International Journal of Infectious Diseases 89 (2019) 62–65

Contents lists available at ScienceDirect

International Journal of Infectious Diseases

journal homepage: www.elsevier.com/locate/ijid

The accuracy of a diagnosis of pneumonia in the emergency department

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ARTICLE INFO

Article history:
Received 1 May 2019
Received in revised form 3 July 2019
Accepted 26 August 2019
Corresponding Editor: Eskild Petersen, Aarhus, Denmark

Keywords:
Infection
Pneumonia
Emergency department
Diagnosis
Accuracy

ABSTRACT

Background: Achieving a high degree of diagnostic accuracy of infections in the emergency department (ED) is crucial since a delay in diagnosis can lead to increased mortality, whereas overdiagnosis can lead to antibiotic overprescription. Limited data are available as to ED diagnostic accuracy of infections. The aim of this study was to demonstrate the degree of discordance of an ED diagnosis of pneumonia in relation to an internal medicine ward's discharge diagnosis of hospitalized adults.
Methods: We reviewed the records of all adults hospitalized in internal wards from November 2017-January 2018 diagnosed with an acute infection by an ED physician. The primary outcome was the discordance degree of an ED pneumonia diagnosis compared to the internal ward discharge diagnosis. The influence comorbidities and clinical characteristics on the diagnostic discordance were also evaluated.
Results: The study included 875 adults; 434 were admitted with an ED diagnosis of a specific infection. Pneumonia was the most frequent ED diagnosis (n = 195, 45%), of them, 56 (29%) were discordant diagnosis in the internal ward.
Conclusion: Interpretation of chest X-rays with the assistance of a radiologist might help in reducing overdiagnosis and minimize antibiotic overprescription, thus improving the ED diagnostic accuracy of pneumonia.

Introduction

Achieving a high degree of diagnostic accuracy is essential in patients diagnosed with a specific infection in the emergency department (ED), thereby reducing unnecessary admissions and/or premature discharges due to over and under diagnosis, respectively (Chiu et al., 2003). Previous studies have reported on a wide range of concordance between admission and discharge diagnoses. A large urban hospital study performed in Chicago, Illinois, found that only 24.4% of 5375 cases received a concordant diagnosis (Johnson et al., 2009), whereas a study performed in Singapore found 81.3% of 116 cases with a concordant diagnosis (Goh and Low,1996). Failure or delay in diagnosing acute infections in the ED can lead to increased morbidity and mortality; however, overdiagnosis of infections may lead to overlooking other significant noninfectious diseases as well as an overprescription of antibiotics which contributes to the emergence of resistant pathogens (Houck et al., 2004; Houck and Bratzler, 2005; Dellinger et al., 2008; Caterino and Stevenson, 2012).

It is not easy to accurately diagnose infections in the ED, especially in elderly patients. A study of older patients hospitalized with a suspected infection in a community hospital in the USA revealed that physicians in the ED do not suspect the presence of bacteremia clinically with a positive predictive value of 0.16 [95% confidence interval (CI), 0.12–0.19] (Fontanarosa et al., 1992). Catrino et al.'s (Caterino and Stevenson, 2012) prospective study on older patients admitted from the ED to internal medicine wards, who were diagnosed with an acute infection, found that 18% of ED diagnoses were discordant with the inpatient ones. The authors also observed that 76% of patients hospitalized with an ED diagnosis of suspected bacteremia (n = 25) were actually not ill with bacteremia. Furthermore, 31% of patients hospitalized with an ED diagnosis of suspected pulmonary infection (n = 55), also were not ill with this infection (Caterino and Stevenson, 2012). A study performed

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https://doi.org/10.1016/j.ijid.2019.08.027

on 800 hospitalized patients with an ED diagnosis of pneumonia in three American academic hospitals showed that approximately 33% of these patients were diagnosed upon discharge with a non-pneumonia (Chandra et al., 2010). A literature review did not reveal any studies reporting on diagnostic accuracy of infections and its risk factors in the general non-elderly population. Therefore, our aim was to demonstrate the degree of discordance between an ED and internal medicine ward discharge diagnosis of pneumonia amongst hospitalized adults (age >18) in a tertiary hospital in central Israel and to try to clarify the risk factors that influence discordant diagnoses.

