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A Clinical Audit Examining the Use of Furosemide by the London Ambulance Service

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Abstract In July 2001, the London Ambulance Service NHS Trust (LAS) introduced furosemide for use by paramedics to treat pulmonary edema secondary to left ventricular failure (LVF). In 2002, a clinical audit identified that paramedics had difficulty distinguishing pulmonary edema secondary to LVF from other conditions, and also had issues with drug administration records. As a result, LAS training packages were reviewed in line with the drug dosage guidelines, which were reissued nationally in 2006. Later publications on furosemide use highlighted some concerns about the accuracy of pre-hospital diagnosis of pulmonary edema. A retrospective re-audit was conducted for 246 cases where furosemide was administered. All clinical records were assessed by clinical audit staff and a clinical advisor, who examined appropriateness of furosemide use in line with the national guidelines. Patient diagnoses upon arrival at hospital were requested for every patient; 166 patient diagnoses were received. The re-audit findings showed patients administered furosemide received a thorough assessment of their observations and appropriate drug administration records, h. owever, only 46% of patients received a hospital diagnosis that indicated pre-hospital furosemide administration was appropriate. The re-audit results indicated the concerns identified in the initial LAS furosemide clinical audit, relating to drug documentation and dosage, were resolved. However, the review of the appropriateness of administration of furosemide demonstrated that it was often used when not indicated. This low figure of diagnostic accuracy supports published evidence, and further demonstrates the difficulties of identifying pulmonary edema secondary to LVF in the pre-hospital setting. As a result of the potential side effects of administering furosemide when it is not indicated the LAS made the decision to withdraw furosemide as a treatment for pulmonary edema.

Keywords: *furosemide, emergency medical services, pulmonary edema, heart failure*

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1. Introduction

Failure in the heart's left ventricle can lead to an accumulation of fluid in the lungs, resulting in decreased gas exchange across the alveoli. A patient with pulmonary edema secondary to left ventricular failure (LVF) will primarily experience respiratory distress, which can progress to respiratory failure if left untreated [1,2].

The short acting loop diuretic, furosemide, prevents the build-up of fluid on the lungs, resulting from LVF [3]. The diuretic and venodilating effects of furosemide in patients with acute pulmonary edema secondary to LVF formed the basis for its introduction to the pre-hospital setting [4,5,6]. In 2001, the London Ambulance Service NHS Trust (LAS) introduced furosemide, to be used alongside oxygen and Glyceryl Trinitrate (GTN) in the treatment of patients with pulmonary edema secondary to LVF [1]. Furosemide was included in national pre-hospital guidelines in 2002, despite limited evidence for use of this drug in the pre-hospital setting [2,7,8,9,10].

Furosemide is not indicated as a first-line treatment and should be used secondary to nitrate administration, which has been shown to be most effective [6,8] due to its ability to reduce both preload and afterload, helping to restore the oxygen supply and demand ratio of the failing heart [11]. Pre-hospital treatment for patients presenting with pulmonary edema secondary to LVF improves the condition of patients on arrival at the emergency department [6,12,13].

Studies on pre-hospital furosemide use have highlighted some concerns about the accuracy of pre-hospital diagnosis of pulmonary edema. Diagnostic accuracy ranges from 89% [12,14] to 58%, with furosemide administration being potentially harmful in 17% of patients [3]. A literature review concluded that misdiagnoses are likely to lie between 9-23%, depending on study methods and criteria [15]. Therefore, in order for crews to distinguish between likely causes of respiratory distress, a thorough assessment of the patient's clinical presentation and history is vital.

The difficulty of providing an accurate diagnosis in the field means that patients are at high risk of being administered furosemide inappropriately. Chest x-rays,

blood tests and measurement of serum brain natriuretic peptide (BNP) levels are used in hospital to assess if a patient is suffering from pulmonary edema secondary to LVF [16,17]. In the pre-hospital setting clinicians are limited to a physical examination of the patient and, an often incomplete, medical history. Ankle edema, chest pain, dyspnoea, a productive worsening cough, and cardiac history are also indicators of pulmonary edema secondary to LVF [1]. Signs and symptoms of chronic obstructive pulmonary disease (COPD) and pneumonia are commonly confused with those of pulmonary edema secondary to LVF, due to the absence diagnostic tools and the limited time spent with the patient by an ambulance crew [3]. This is alarming in light of the potentially harmful side effects that a patient may suffer [3,6,18].

In 2002, the LAS carried out a clinical audit of furosemide use. The report identified a requirement to train ambulance crews to distinguish heart failure from COPD. The audit also identified some issues relating to documentation of the correct drug code, and administration of the correct dose. As a result of this audit, a new drug code was introduced and a weight dependent dosage was replaced with a dose of 40mg or 50mg. The objective of this audit is to examine the impact of these changes on the appropriateness of furosemide use.

2. Methods

2.1. Setting

Greater London covers a geographical area of 1580 km^2 (610 m^2), with a population of 8.2 million people. The London Ambulance Service NHS Trust (LAS) responds to approximately 1.6 million calls annually, attending more than one million incidents [19]. Only a very small number of these patients are thought to have pulmonary edema secondary to LVF.

