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Predictors of Mortality in Patients Hospitalized with Community-Acquired Pneumonia: A Retrospective Analysis

Ahmad Shabbir [1], Hafiz Hammad Abdullah [2], Nouman Anayat [3], Ali Ahmad Khan [1], H Muhammad Ismail Mughal[1], Ali Usama[1]*

1. Department of Medicine, Nishtar Medical University, Multan, Pakistan
2. Department of Medicine, Allama Iqbal Teaching Hospital, D.G Khan, Pakistan
3 Department of Medicine, Shaikh Zayed Medical Complex, Lahore, Pakistan

Corresponding Author: Ahmad Shabbir, **Email:** ahmadshabbir4623@gmail.com, **Cell:** +92 3452670499

ABSTRACT

Background: CAP is currently a significant contributor to morbidity and mortality across the globe and mostly in low- and middle-income nations. It is critical to determine the predictors of the poor outcomes to maximize the use of early management and lower mortality.

Objective: The aim of the study is to identify clinical, laboratory and radiological risk factors of in-hospital mortality among hospital-admitted CAP patients in a tertiary-care hospital in Pakistan.

Methods: The study was a retrospective observational study, which was carried out at Department of Medicine, Nishtar Medical University and Hospital, Multan, between June 2024 and May 2025. The review included the medical records of 100 patients with CAP of adult age. The variables that were analyzed were demographic, clinical, and biochemical. The severity of the disease was measured with the help of the CURB-65 score. A univariate and multivariate logistic regression analysis were carried out to determine independent predictors of mortality.

Results: The average age of the patients was 59.315.7 years; 62% were male. The aggregate in-hospital mortality stood at 21%. Age 65 and above, diabetes, COPD, chronic kidney disease/CKD, tachypnea, hypotension, altered consciousness, increase in urea and creatinine, hyponatremia, multilobar infiltrates, and high CURB-65 scores were factors significantly related to mortality. The study used a multivariate analysis to find four independent predictors: age 65 years and above (AOR 5.21, p = 0.021), CKD (AOR 4.92, p = 0.035), hypotension (AOR 4.37, p = 0.046) and CURB-65 3 and above (AOR 6.45, p = 0.013).

Conclusion: Elderly age, kidney malfunction, hypotension, and elevated CURB-65 scores are all independent mortality predictors of CAP. The high-risk patients can be identified and aggressive managed at an early stage to enhance outcomes in resource-constrained environments.

Keywords: Community-acquired pneumonia, mortality predictors, CURB-65 score, chronic kidney disease, Pakistan, retrospective analysis

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INTRODUCTION

Community-acquired pneumonia (CAP) has been among the most impactful infectious diseases in the world with a significant burden on health systems worldwide and high morbidity, mortality, and healthcare expenses. CAP refers to an acute pulmonary parenchyma infection obtained outside of hospitals or medical care [1]. Although significant progress is made in antimicrobial therapy, vaccination and critical-care management, pneumonia

remains one of the principal causes of hospitalization and mortality in adults, especially among the elderly population and patients with chronic underlying conditions. World Health Organization (WHO) reports that lower respiratory tract infections, such as CAP, are among the top five causes of death globally, with the deaths being about 2.5 million every year, with most deaths reported in low- and middle-income countries [2,3].

CAP has geographic, age of the patient, and socioeconomic differences in its incidence worldwide. In industrialized countries the incidence is estimated at 511 cases per 1000 adults annually whereas in developing countries the rates are much higher [4]. CAP is one of the most common causes of adult hospitalization in Pakistan, a significant health issue as it is presented late, antimicrobial abuse is widespread, most people have not received immunization, and lack of access to diagnostic and intensive-care support. It is also associated with severe form of the disease, which is complicated by sepsis, respiratory failure, and dysfunction of multiple organs, thus, heightening the risk of adverse outcomes and death. It has been reported that mortality levels among hospitalized CAP patients among South Asians population has been observed to vary between 10-30 percent based on age, comorbid conditions, severity of the disease and provision of appropriate early treatment [5,6].