Methods

Electronic records of all consecutive adult patients (≥18 years) hospitalized between November 2017-January 2018 in an internal medicine ward with an ED diagnosis of a specific acute infection in a 900-bed tertiary academic hospital in central Israel were examined by an infectious disease physician and an internal medicine resident. Data as to demographics, comorbidities including Charlson's comorbidity score, active smoking, dementia, hypertension, ischemic heart disease, congestive heart failure, peripheral vessel disease, previous stroke, chronic obstructive pulmonary disease, diabetes mellitus, chronic liver disease, chronic kidney disease, pressure ulcers, hypothyroidism, active malignancies and organ transplants, were retrieved. Furthermore, data relating to the characteristics of patients who visited the ED and their initial workup during their stay were also documented including the ED referral day (weekday or weekend), time of visit—daytime (8:00 am–23:00 pm) or nightime (23:00pm–8:00am), length of stay (hours), rank of the ED evaluating physician (resident or senior/specialist), ED empiric antibiotic administration, vital signs [body temperature, pulse rate, systolic blood pressure, oxygen saturation at room air], chest X-ray, as well as laboratory results including white blood cell and C reactive protein (CRP). Inpatient measures for diagnostic confirmation including consultation with an infectious diseases specialist, chest X-ray revision by an expert radiologist, as well as influenza virus PCR were retrieved. ED and internal medicine ward discharge diagnosis were also documented. All data were extracted and tabulated in encrypted EXCEL datasheets. The primary outcome was the degree of discordance between the ED diagnosis of pneumonia compared to the internal medicine discharge diagnosis and adjudicated by the treating internal medicine physician and a blinded radiologist. The influence of age, comorbidities, ED visit characteristics and other factors of diagnostic discordance were evaluated.

The study was approved by the hospital ethics committee. Informed consent was waived due to the retrospective, non-interventional nature of the study. Data processing and analysis were performed via the SAS analysis program. All dichotomous variables were compared by the chi-square test. Continuous data were expressed as mean ± standard deviation and compared using the T-test.

Definitions

ED specific infection diagnosis: defined as a specific infection if it indicates a specific pathological process involving particular organs, i.e., pneumonia was considered a specific infection, whereas a cough or dyspnea was not.

ED suspected infection diagnosis: identified as any documentation by the ED physician of signs, symptoms or laboratory results indicating a suspected infection, yet without documentation of any specific infection diagnosis.

Pneumonia diagnosis: defined as a new or progressive existing chest X-ray infiltrate read by a blinded radiologist, in addition to a clinical manifestation suggesting a respiratory infection (fever **and** respiratory symptoms).

Discordant diagnosis: considered as discordant if the ED and internal medicine ward discharge diagnosis were unrelated.

Results

Study cohort

A total of 875 consecutive adult patients were referred from the ED to an internal medicine ward and diagnosed with a suspected infection. Of these patients, 434 were admitted with an ED diagnosis of a specific acute infection; 168 with a suspected infection but without a specific diagnosis; and 273 presented with a fever without a specific infection diagnosis (Figure 1). The distribution of ED infection diagnoses is presented in Figure 2. Pneumonia was the most frequent diagnosis (195/45%), followed by urinary tract infection (95/22%).

Pneumonia

Of the 434 patients admitted with an ED specific infection diagnosis, 195 (45%) were admitted with an ED diagnosis of pneumonia. Of these, 139 (71%) were concordant with the internal medicine ward discharge diagnosis. Of the 56 (29%) patients with a discordant diagnosis, 54% were diagnosed with an upper respiratory infection, and 30% had no infection at all (Figure 3). There were no significant differences regarding the patient's age and comorbidities in the two groups (Table1). The majority of patients visited the ED during the week with approximately 50% evaluated during the night by a senior ED physician (Table 2). Clinically, patients with a concordant diagnosis of pneumonia were more tachycardic and elevated levels of CRP (>10 mg/dl) were observed more frequently (103±22 vs. 94±24, p = 0.01 and 56% vs. 30%, p = 0.001, respectively). The majority (91%) of patients in the two groups had received empiric antibiotic therapy in the ED.