2.2. Study Data

A retrospective clinical audit was conducted of 14 months' data (n=246) where patients were treated with furosemide, indicating a suspicion of pulmonary edema secondary to LVF. Treatment with furosemide was identified through paramedics' documentation. Data was extracted from the patients' clinical records and the Emergency Operations Centre (EOC) log. For patients with more than one crew in attendance, all of the relevant clinical records were analyzed.

2.3. Outcome Measures

Hospital diagnoses were obtained to identify whether or not the patient was suffering with pulmonary edema secondary to LVF upon arrival at hospital. The required sample size was considered to be 151 to allow for a 5% margin of error [20]. Hospital diagnoses were obtained for 171 patients in the sample, 166 of which contained sufficient detail regarding the patients' diagnoses. It was not possible to obtain the further 75 hospital diagnoses due to hospital specific data protection policies. The response rate from hospitals exceeded pre-study sample size calculations.

2.4. Judgement of Appropriateness

All cases were assessed by clinical audit staff for appropriateness of use, administration and assessment. A clinical advisor determined the appropriateness of furosemide administrations through clinical review, using the hospital diagnoses. Appropriateness of furosemide use was also examined against the Joint Royal Colleges Ambulance Liaison Committee (JRCALC) National Clinical Practice Guidelines [1].

3. Results

3.1. Demographics

The age range of patients in the sample was 34 to 102 years with a median of 82. Male patients accounted for 57% of the sample (n=140).

3.2. Clinical Presentation

Figure 1 shows the most common symptoms on presentation. After dyspnea (97%), the most common symptom was crackling/bubbling sounds from the chest (84%).

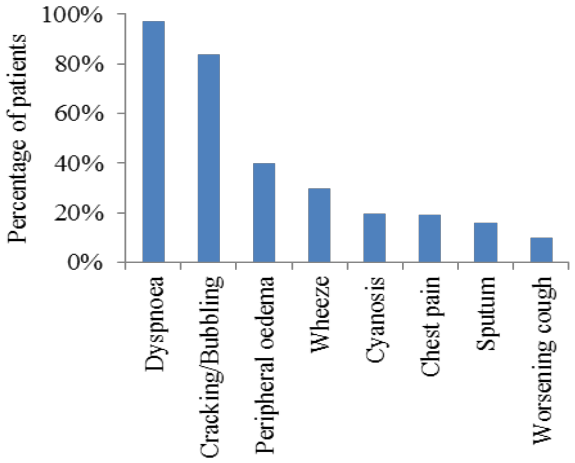

Figure 1. Common symptoms

3.3. Assessment of the Patient

Figure 2 shows the assessment of respiratory rate, blood pressure and pulse rate. Respiratory distress is a key symptom of acute pulmonary edema, and respiratory rate was assessed before treatment for 100% of patients (n=246).

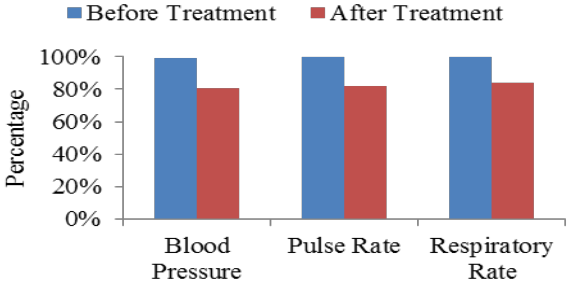

Figure 2. Assessments undertaken

All patients with suspected left ventricular failure should have a 12-Lead electrocardiogram (ECG) carried out. A 12-Lead ECG was carried out, or a reason for being unable to carry out a 12-Lead ECG was documented (e.g. patient too sweaty or patient movement) for 70.5% of patients (n=173).

3.4. Nitrate Administration

The JRCALC furosemide guidelines [1] state that, where indicated, furosemide should be administered as a second line treatment after nitrates (five minutes is recommended between nitrate and furosemide administration). Nitrates were given before furosemide to 157 patients (64%) and not given in the remaining 81 patients (33%), including eight patients (3%) where nitrates were either given after furosemide or the times of administration were not recorded.

3.5. Administration of Furosemide

Furosemide should be administered intravenously in doses of 40mg or 50mg [1]. Furosemide was given intravenously to 100% of patients (n=246). Crews gave a 50mg dose to 98% of patients (n=240) and 1% of patients received a 40mg dose. The incorrect dose was given to three patients and the dose given was not recorded for one patient.

3.6. Pre-alert to Hospital

A pre-alert call was placed for 87% of patients (n=215), informing the hospital of the patient's impending arrival. Of the 31 patients where a pre-alert call was not placed, nine (29%) were diagnosed with pulmonary edema secondary to LVF at hospital, highlighting further the difficultly of diagnosing this condition in the pre-hospital setting.

3.7. Hospital Diagnoses

Forty-five percent of patients (n=74) treated by the LAS with furosemide were diagnosed at hospital with pulmonary edema secondary to LVF. Diagnoses given to the 92 patients could be grouped into 14 categories, as outlined in Table 1.

