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# Effectiveness of environmental control measures to decrease the risk of invasive aspergillosis in acute leukaemia patients during hospital building work

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SUMMARY

***Background:*** Invasive aspergillosis (IA) is a significant problem in acute leukaemia patients. Construction work near hospital wards caring for immunocompromised patients is one of the main risk factors for developing invasive pulmonary aspergillosis (IPA).
***Aim:*** To assess the impact of environmental control measures used during hospital construction for the prevention of IA in acute leukaemia patients.
***Methods:*** A retrospective cohort study was developed to evaluate the IA incidence in acute leukaemia patients with different environmental control measures employed during hospital construction. We used European Organisation for the Research and Treatment of Cancer (EORTC) criterial diagnosis parameters for definition of IA.
***Findings:*** A total of 175 episodes of inpatient care were evaluated, 62 of which did not have any environmental control measures (when an outbreak occurred), and 113 that were subject to environmental control measures directed to preventing IA. The study showed an IA incidence of 25.8% for the group without environmental control measures vs 12.4% for those who did receive environmental control measures ($P = 0.024$). The relative risk for IA was 0.595 (95% confidence interval: 0.394–0.897) for the group with environmental control measures.
***Conclusion:*** The current study suggests that the implementation of environmental control measures during a hospital construction has a positive impact for prevention of IA in patients hospitalized with acute leukaemia.


## Introduction

Invasive fungal disease is an important cause of morbidity and mortality among patients with haematological disease. Risk factors associated with the underlying disease include neutropenia, use of steroids, high-dose cytarabine treatment and bone marrow transplantation [1].

Construction and renovation activities may cause serious dust contamination and disperse large amounts of fungal spores. Construction activity has been reported to be an independent risk factor for invasive fungal disease. Numerous fungal outbreaks have been reported in healthcare settings, showing that construction activities are a serious threat to immunocompromised hosts [2–6].

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*Aspergillus* spp. are perhaps the most notorious construction-related pathogens. Preventive measures to control invasive aspergillosis (IA) are therefore considered essential. Recommendations include minimizing the dust generated during construction activity and prevention of dust infiltration into adjacent patient care areas. The Centers for Disease Control and Prevention guideline recommends high-efficiency particulate air (HEPA) filter systems for high-risk patients to reduce fungal spore counts in the environment of healthcare facilities during construction and renovation [7–10]. However, rooms with HEPA filter systems are scarce in developing countries, and portable systems are not easily affordable.

A nosocomial outbreak of invasive pulmonary aspergillosis occurred in our hospital in Medellin, Colombia, between August 2013 and December 2013. This outbreak was associated with an extensive building work. After this outbreak, further construction work was taking place and was expected to continue for at least the next three years, and therefore strategies to minimize IA were implemented. These included environmental control measures, in order to decrease the dust generated during construction, as well as active epidemiological surveillance. After one year of follow-up, primary prophylaxis with posaconazole was added for acute leukaemia patients undergoing intensive chemotherapy for remission induction. The three HEPA-filtered rooms available in the hospital were used for allogeneic transplantation and high-risk patients who did not receive posaconazole.

The aim of the study was to assess retrospectively the impact of environmental control measures used during hospital construction for the prevention of IA in acute leukaemia patients.

## Methods

### *Patients*

Ethical approval for the study was obtained from the hospital ethics committee. All patients aged >14 years with acute lymphoblastic leukaemia or acute myeloid leukaemia receiving treatment as inpatients at Hospital Pablo Tobón Uribe between August 2013 and December 2015 were enrolled. Patients with a previous diagnosis of IA were excluded.

### *Preventive measures during building work*

Following an outbreak of hospital-acquired aspergillosis in the haematology ward, the hospital adopted preventive measures applied to decrease the risk of nosocomial aspergillosis during construction work. Three different strategies were implemented to minimize IA: (i) environmental control measures; (ii) HEPA filtration; and (iii) primary prophylaxis with posaconazole.

The environmental control measures included dust-control procedures and barriers during construction, repairing, renovation, or demolition. Dust accumulation was avoided by supervising the cleaning of surfaces and air conducts, and by controlling the sealing of rooms containing at-risk patients. Healthcare workers were educated on the dangers of nosocomial IA, especially among immunocompromised patients, and the control procedures taking place during the building construction.

Other measures were periodic reviews of the local epidemiology for IA and multidisciplinary meetings to develop guidelines for each construction project. Temporary plastic barriers were placed between inpatient-care areas and construction areas to prevent dust from entering. Patient transit during hospitalization was limited when possible and pedestrian traffic (workers, patients, healthcare workers, and visitors) was directed to avoid construction areas and limit the entrance of contaminated particles. Use of high-efficiency filtration masks in immunosuppressed patients was mandatory when going near construction work areas.

The second intervention was the use of rooms equipped with HEPA and positive pressure for patients with haematological diseases. However, our institution only has three rooms meeting these characteristics. These rooms were reserved for highly immunocompromised patients with haematological malignancies such as acute leukaemia and/or bone marrow transplant. The remaining patients were placed in conventional units.

A third intervention was the use of posaconazole as prophylaxis for patients.

Throughout the study period, systematic monitoring of high-risk patients (bone marrow transplant and severely neutropenic patients) was performed, including galactomannan antigen tests performed twice weekly during hospital stay, to detect possible cases of IA.

### *Analysis*

A retrospective cohort study was employed to evaluate the IA incidence in acute leukaemia patients with different environmental control measures employed during hospital construction. For this study, we analysed the results in two groups, the first being the baseline group without environmental control measures. This group consisted of patients admitted between the beginning of the construction, in August 2013, and April 2014 when the IA outbreak was detected. The group had only conventional measures applied for diagnosis and treatment treatment of IA. The second group was the environmental control group, and was subject to combinations of the three strategies adopted for the hospital as preventive measures of IA.

### *Definition of cases*

Medical reports of patients aged ≥14 years with a diagnosis of acute leukaemia and treated at our institution during the period of August 2013 and December 2015 were reviewed retrospectively and follow-up data including information on mortality were obtained. Diagnosis of invasive fungal disease was made based on the revised European Organization for Research and Treatment of Cancer/Mycoses Study Group (EORTC/MSG) definitions published in 2008 [11].

### *Sample size*

The sample size was calculated with Stata 11.1 software (StataCorp, College Station, TX, USA).

The two-sample proportion comparison was used with later data entry. Incidence of IA without environmental control was 40% versus 15% with environmental control measures.