

Butyrfentanyl Overdose Resulting in Diffuse Alveolar Hemorrhage

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abstract

Butyrfentanyl is a potent short-acting opioid and a fentanyl analog with uncertain clinical effects. A review of the literature reveals no human case reports of butyrfentanyl overdose. As the use of analog and synthetic drugs continues to increase, clinicians are often faced with tremendous uncertainty when they encounter patients exposed to these synthetic drugs. We describe, to our knowledge, the first case of a butyrfentanyl overdose that resulted in clinically significant hemoptysis, acute lung injury, hypoxic respiratory failure, and diffuse alveolar hemorrhage. Complicating this case was a false-positive urine drug screen for fentanyl. Clinicians who encounter fentanyl exposures should be aware they may in fact be dealing with butyrfentanyl. As little is known of butyrfentanyl and our patient suffered a significant pulmonary hemorrhage, those who encounter butyrfentanyl exposures should monitor for hemorrhagic complications.

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Opioid overdoses are a growing problem in the United States, rivaling other major sources of morbidity and mortality, such as motor vehicle collisions.¹ The burden of disease has become great enough that the US Centers for Disease Control and Prevention has declared opioid overdoses to be at epidemic levels.² Complicating this problem further is the rise in abuse of synthetic opioids that are not approved by the Food and Drug Administration, the clinical effects of which are less well understood and perhaps more dangerous than more common opioids, such as heroin and oxycodone.³ For example, acetyl fentanyl has been hypothesized to be exceptionally dangerous because of the narrow range between its effective dose and lethal dose.⁴

Butyrfentanyl is a potent short-acting opioid and an analog of fentanyl; in fact, its chemical structure differs only by 1 methyl group from fentanyl.⁴ There are virtually no human data on butyrfentanyl in humans, particularly in overdose. To our knowledge, we report the first human case of

a butyrfentanyl overdose, which resulted in clinically significant hemoptysis, acute lung injury, and diffuse alveolar hemorrhage.

CASE DESCRIPTION

An 18-year-old male high school student with a past medical history of intravenous heroin abuse was found by his mother unconscious with labored breathing. Drug paraphernalia, including a rolled up dollar bill, was found at the scene. Emergency Medical Services was activated, and on arrival found the patient obtunded with gurgling respirations. His mental status drastically improved with 0.4 mg of intravenous naloxone, and he was transported to a local emergency department (ED). In the ED, his vital signs were as follows: temperature 37.3°C, heart rate 113 beats per minute, blood pressure 105/70 mm Hg, respiratory rate 28 breaths per minute, and pulse oximetry 97% on 15 L/min of oxygen by facemask. He stated he had been in good health recently and that just before becoming unconscious he had snorted what he believed to be

acetyl fentanyl that he had purchased surreptitiously on the Internet. On waking after receiving naloxone, he complained of dyspnea and was noted to be coughing up frank blood in the ED (Fig 1). Physical examination in the ED was notable for an alert patient oriented to person, place, and time with tachypnea, blood in his nares, an increased work of breathing, and coarse rales in all lung fields on auscultation. His initial chest radiograph was notable for bilateral “batwing”-shaped perihilar predominant airspace opacities with diffuse increased interstitial markings (Fig 2). Laboratory values were as follows: white blood cell count 17.6 k/cmm, platelets 217 k/cmm, hemoglobin 15.5 g/dL, sodium 136 mEq/L, potassium 3.6 mEq/L, chloride 108 mEq/L, bicarbonate 25 mEq/L, creatinine 1.06 mg/dL, glucose 142 mg/dL, aspartate aminotransferase 37 IU/L, alanine aminotransferase 22 IU/L, total creatine kinase 318 IU/L, troponin 0.103 µg/L, pro-brain natriuretic peptide 41 pg/mL, activated partial thromboplastin time 27.3 seconds, prothrombin time 15.3 seconds, fibrinogen 309 mg/dL, and lactate 0.8 mmol/L. Urine drug screening was negative for cocaine,



FIGURE 1
The patient's hemoptysis in a suction canister.



FIGURE 2
PA chest film demonstrating bilateral “batwing”-shaped perihilar opacities with diffuse interstitial markings.

methamphetamine, and other sympathomimetics. Immunoassays for opiates and fentanyl were both positive; however, high-performance liquid chromatography and mass spectrometry revealed no evidence of fentanyl. The substance snorted by the patient was identified by the Bureau of Criminal Apprehension by using high-performance gas chromatography and mass spectrometry as butyrfentanyl.

