anthracosis, COPD, pulmonary fibrosis, emphysema; and a diagnosis of pulmonary insufficiency was made as the cause of death.

**Conclusion:** Indoor air pollution, particularly through the burning of biomass and coal in closed rooms, is a relevant risk factor for the development of pulmonary diseases such as anthracosis and COPD. Mainly affected are regions in developing and emerging countries, especially in the countryside. Therefore, the reduction of the concentration of pollutants inside closed rooms is the most important aim, either by using more effective technical devices or by improving ventilation in these rooms. These objectives should be pursued by educational and policy measures.

**Keywords :** Indoor pollution – Anthracosis - COPD

## INTRODUCTION

The deposition of particles of coal dust into the lung tissue, particularly due to high exhaust pollution levels in large cities, smoking, or in the coal mining sector, is generally considered as less harmful than the deposition of other kinds of dust that lead to unspecific clinical pictures of the lung tissue (e.g. asbestosis, silicosis, silicatosis). Especially the so-called anthracosis, a more or less intensive deposition of coal dust into the pulmonary interstitium and lymphatic system that is connected with a blackish pigmentation (1), is a common macroscopic and microscopic finding, especially in cities (2,3). Furthermore, the deposition of dust particles and other inhaled combustion products can contribute to the development of the chronic obstructive pulmonary disease (4). A special form of pollution is found in poorly ventilated and narrow rooms (5). Our own experience is based on autopsies performed in the context of a medico-legal project in Kigali, Rwanda. For many years now, the department of Legal Medicine of the University Medical Center Hamburg-Eppendorf in Germany has run with Rwanda, a cooperation supported by the German Academic Exchange Service (DAAD) program "PAGEL" ("Partnerships for the Health Sector in Developing Countries"). Its key element is the yearly "Interdisciplinary Forensic Summer School" in Kigali, which consists of a four-day academic conference and performing several autopsies. This paper focuses on indoor air pollution as a risk factor for anthracosis and COPD.

### Case presentation

Scene and external investigation: The unknown deceased, an unidentified man aged between 50 and 60 years with a length of 170 cm and a weight of 45 kg (body mass index [BMI] 15,6 kg/m2, cachexia), was found dead in Kigali by the roadside. He was fully clothed. Neither injection marks nor signs of relevant trauma (e.g. bone lesions or organ injuries) were found. The pupils were of middle size, no petechiae were present. The deceased had short grey hair and a scar on the left forehead. His mandibular teeth were partly missing.

**Autopsy findings:** Generalized moderate arteriosclerosis. Severe anthracosis in both lungs and hili, as well as in the paratracheal and peribronchial lymph nodes. Signs of a progressive COPD; chronic adhesive pleuritis with

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extended scarification of the pleural cavity, chronic bronchitis, pulmonary emphysema, and pulmonary fibrosis were detected as well as purulent bronchitis and consecutive bronchopneumonia. In addition, consecutive right ventricular insufficiency with chronic and acute blood stasis in the liver and spleen were observed. No further macroscopic internal disease or cerebral alteration was noted.

*Cause of death:* Pulmonary insufficiency caused by severe chronic anthracosis and pulmonary fibrosis, complicated by purulent bronchitis and confluent bronchopneumonia, COPD and emphysema was suggested. The manner of death was attributed as natural.

*Complementary investigations*
*Histology:* in lungs, the histology showed very extensive anthracosis and fibrosis of the interstitial tissue. It also revealed acute purulent bronchitis and peribronchial pneumonia with confluent intra-alveolar granulocytic infiltration, thus forming micro-abscesses (Figures 1, 2, 3, 4, 5).
Toxicological investigations were not performed.
Diagnosis: Pulmonary fibrosis, severe chronic anthracosis, COPD

## Discussion

Under special living conditions, intensive burdens through the inhalation of dust and other pollutants can occur. Such conditions can be found especially in economically weaker regions in many countries worldwide – particularly in the countryside (6,7,8). For example, in many regions in Africa, Latin America and Asia, large sections of the population use solid fuel for the daily cooking and heating (9,10), which regularly leads to a production of dust over several hours per day (4).
The pollution resulting from flue gases is particularly high in poorly ventilated narrow rooms with lack of extractors, dusting systems, or even windows, in which open fire is used for heating or cooking purposes (5,11,12).

The morphological picture of the anthracotic lung is usually dominated by extensive depositions of materials including coal dust in the pulmonary interstitium – located near the fibrous septa – with consecutive fibrosis, pulmonary arteriosclerosis, emphysema and subsequent infections – with a bronchopneumonia at the end (2,3). COPD is a generic term for several diseases that have in common, the symptoms such as cough (often with sputum) and exertional dyspnea – particularly concerning the exhalation (13).