Interestingly, 36 patients out of the 195 (18%) were admitted to the internal medicine wards with an ED diagnosis of pneumonia even though their chest X-rays were normal. Most (92%) had received empiric antibiotics in the ED, demonstrating a 100% discordant diagnosis, compared with the internal medicine ward discharge diagnosis with 44% (16/36) diagnosed with a laboratory confirmed influenza virus infection. Two thirds of them (21/36) required a chest X-ray revision by an expert radiologist, and 42% (15/36) were examined by an infectious disease specialist. During hospitalization, patients in the concordant group received a longer antibiotic course compared with the discordant group (median 5 vs. 3 days, p < 0.001). No significant difference was observed as to

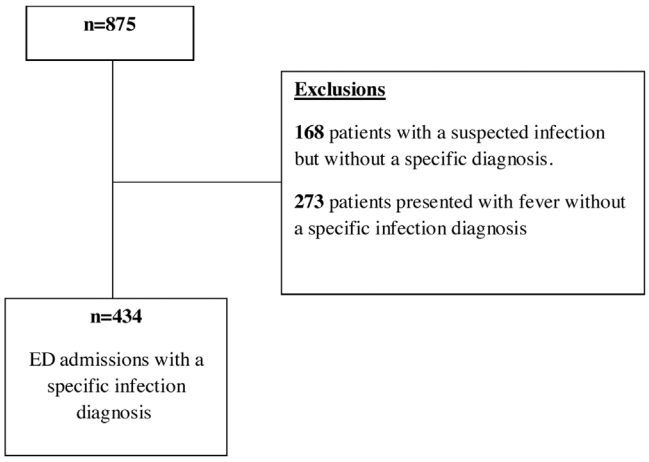

Figure 1. Study flow diagram.

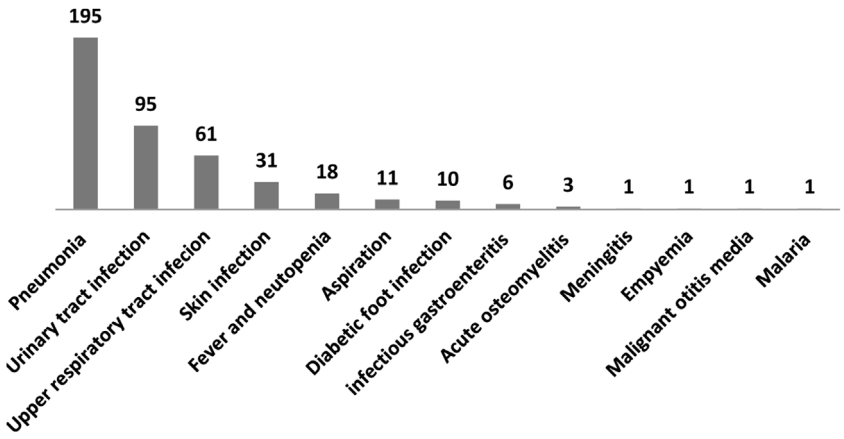

Figure 2. Distribution of specific infection diagnoses in the ED.

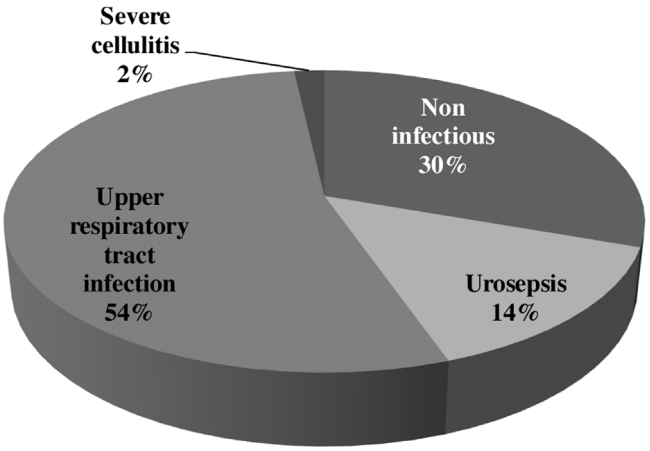

Figure 3. Discharge diagnosis of 56 hospitalized patients with an ED discordant diagnosis of pneumonia.

the length of the hospital stay in the two groups (median 6 vs. 5 days, p = 0.5) (Table 2).