In the PICU, the patient became progressively more dyspneic, eventually failing noninvasive positive-pressure ventilation and requiring intubation. Bronchoscopy revealed thin red-tinged secretions with subepithelial petechiae and progressive reddening of fluid returns from bronchoalveolar lavage (Fig 3). Cytology of this fluid showed numerous red blood cells and hemosiderin-laden macrophages. Serial hemoglobin measurements revealed a progressive decline from 15.5 g/dL in the ED to 12.3 g/dL the next day. These results are consistent with diffuse alveolar hemorrhage; there was no evidence of airway wall edema, airway epithelial sloughing, or carbon particles. Echocardiography revealed an ejection fraction of 55% to 60% with no wall-motion abnormalities. Sedation was difficult; the patient required drips of fentanyl (100 µg/h), midazolam (5 mg/h), and dexmedetomidine (2.0 µg/kg/h)

simultaneously to maintain adequate sedation. The patient required prolonged ventilation for a drug overdose and could not be extubated until hospital day 4. He was discharged from the hospital on hospital day 7 after treatment of ventilator-associated pneumonia. He suffered no known permanent adverse sequelae.

DISCUSSION

To our knowledge, this is the first well-documented case of butyrfentanyl overdose. Our patient experienced pulmonary edema and acute lung injury (ALI), as well as diffuse alveolar hemorrhage. Although pulmonary edema and ALI are well described in opioid overdose,⁵ diffuse alveolar hemorrhage is far less common.⁶ The exact mechanisms for opioid-related pulmonary edema are not agreed on; however, the proposed mechanisms may provide insight and plausibility into why our patient suffered hemoptysis and diffuse alveolar hemorrhage.

One theory on opioid-related ALI is that the opioid antagonist naloxone is responsible. In this model, the administration of naloxone and subsequent rapid precipitation of opioid withdrawal causes a massive increase in blood catecholamines. This rise in catecholamines creates a tremendous afterload increase, with resulting cardiac strain leading to fluid accumulation in the alveoli; thus, in effect this theory suggests opioid-related ALI is in fact “cardiogenic” pulmonary edema. This theory is supported by numerous anecdotal human cases, as well as animal evidence in which opioid-naïve canines intoxicated on fentanyl had significant increases in catecholamine concentrations after naloxone infusion.^{7,8} This theory is also supported by a series of opioid-naïve patients given opioids while undergoing surgery who developed opioid-related ALI after the administration of naloxone.⁹



FIGURE 3
Bronchoscopy images revealing bloody secretions and subepithelial petechiae.

A second theory purports that negative-pressure barotrauma is to blame for opioid-related ALI. In this theory, a closed glottis made lax from opioid intoxication is inhaled against; this negative intrathoracic pressure creates a pressure gradient that draws fluid into the alveolar space. Sound reasoning supports this theory. Opioid-related ALI is described to occur in the absence of naloxone. In fact, it was first described in the 19th century, long before naloxone had been synthesized.¹⁰ This mechanism has even been described to cause pulmonary hemorrhage, which may explain our patient's findings.¹¹ One can imagine the additional load of catecholamines precipitated by the administration of naloxone contributing further to pulmonary hemorrhage.

Little is known of butyrfentanyl; published literature involves primarily rodent experiments. Animal evidence suggests butyrfentanyl is 7 times more potent than morphine but only 0.13 the potency of fentanyl.⁴ Despite the dramatic difference in potency compared with fentanyl, the cross-reactivity on immunoassay between the 2 is high. Compared with

other fentanyl analogs, butyrfentanyl is extremely likely to cross-react on a fentanyl immunoassay; cross-reactivity with fentanyl on immunoassay was 77% in 1 study and was higher than all other fentanyl analogs in another, reacting at nearly the same rate as fentanyl.^{12,13} This was consistent with the false-positive fentanyl immunoassay in our patient, which is an important finding that clinicians should note for presumed future fentanyl exposures.

Additionally, it is of note that mice poisoned with butyrfentanyl had significant bleeding in the small intestines on autopsy.⁴ No proposed mechanism, however, was provided by the authors of this study. The clinical significance of this in humans is of course uncertain, but given that our patient suffered significant hemorrhage, those who also encounter butyrfentanyl exposures should monitor for hemorrhagic complications.

CONCLUSIONS

We present a case of butyrfentanyl overdose in a teenage boy resulting in hemoptysis and diffuse alveolar

hemorrhage. In this case, the clinical urine drug screen was false-positive for fentanyl; clinicians should be aware this might actually represent a butyrfentanyl exposure. This case also highlights that although drug users may attempt to purchase 1 chemical on the Internet, the reliability of the substance received is highly dubious. As there are virtually no human data on butyrfentanyl overdose, clinicians encountering this synthetic opioid should monitor for diffuse alveolar hemorrhage.

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