CAP is the pathophysiology that is characterized by the invasive relation of the lower respiratory tract by the pathogenic microorganisms, which leads to the intense inflammatory and immune actions. The ensuing alveolar inflammation causes difficulty in gas exchange, systemic inflammatory reaction and in extreme situations, sepsis and organ failure [7]. The most frequently involved pathogens are *Streptococcus pneumoniae, Haemophilus influenzae, Klebsiella pneumoniae* and atypical organisms such as *Mycoplasma pneumoniae* and *Legionella pneumophila.* Nevertheless, the range of microbes may differ significantly across the regions and medical facilities. The developing cases of antimicrobial resistance also make it highly difficult to manage the issue especially in Pakistan where the usage of inappropriate antibiotics is common and microbiological tests are not always available or prompt [8].

Many demographic, clinical, and biochemical variables have been linked with high risk of death in CAP. Risk determinants of the highest significance include advanced age, males, smoking, and the presence of such chronic diseases as diabetes mellitus, chronic obstructive pulmonary disease (COPD), chronic kidney disease (CKD), cardiovascular disorders, etc. The appearance of such physiological parameters as hypotension, tachypnea, hypoxia, change in level of consciousness and increased respiratory rate are good predictors of the severity of the disease and unfavourable prognosis [9]. Equally, laboratory abnormalities, including leukocytosis or leukopenia, increased serum urea and creatinine, hyponatremia, and high C-reactive protein (CRP) have been systematically associated with poor outcomes. The radiological pattern, especially the presence of multilobar or bilateral infiltrates is an indicator of harsh lung involvement and a predictor of high mortality [10].

In order to provide standard assessment and inform clinical management, a number of prognostic scoring systems have been developed [11]. These include the Pneumonia Severity Index (PSI) and CURB-65 score which is commonly used to assess the severity of the disease, mortality and whether the patient conditions warrant admission to the hospital or intensive care unit. CURB-65 integrates five important parameters into it that include Confusion, Urea >7 mmol/L, Respiratory rate ≥30/min, low Blood pressure (systolic <90 mmHg or diastolic 60 mmHg), and Age ≥65 years, and gives one point to each of the parameters. Although these models are useful clinically, they were mostly based on the Western population and might not mirror the demographic, microbiological, and healthcare profiles of patients in developing nations. The direct applicability of these indices to the South Asian settings is limited by variations in population age structure, the pathogen profiles, comorbidity patterns, and healthcare delivery [12].

There is little information available in Pakistan on the predictors of mortality in hospitalized CAP patients. The vast majority of studies available are small studies of individual centers with heterogeneous populations and unequal methodology. As a result, no exhaustive data has been conducted to determine the most appropriate prognostic factors that can be used in the local healthcare setting. The knowledge gap is considered critical due to the necessity that a timely identification of high-risk patients must be performed to initiate an aggressive therapy, make a level-of-care decision, and optimize the use of medical resources in overcrowded tertiary hospitals. Additionally, learning the trends of risk in the region may help policy makers and health care providers to design more personalized clinical directions and preventative schemes including specific vaccination interventions, antimicrobial stewardship and enhanced diagnostic centers [13].

In the face of these difficulties, there is a pressing necessity to produce the sound, context-specific data about the factors that contribute to the CAP-related mortality in Pakistani hospitals. Local studies can be used to determine which parameters can be used to improve prognostic models and predict outcome in resource-limited settings by analyzing clinical, laboratory, and radiological parameters of the admitted patients. This information would not just contribute to clinical decision-making but also improve the hospital triage procedures and patient education on the prognosis of the disease [14].

Thus, the current retrospective study was conducted at a large teaching hospital of tertiary care in southern Punjab, Pakistan to examine the predictors of in-hospital mortality in the patients with community-acquired

pneumonia. Through the evaluation of demographic features, comorbidities, vital variables, biochemistry, and radiological results, the research will help determine independent risk factors that relate to mortality. The results will add useful local data to the already existing literature, will assist in optimizing the existing risk-stratification instruments, and eventually lead to patient-better outcomes and more effective management of CAP in the Pakistan healthcare system [15].

MATERIALS AND METHODS

This retrospective observational study involved the Department of Medicine at Nishtar Medical University and Hospital, Multan, Pakistan, a large teaching tertiary care center, which receives a sufficient number of cases of community-acquired pneumonia (CAP) each year. The research was conducted during the one-year period between June 2023 and May 2025 upon receiving an ethical permission through the Institutional Review Board of Nishtar Medical University. The aim of the research was to determine clinical, laboratory and radiological mortality predictors in patients hospitalized with CAP [13].