Table 1. Hospital diagnosis documented when furosemide administration was determined as inappropriate

Primary hospital diagnosis	Number of patients
Respiratory tract infection (including pneumonia)	52
Chronic obstructive pulmonary disease	10
Malignant disease	8
Urinary tract infection	6
Sepsis	3
Cerebrovascular accident	2
Chronic disease (other)	2
Dyspnea	2
Volume depletion	2
Constipation	1
Malaise	1
Pulmonary embolism	1
Renal failure	1
Volvulus	1
Total	92

4. Discussion

This re-audit showed that, when given, furosemide is being administered via the correct route and dose for the majority of patients. The results indicate that the concerns identified in the original LAS furosemide audit, relating to documentation and dosing, have now been resolved. Correct dosage was documented for 98% of patients. The correct route for drug administration (intravenous) was documented for all patients.

However, findings also highlight that furosemide is being administered too frequently, as only 45% of patients were shown to have needed it based on hospital diagnosis. This contradicts previous findings that paramedics are accurately able to diagnose pulmonary edema secondary to LVF in the pre-hospital setting, and that there is a correlation between pre-hospital and hospital diagnosis of pulmonary edema secondary to LVF [12]. Instead, it demonstrates the difficulty of diagnosing pulmonary edema secondary to LVF in the pre-hospital setting. The lack of diagnostic tools in the pre-hospital setting make it difficult for clinicians to differentiate between symptoms of pulmonary edema secondary to LVF and those of other medical conditions with similar presentation [6,21]. Therefore furosemide was often administered when it was not indicated. Electrolyte complications, glucose intolerance, hypotension, hypokalemia, and a need for fluid replenishment, are amongst the side effects exhibited by patients relating to the use of furosemide [2,6,10]. If furosemide is administered to patients with chronic heart failure, a transient vasoconstrictor effect may occur, leading to increased afterload. Cardiac output and stroke volume can be negatively affected by furosemide administration in these circumstances [5,11,18,22,23].

In line with the original furosemide clinical audit, documentation of key observations such as blood pressure, pulse and respiratory rate, was high. Although guidelines state that a 12-Lead ECG should be carried out for all patients where pulmonary edema secondary to LVF is suspected, for nearly 30% of patients no ECG assessment was undertaken and no reason for this given.

Eighty-nine patients (36%) did not receive nitrates before furosemide. Nitrates have been shown in clinical trials to be a more effective treatment than furosemide [11] and should be administered before furosemide when acute pulmonary edema secondary to LVF is suspected.

The implication of this study is that a treatment is needed that is beneficial in the pre-hospital setting, and that presents less risk to patients who are incorrectly diagnosed with pulmonary edema secondary to LVF in the field. As a result of the potential side effects of administering furosemide when it is not indicated, the LAS made the decision to withdraw furosemide as a treatment for pulmonary edema. Instead, the LAS has investigated Continuous Positive Airway Pressure (CPAP). CPAP is amongst treatments currently recommended in pre-hospital guidelines for patients presenting with pulmonary edema secondary to LVF [1]. Studies into the pre-hospital use of CPAP have shown that its use can result in the improvement of symptoms, prevent the need for endotracheal intubation and reduce mortality [1,24,25,26,27]. However, there are contraindications to CPAP including hypotension and inability to tolerate the face mask (reasons for this include anxiety, severe

agitation, facial hair, and claustrophobia). It is also not without side effects, which can include eye irritation and facial skin breakdown [28,29], therefore diagnosis of pulmonary edema secondary to LVF still requires improvement to ensure patients are not treated unnecessarily.

4.1. Limitations

The primary aim of this re-audit was to assess the appropriateness of furosemide use, by reviewing the information on the clinical record.

This study is based on a small sample of the London population and reported on diagnoses given to the patients upon arrival at hospital, however it did not report on side effects suffered by patients inappropriately administered furosemide. We would have liked to have examined any side effects suffered by patients following the inappropriate administration of furosemide. This would have further informed our understanding of the extent of clinical risks involved in the pre-hospital use of this drug, but this was not possible with the level of information provided by the hospitals.

5. Conclusions

Identifying pulmonary edema secondary to LVF in the pre-hospital setting is challenging and symptoms of pneumonia, COPD and other cardiac complaints are often mistaken for the condition. The risk of administering furosemide to a patient where the drug is not clinically indicated is high. This study found that the number of correct administrations was not significant enough to warrant the clinical risk involved in administering this drug. Furosemide is currently used to treat pulmonary edema secondary to LVF by the majority of ambulance services in England. The results of this study suggest furosemide should be withdrawn from pre-hospital care.

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Statement of Competing Interests

The authors have no competing interests.

List of Abbreviations

BNP: Brain Natriuretic Peptide
COPD: Chronic Obstructive Pulmonary Disease
CPAP: Continuous Positive Airway Pressure
ECG: Electrocardiogram
EOC: Emergency Operations Centre
GTN: Glyceryl Trinitrate
JRCALC: Joint Royal Colleges Ambulance Liaison Committee
LAS: London Ambulance Service NHS Trust
LVF: Left Ventricular Failure
SpO_2: Oxygen Saturation

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