The presented case demonstrates the high relevance of indoor air pollution for the development of respiratory diseases such as COPD, in comparison to other external environmental factors. This pollution can be the result of the production of pollutants through open fire, especially when different fuels (e. g. wood or charcoal) are used. By the burning, numerous different gaseous substances are released into the air, for instance carbon monoxide (CO), nitrogen dioxide (NO2) and sulphur dioxide (SO2) (9,14,15,16). Along with a reduced removal of the substances due to insufficient ventilation, the pollutants can accumulate in closed rooms (11).

COPD was originally considered as a typical disease in industrial nations, as cigarette smoke is an important risk factor (4,14,18). However, it is recognized that COPD is also common in less developed countries (11). Worldwide, it is the fourth major cause of death (4). The relevance of air pollution for the development of COPD has already been known since the beginning of the 20th century (14). Next to cigarette smoke and indoor air pollution with exhaust gases from combustion, genetic factors are regarded as risk factors (14). Furthermore, low standards in income and education as well as malnutrition are discussed as promoting factors (4,7). Women (14) and young children (7,16) are particularly at risk (17). This is presumably attributable to the fact that it is common that women run the household in many of the affected regions, with small children or babies in their immediate environment, for instance carried on the mother's back (15,16). Next to the concentration of the pollutants in the air, the exposure period is a critical factor. It is estimated that the affected populations are exposed to the pollutants over a period of three to seven hours, depending on the duration of the stay inside the closed rooms (15,16). Also in industrial nations, many households exceed the critical limits for pollutants, due to the use of fuels, particularly in ovens (7). However, the concentrations are comparatively low, as higher technical standards (e. g. effective ventilation systems in ovens) are widely distributed (7).

Many studies have examined the relevance of indoor air pollution as a risk factor (4). However, they mainly concentrate on Latin America and Asia (4). So far, there is little data available for Africa. A possible reason for this is the relatively small number of autopsies in African countries and the comparatively little practical patho-morphological experience of many pathologists and forensic pathologists. In addition, it is conceivable that cases of anthracosis and COPD often remain hidden behind the relatively low life expectancy especially in sub-Saharan Africa. Therefore, systematic autopsies (especially of elderly people) are suggested, as well as clinical and environmental health studies, with a special focus on pulmonological aspects.

From this knowledge, direct conclusions for prevention measures can be drawn. The causal therapy is the termination of the exposition by the pollutants (5). Therefore, government measures that aim to reduce the concentration of pollutants in closed rooms are recommended (14). One approach are government subsidies for housing construction and renovation, connected with the implementation of mandatory provisions into the building laws of the affected countries, in order to raise the distribution of windows and ventilation systems in private homes even in the countryside (14). Another approach is the education about the dangers connected with the use of open fire in closed rooms. By that, many people could be encouraged to only cook in front of the house or at least to ventilate the rooms by opening the door on a regular basis (11). Especially education is a cost-effective measure to bring about changes (19). However, it can be expected that indoor air pollution will remain a widespread health problem in Africa and worldwide (7).

## Conclusion

Indoor air pollution, particularly through the burning of biomass and coal in closed rooms, is a relevant risk factor for the development of pulmonary diseases such as anthracosis and COPD. Mainly affected are regions in developing and emerging countries, especially in the countryside. The presented case highlights the morphological consequences of long exposures to the pollutants in question. The only causal therapy is a preventive approach. Therefore, the reduction of the concentration of pollutants inside closed rooms is the most important aim, either by using more effective technical devices or by improving ventilation in these rooms. These objectives should be pursued by educational and policy measures.