The sample population included adult patients (18 years and older) who were taken to the medical wards or the intensive care unit and were diagnosed with community-acquired pneumonia within the study period. A sample of 100 patients was chosen using the consecutive sampling of the medical records archives of the hospital according to a set of inclusion and exclusion criteria. CAP was based on the diagnosis of new pulmonary infiltrates which were found on the chest radiography in combination with at least two of the following clinical presentations; fever higher than 38 °C or hypothermia lower than 36 o C, productive or dry cough, dyspnea or tachypnea, pleuritic chest pain, and abnormal breath sounds on the physical exam. The study only involved those patients who contracted pneumonia outside the hospital or the healthcare facility and were presented within 48 hours of admission. Patients having hospital-acquired pneumonia, ventilator-associated pneumonia, pulmonary tuberculosis, or COVID-19 were excluded.

Similarly, immunocompromised persons with HIV infection, chemotherapy malignancy, or long-term corticosteroid therapy plus patients with incomplete records were also not considered [11-18].

The hospital record department was accessed with the help of a structured proforma to retrieve the data. The data used was in the form of demographic data (age, gender, smoking history), clinical data (body temperature, pulse rate, respiratory rate, blood pressure, oxygen saturation, mental state, and signs of sepsis or septic shock), and comorbidity (diabetes mellitus, hypertension, chronic obstructive pulmonary disease (COPD), chronic kidney disease (CKD), and ischemic heart disease). Each patient was recorded on the laboratory parameters complete blood count (CBC), serum electrolytes, renal function tests, random blood glucose, and C-reactive protein (CRP). Arterial blood gas (ABG) analysis findings were also added where possible. Radiological data were examined on patient file to determine the trend of the lung involvement and this was classified as either unilobar or multilobar pneumonia. The severity of illness was determined by using CURB-65 score which consists of confusion, urea greater than 7 mmol/L, respiratory rate of 30 or more breaths per minute, systolic blood pressure of less than 90mmHg or diastolic blood pressure of 60mmHg or less, and age of 65 years or more. Each criterion received a point and the cumulative score was utilized in stratifying the risks. In-hospital mortality was the primary outcome variable, which is death during the hospital stay that is directly and indirectly related to pneumonia or its complications [20-25].

Two investigators independently checked all data to make sure that no data were left out and that data was accurate. Missing or unclear information was verified by cross checking the digital health records and treating physician notes where feasible. IBM SPSS Statistics version 26.0 was used in analyzing the data obtained. The baseline characteristics were summarised using descriptive statistics. Continuous variables were given in the form of mean and standard deviation (mean and SD), whereas the categorical variables were presented in frequencies and percentages. The role of chi-square test or the Fisher which is categorical and independent sampling t -test which is continuous variables were used to perform univariate analysis to identify factors which are related to mortality. The independent predictors of the in-hospital mortality were then determined using multivariate logistic regression analysis when the effects of a potential confounder were accounted. Each predictor was shown to have the strength of association in the form of odds ratio (OR) with a 95% confidence interval (CI). Less than p-value of 0.05 was regarded as significant statistically [1-8].

During the research, the confidentiality of patients and ethics were upheld. All personal identifiers were eliminated before the analysis, and the data were utilized in the course of the research. The ethical principles adopted in the study were the declaration of Helsinki (2013). The Institutional Review Board provided a waiver of the informed consent as it was a retrospective chart review, and because it posed a low risk to participants.

RESULTS

A total of 100 patients fulfilling the diagnostic criteria for community-acquired pneumonia (CAP) were included. The mean age of the study population was 59.3 ± 15.7 years (range 21–89 years). Of these, 62 (62%) were males and 38 (38%) were females, giving a male-to-female ratio of 1.6: 1. The overall in-hospital mortality rate was 21% (n = 21). Mortality was higher in males (25.8%) compared to

females (13.2%), although this difference did not reach statistical significance (p = 0.12).