Discussion

According to our findings, in 29% of the cases, the ED diagnosis of pneumonia did not concur with the internal medicine ward's diagnosis. Several studies have reported similar percentages of discordant diagnosis. A retrospective study by Chandra et al reported that a discordant ED pneumonia diagnosis occurred in 27% of 800 hospitalized patients from 3 hospitals in the USA (Chandra et al., 2010). Welker et al demonstrated that 39% of ED pneumonia diagnoses were less likely to meet the predefined diagnostic criteria for pneumonia (Welker et al., 2008). According to our results, a pneumonia overdiagnosis was not influenced if the patient had visited the ED on weekends or weekdays, during a day or night shift, or if the patient was evaluated by a senior ED physician or a resident. This could be explained in part by the lack of significant differences between the discordant and concordant

Table 1
Baseline characteristics of hospitalized patients with an ED diagnosis of pneumonia divided into two groups according to the concordance of the ED diagnosis compared to the internal medicine ward discharge diagnosis.

Variable	Concordant diagnosis (n = 139)	Discordant diagnosis (n = 56)	P value
Age, mean ± SD (years)	76 ± 17	79 ± 12	0.1
Charlson score, mean ± SD	5 ± 2	5 ± 2	0.5
Body mass index (kg/m^2), mean ± SD	27 ± 5	27 ± 5	0.4
Male gender (n, %)	83 (60%)	26 (46%)	0.1
Assistance in active daily living (n, %)	52 (37%)	21 (38%)	1
Nursing home resident (n, %)	13 (9%)	10 (18%)	0.1
Active smoking (n, %)	16 (12%)	6 (11%)	1
Dementia (n, %)	19 (14%)	5 (9%)	0.5
Hypertension (n, %)	68 (49%)	32 (57%)	0.3
Ischemic heart disease (n, %)	27 (19%)	14 (25%)	0.4
Congestive heart failure (n, %)	14 (10%)	9 (16%)	0.3
Chronic obstructive pulmonary disease (n, %)	17 (12%)	10 (18%)	0.4
Peripheral vascular disease (n, %)	4 (3%)	2 (4%)	1
Previous stroke (n, %)	18 (13%)	5 (9%)	0.6
Chronic kidney disease (n, %)	13 (9%)	3 (5%)	0.6
Hyperthyroidism (n, %)	1 (0.7%)	1 (2%)	0.5
Hypothyroidism (n, %)	16 (12%)	3 (5%)	0.3
Chronic liver disease (n, %)	2 (1%)	0 (0%)	1
Diabetes mellitus (n, %)	39 (28%)	22 (39%)	0.1
Pressure ulcers (n, %)	3 (2%)	0 (0%)	0.6
Active malignancy[a] (n. %)	19 (14%)	4 (7%)	0.2
Organ transplantation[b] (n, %)	5 (4%)	1 (2%)	0.5

SD, standard deviation; NS, not significant.
[a] Actve malignancies: lung (5% vs. 2%); pancreas (0.7% vs. 2%); renal (0.7% vs. 0%); breast (3% vs. 0%); liver (0.7% vs. 0%); unknown primary (3% vs. 2%); lymphomas (0.7% vs. 2%). All are not statistically significant.
[b] Organ transplantation: kidney (3% vs. 0%); heart (0% vs. 2%); lung (0.7% vs. 0%). All are not statistically significant.

Table 2
ED visit and clinical characteristics of hospitalized patients with an ED diagnosis of pneumonia divided into two groups according to the concordance of the ED diagnosis compared to the internal medicine ward discharge diagnosis.