***Figure 1***

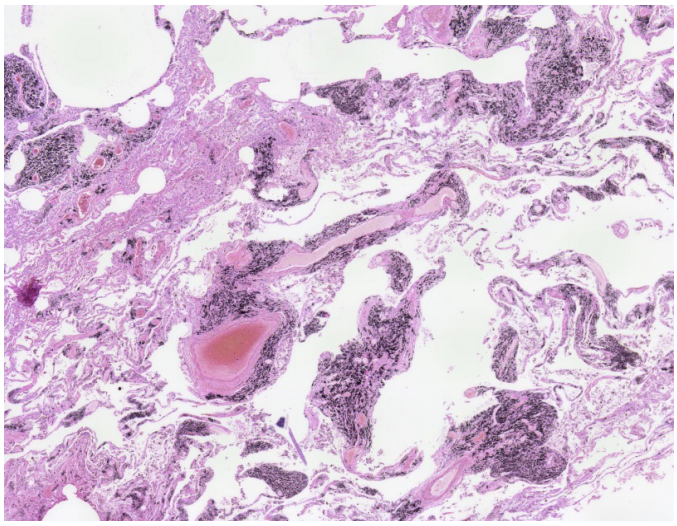

***Figure 1:*** *Anthracosis (Hematoxilin and Eosin [HE], x50)*

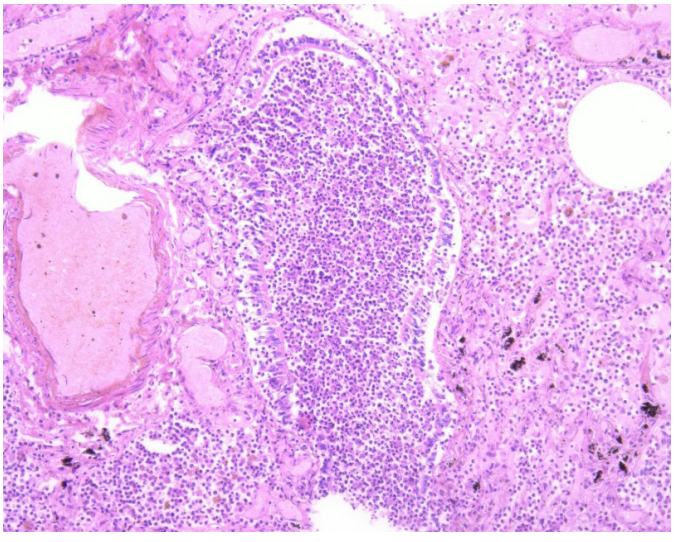

***Figure 2:*** *Purulent bronchitis (HE, x 150)*

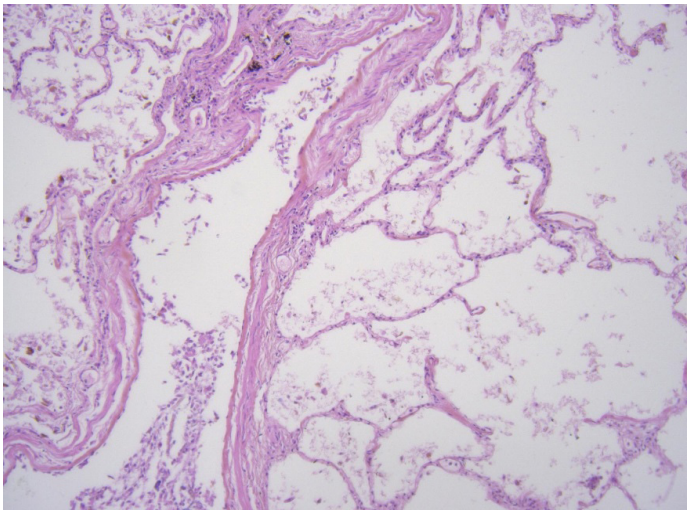

***Figure 3:*** *Emphysema (HE, x100)*

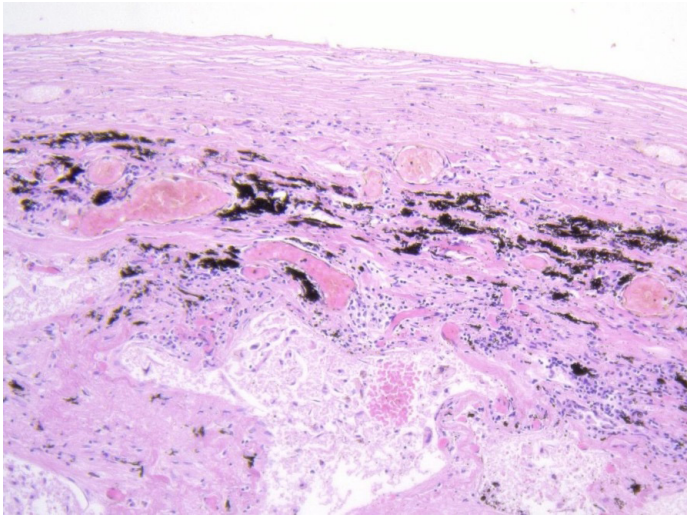

***Figure 4:*** *Pleura fibrosis (HE, x100)*

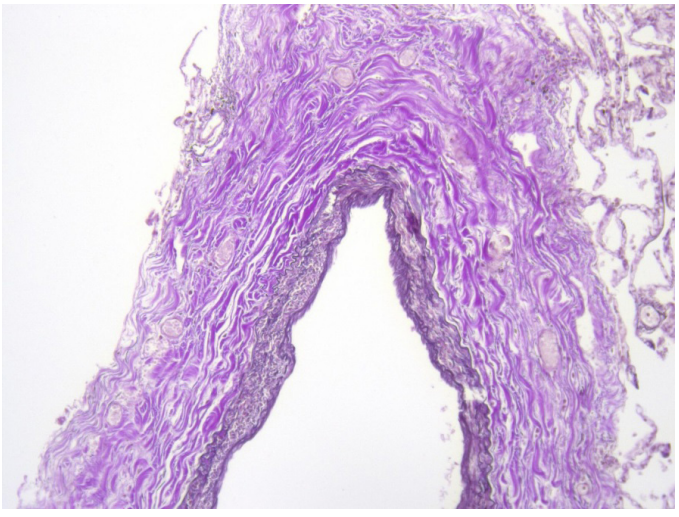

***Figure 5:*** *Pulmonary arteriosclerosis (Elastica-van-Gieson, x50)*

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