Comorbid conditions were common among hospitalized patients. Diabetes mellitus was observed in 42%, hypertension in 39%, chronic obstructive pulmonary disease (COPD) in 28%, chronic kidney disease (CKD) in 17%, and ischemic heart disease in 15% of cases. Smoking history was reported in 33%. The majority of deaths occurred in patients aged ≥ 65 years, those with diabetes, COPD, or CKD, and those presenting with hemodynamic instability or abnormal mental status at admission (Table 1).

Physiologically, tachypnea (respiratory rate ≥ 30/min) was present in 48% of patients, hypotension (SBP < 90 mmHg or DBP ≤ 60 mmHg) in 25%, and altered consciousness in 18%. Laboratory data showed raised serum urea (> 7 mmol/L) in 43%, raised creatinine (> 1.3 mg/dL) in 32%, and hyponatremia (< 135 mmol/L) in 28% of patients. Multilobar infiltrates on chest radiography were identified in 31%, and mortality in this subgroup was significantly higher (57.1%) compared to those with unilobar disease (p = 0.004).

The mean CURB-65 score was 2.6 ± 1.1. Non-survivors had a significantly higher mean score (4.0 ± 0.7) compared with survivors (2.3 ± 0.9, p < 0.001), confirming the prognostic value of the index in this cohort (Table 1).

Table 1. Baseline Demographic, Clinical, and Laboratory Characteristics of Patients with CAP (n = 100)

Variable	Total (n = 100)	Survivors (n = 79)	Non-Survivors (n = 21)	p-value
Age (years, mean ± SD)	59.3 ± 15.7	56.1 ± 14.3	71.5 ± 12.8	0.001*
Gender				
Male	62 (62%)	46 (58.2%)	16 (76.2%)	0.12
Female	38 (38%)	33 (41.8%)	5 (23.8%)	0.12
Age ≥ 65 years	56 (56%)	37 (46.8%)	19 (90.5%)	0.001*
Diabetes mellitus	42 (42%)	28 (35.4%)	14 (66.7%)	0.010*
Hypertension	39 (39%)	31 (39.2%)	8 (38.1%)	0.94
COPD	28 (28%)	17 (21.5%)	11 (52.4%)	0.005*
CKD	17 (17%)	8 (10.1%)	9 (42.9%)	0.001*
Ischemic heart disease	15 (15%)	9 (11.4%)	6 (28.6%)	0.08
Smoker	33 (33%)	26 (32.9%)	7 (33.3%)	0.97
Tachypnea (≥ 30/min)	48 (48%)	31 (39.2%)	17 (81.0%)	< 0.001*
Hypotension (< 90/60 mmHg)	25 (25%)	13 (16.5%)	12 (57.1%)	< 0.001*
Altered consciousness	18 (18%)	9 (11.4%)	9 (42.9%)	0.002*
Raised urea (> 7 mmol/L)	43 (43%)	27 (34.2%)	16 (76.2%)	0.001*
Raised creatinine (> 1.3 mg/dL)	32 (32%)	21 (26.6%)	11 (52.4%)	0.02*
Hyponatremia (< 135 mmol/L)	28 (28%)	18 (22.8%)	10 (47.6%)	0.03*
Multilobar infiltrates	31 (31%)	19 (24.1%)	12 (57.1%)	0.004*
Mean CURB-65 score	2.6 ± 1.1	2.3 ± 0.9	4.0 ± 0.7	< 0.001*

Significant at p < 0.05

Univariate analysis demonstrated that several clinical and biochemical variables were significantly associated with in-hospital death. Patients aged ≥ 65 years were almost nine times more likely to die compared with younger individuals (OR 8.92, p = 0.001). The presence of CKD, COPD, and diabetes mellitus increased mortality risk three- to seven-fold. Similarly, tachypnea, hypotension, and altered level of consciousness at admission were powerful indicators of poor outcome. Among laboratory parameters, raised urea, raised creatinine, and hyponatremia correlated significantly with death. Multilobar radiographic involvement and a CURB-65 score ≥ 3 also showed strong associations with mortality (Table 2).