Variable	Concordant diagnosis (n = 139)	Discordant diagnosis (n = 56)	P value
ED visit during the weekday (n, %)	103 (74%)	43 (77%)	0.9
ED visit during the night (n, %)	65 (47%)	28 (50%)	0.7
Attendant senior ED physician (n, %)	67 (48%)	24 (43%)	0.5
Duration of ED evaluation >3 h (n, %)	71 (51%)	24 (43%)	0.3
Time duration for ED evaluation, mean±SD	3.3(2–5)	2.8 (2–4)	0.3
Antibiotics given in ED (n, %)	127 (91%)	51 (91%)	1
Maximal temperature at ED visit >38 C° (n, %)	78 (56%)	26 (46%)	0.2
Heart rate (beats per minute), mean±SD	103 ± 22	94 ± 24	0.01
Systolic blood pressure (mmHg), mean±SD	109 ± 24	114 ± 25	0.2
ED visit WBCs >15000 cells/cc^3, (n, %)	39 (28%)	12 (21%)	0.4
ED visit CRP > 10 mg/dl, (n, %)	78 (56%)	17(30%)	0.001
ED visit albumin <2.5 mg/dl, (n, %)	7 (5%)	2 (4%)	1
Normal chest X-ray (n, %)	0 (0%)	36 (64%)	<0.001
Chest X-ray infiltrate (n, %)	119 (86%)	2 (4%)	<0.001
Length of hospital stay (day), median (IQR)	7 ± 5	6 ± 5	0.5
Antibiotic duration (day), median (IQR)	5 (3–6)	3 (3–4)	<0.001

SD, standard deviation; NS, not significant; WBC, white blood count; CRP, C reactive protein; IQR, interquartile range.

groups regarding patient age, domicile and comorbidities, in addition to the overlap of clinical parameters at presentation that might render the diagnosis of pneumonia more challenging.

Findings on chest X-rays are a prerequisite criterion in the diagnosis of pneumonia; however, we reported that 18% of ED pneumonia patients exhibited a normal chest X-ray and 92% had received antibiotics in the ED. Similar percentages of patients diagnosed with pneumonia presented with normal chest X-rays (Chandra et al., 2010). A reasonable explanation for this finding is the need for administering antibiotics as soon as possible in pneumonia patients in order to seek better outcomes. The time pressure exerted on the ED physician to arrive at an early diagnosis of pneumonia might lead to an over-interpretation of chest X-rays. Welker et al compared two time periods. During the first time period, patients with pneumonia received antibiotics within 8 h of admission, whereas in the second time period, patients received antibiotics within 4 h. The authors found a less concordant ED diagnosis in relation to discharge in patients who received antibiotics within 4 h compared to those who received the antibiotics within 8 h (67% vs. 75%; p = 0.05) (Welker et al., 2008).

In the ED, clinicians usually depend on their own reading of chest X-rays and do not have the benefit of a radiologist reading the X-rays. In real time, reading X-ray films is performed by a radiologist after patient admission to the internal ward, usually in a meeting including the treating internal medicine physicians. One way to improve the diagnostic accuracy of pneumonia in the ED and remain within an optimal time frame for antibiotic administration is by employing a radiologist in the ED and seeking his/her opinion on equivocal chest X-ray findings. This could, to some extent, help in reducing overdiagnosis and minimize antibiotic overprescription when an alternative diagnosis (e.g. influenza) is found. Our study's retrospective nature makes it vulnerable to a collection bias and potential inaccuracy in data collection.

In conclusion, there is an urgent need for improving the diagnostic accuracy of infections in the ED, especially pneumonia. A better interpretation of chest X-rays with the assistance of a radiologist might help in reducing overdiagnosis and consequently minimize antibiotic overprescription.

Funding

This research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors.

Conflict of interest

All authors have none to declare.

Ethical approval

Study was approved by the hospital ethics committee.

Declarations of interest

None.

Acknowledgements

The authors thank Mrs. Phyllis Curchack Kornspan for her editorial assistance.

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