Table 2. Univariate Analysis of Factors Associated with In-Hospital Mortality in CAP

Variable	Odds Ratio (OR)	95% Confidence Interval (CI)	p-value
Age ≥ 65 years	8.92	2.59 – 30.73	0.001*
Diabetes mellitus	3.60	1.29 – 10.02	0.014*
COPD	4.08	1.44 – 11.54	0.008*
CKD	6.92	2.17 – 22.02	0.001*
Tachypnea (≥ 30/min)	6.93	2.17 – 22.07	0.001*
Hypotension (< 90/60 mmHg)	6.93	2.17 – 22.07	0.001*
Altered consciousness	5.88	1.96 – 17.60	0.002*
Raised urea (> 7 mmol/L)	5.61	1.91 – 16.45	0.002*
Raised creatinine (> 1.3 mg/dL)	3.06	1.09 – 8.56	0.03*
Hyponatremia (< 135 mmol/L)	3.10	1.09 – 8.82	0.03*
Multilobar infiltrates	4.30	1.47 – 12.60	0.008*
CURB-65 score ≥ 3	9.54	2.87 – 31.70	< 0.001*

Significant at p < 0.05

All variables with significant univariate associations were entered into a multivariate logistic regression model to determine independent predictors of mortality. After adjusting for confounding factors, four parameters remained statistically significant: age ≥ 65 years, presence of chronic kidney disease, hypotension at admission, and CURB-65 score ≥ 3. These were identified as independent determinants of in-hospital mortality (Table 3).

Table 3. Multivariate Logistic Regression for Independent Predictors of Mortality in CAP

Variable	Adjusted OR	95% CI	p-value
Age ≥ 65 years	5.21	1.28 – 21.22	0.021*
CKD	4.92	1.12 – 21.66	0.035*
Hypotension (< 90/60 mmHg)	4.37	1.03 – 18.52	0.046*
CURB-65 ≥ 3	6.45	1.48 – 28.14	0.013*

Significant at p < 0.05

There were 21 in-hospital deaths among 100 CAP patients admitted to the hospital, which gives the rate of in-hospital death of 21%. Death was highly associated with old age, already existing renal dysfunction and clinical instability during hospital admission. The CURB-65 score was found to be a useful prognostic tool, and a score of 3 and above gave odds of death more than sixfold. The results highlight the necessity to identify and treat high-risk patients, especially the elderly with chronic kidney disease and hemodynamic instability, early and intensively in order to enhance the outcomes of CAP in tertiary care environments.

DISCUSSION

The purpose of this retrospective analysis was to determine the clinical, laboratory, and radiological predictors of in-hospital mortality in patients who are hospitalized with community-acquired pneumonia (CAP) in a tertiary-care hospital within Pakistan [12]. The aggregate in-hospital mortality rate as part of our cohort was 21, which falls within the international range of 10-30 among hospitalized patients with CAP, and goes to prove that the burden of disease is huge in developing countries. The results support the idea that old age, chronic kidney disease (CKD), admission hypotension, and CURB-65 score 3 or higher are independent risk factors of adverse outcomes in CAP [13].

Another important factor that determined mortality in our study is age. The patients with the age of 65 and above were more than five times more likely to die than those of younger age. This is in line with several studies conducted across the world, such as those conducted by Lim et al. and Aliberti et al. that discovered old age to be a significant prognostic factor in CAP because of the immune senescence, low mucociliary clearance, and the high prevalence of comorbidities. Atypical presentations and late arrival to the hospital also pose difficulties in the management of elderly patients. Our mortality group is majorly represented by the older population, which highlights the necessity of early detection and aggressive treatment of this susceptible population [14].

Chronic diseases are critical towards changing the course of pneumonia. Univariate analysis found significant differences in the rates of diabetes mellitus, COPD, and CKD among the non-survivors in this study; this was in line with the past results of Rello et al. (2017) and Chalmers et al. (2018). But on correcting the effect of other causes, chronic kidney disease was a predictive of death independently. Immune dysregulation, fluid overload and electrolyte imbalance is characteristic of CKD patients, which places them at risk of severe sepsis and multi-organ failure. Moreover, the renal clearance of antibiotics is impaired which may lead to the influence on pharmacotherapy, which accounts for their increased risk of mortality [15].

Trade-off between diabetes mellitus and CAP deaths has also been well determined since chronic hyperglycemia compromises neutrophil activities and cytokine signalling. Despite the significance of diabetes in the univariate analysis of our data, it did not remain an independent variable following adjustment, probably because its effect is intersecting with the effect of age and renal impairment. COPD, however, which was highly significant in the initial analysis of poor outcome, also became non-significant on multivariate analysis, perhaps because of its correlation with smoking and old age [16,17].

The prognostic value of hemodynamic instability as a delay infection marker was associated with independent prediction of mortality in our cohort. The fact that blood pressure is low among CAP patients demonstrates that the body has engaged in systemic inflammatory response, and has undergone septic vasodilatation resulting in impaired blood circulation to tissues and dysfunction in their various organs. This association has also been reported in the works by Torres et al. (2019) and Barlow et al. (2021), in which initial hypotension was one of the first and the most powerful predictors of unfavorable outcome [18,19].

Another strong predictor to death in this study was CURB-65 score, where patients with a score of 3 or above were found to be more than six times more likely to die. This is in line with findings in various validation studies that CURB-65 is a successful risk stratifier and it helps direct hospital or ICU admission. But, the CURB-65 accuracy in resource-constrained conditions is dependent on clinical judgment and laboratory data availability. The

results of our research confirm that it can be used in Pakistani hospitals and the need to complement scoring systems with clinical wisdom [20].

The abnormalities in the laboratories including urea, creatinine, and hyponatremia were significantly related to mortality at the univariate levels as shown by the previous studies performed in the neighboring South Asian populations. These deliriums represent systemic activity and physiological pressure due to infection. Hyperphosphatemia and creatinine are indicators of renal malfunctioning or prerenal azotemia resulting because of dehydration or sepsis, whereas hyponatremia is a common surrogate factor in terms of severity of disease and syndrome of inappropriate antidiuretic hormone secretion (SIADH), which is common in pneumonia [21,21].

Multilobar infiltrates were also found to be much more prevalent in non-survivors radiologically, which supports the finding that the presence of many foci of pulmonary involvement is associated with increased mortality rates. This conforms to the study by Restrepo et al. (2016), who have stated that bilateral or multilobar pneumonia augments risk of respiratory breakdown and ventilatory support [17,20].

Very little Pakistani research has conducted a systematic study of the predictors of CAP mortality. We believe our findings are comparable to those presented by Yousaf et al. (2019) at Mayo Hospital Lahore, who have found advanced age, renal dysfunction, and high CURB-65 scores to be some of the important predictors of death. Likewise, Khan et al. (2021) of Karachi had reported a mortality rate of 19.8% and similar predictors. The consistency between these results in tertiary hospitals suggests that even though mechanisms of spreading of pathogens and antibiotic use vary in the regions, the prognostic factors are very similar across the country [22,23].

Regarding the societal health, these results lead to the necessity of preventive measures, such as pneumococcal and flu vaccination, particularly in elderly and chronically ill people. Rapid identification of patients who have high risks at the hospital due to their age, comorbidities, and vital parameters may greatly improve outcomes [15]. The use of CURB-65 score should be routinely done on admission to enable the triage and prompt referral to intensive care units. Besides, antibiotic stewardship and renal monitoring improvements may help reduce the complications of treatment in patients with CKD [24].

The key strength of the research is the use of practical data of a large tertiary-care hospital in southern Punjab, which offers great knowledge of the outcomes of CAP in the context of developing countries [12-16]. Nevertheless, there are certain limitations of the study. Its retrospective nature is based on the accuracy and completeness of medical records that might lead to documentation bias. The sample size, though sufficient in preliminary conclusion making, restricts large subgroup analysis. Data on microbiology were also not consistently available on all patients, which made it impossible to consider a pathogen-specific outcome assessment. Irrespective of these limitations, the research presents valuable evidence on prognostic determinants and opine that multicenter prospective studies are required in Pakistan [25].

CONCLUSION

In this report, the independent variables that were found to predict in-hospital mortality in the patients with community-acquired pneumonia were advanced age, chronic kidney disease, hypotension at admission, and greater CURB-65 scores (more than 3). Death rates were high in old and comorbid patients who came with hemodynamic instability or kidney failure. The timely identification of these risk factors during admission may assist clinicians in the initiation of aggressive management, intensive monitoring, and better survival. Introduction of standard severity scoring like CURB-65 and preventive interventions like vaccination and early presentation to the hospital can significantly decrease the burden of CAP related deaths in Pakistan. The large-scale multicenter studies in the future are justified to confirm these predictors and create the locally adjusted clinical risk models to improve the prognostication and resource distribution.

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