



## Case report

# Pulmonary embolism and hemorrhage after displacement of angiographic catheter tip to pulmonary artery: A case report and literature review

Liangwei Xiong<sup>a,1</sup>, Li Zhuo<sup>a,1</sup>, Jianhua Zhang<sup>b,1</sup>, Shaoyong Liang<sup>c,d,\*\*</sup>, Zongding Wang<sup>c,d,\*</sup>

<sup>a</sup> Department of Nephrology, Anyue County People's Hospital, Ziyang City, Sichuan Province, 642350, PR China

<sup>b</sup> Interventional Department, Fengjie County People's Hospital of Chongqing, 404600, PR China

<sup>c</sup> Department of Hepatobiliary Surgery, Fengjie County People's Hospital of Chongqing, 404600, PR China

<sup>d</sup> Department of Hepatobiliary Surgery, Fengjie Hospital, The Second Affiliated Hospital of Chongqing Medical University, 404600, PR China

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## ABSTRACT

Pulmonary embolism and massive hemoptysis caused by intravascular foreign bodies have rarely been reported. We report a case of an end-stage renal disease patient in which the tip of the angiographic catheter fell off into the pulmonary artery during endovascular interventional opening when the patient underwent vascular access occlusion for dialysis. During the operation, the foreign body was displaced repeatedly and finally anchored to the posterior basal segment branch of the right lower pulmonary artery. A pulmonary embolism occurred during the operation, and massive hemoptysis and hemorrhagic shock occurred after anticoagulation and thrombolytic therapy. After receiving anti-shock and symptomatic treatment, the patient gradually recovered. After six months of follow-up, no pulmonary embolism or pulmonary infarction occurred. Our case report presents an alternative approach to extracting a foreign object from the pulmonary artery by locating the foreign object within the vascular terminations, without resorting to forceful removal. This method mitigates the potential risks of pulmonary embolism and bleeding associated with forceful extraction.

## 1. Background

With the wide application of intravascular indwelling catheters and intracavitary interventional therapy, the probability of catheters, guide wires, pacemaker parts, stents, spring coils and so on remaining in the body increases significantly [1]. According to statistics, the incidence of intravascular foreign bodies during interventional therapy is as high as 2 %.

These foreign bodies can increase the risk of thrombosis, blood vessel stenosis, blood vessel occlusion, infection and so on. As a result, these patients had to undergo surgery to remove the foreign body. In addition, the patients have been treated with anticoagulant or antiplatelet drugs, resulting in adverse drug reactions and even death [2,3].

\* Corresponding author. Department of Hepatobiliary Surgery, Fengjie County People's Hospital of Chongqing , 404600, PR China.

\*\* Corresponding author. Department of Hepatobiliary Surgery, Fengjie County People's Hospital of Chongqing , 404600, PR China.

E-mail addresses: [491607830@qq.com](mailto:491607830@qq.com) (S. Liang), [2451286438@qq.com](mailto:2451286438@qq.com) (Z. Wang).

<sup>1</sup> Liangwei Xiong, Li Zhuo and Jianhua Zhang contributed equally to this work.

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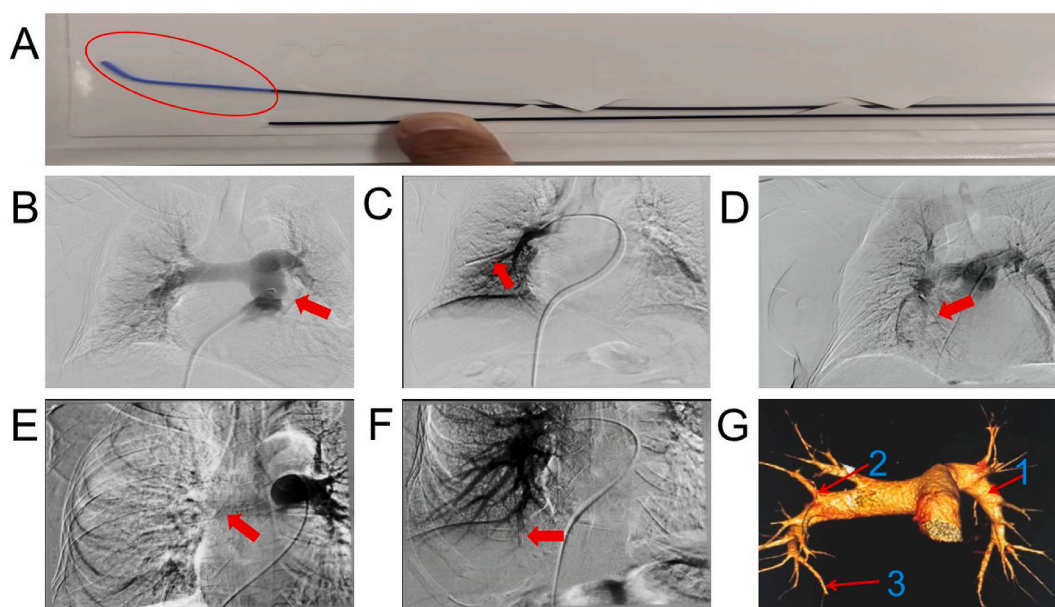
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Therefore, the treatment of intravascular foreign bodies is mainly through endovascular interventional therapy or surgical removal. If there are contraindications to surgery or failure of surgical removal, long-term anticoagulation or antiplatelet therapy is needed to prevent vascular embolism. Once the foreign body in the blood vessel cannot be removed, complications such as pulmonary embolism and pulmonary hemorrhage will occur simultaneously, which is a great clinical challenge [4]. Therefore, early and accurate discovery of residual foreign bodies and timely intervention are considered to be very important issues. Herein, we report a rare case of iatrogenic foreign body removal failure complicated by pulmonary embolism, pulmonary hemorrhage and hemorrhagic shock.

### 1.1. Case presentation

A 66-year-old female farmer, Han nationality, patient with end-stage renal disease developed occlusion of the right upper arm cephalic vein and median cubital vein after long-term hemodialysis, and she had been receiving hemodialysis and intravenous infusion of hemopoietin 3000U twice a week for 3 years. She had never smoked or drank alcohol, had no diabetes or hypertension, denied substance abuse, and had no history of hereditary diseases or relevant family history. She was admitted 3 years prior with an unknown cause of end-stage renal disease and refused a kidney transplant. The preoperative blood laboratory tests revealed the following values: creatinine at 878.3 $\mu$ mol/L (41.0–111.0 $\mu$ mol/L), urea at 17.85mmol/L (3.10–8.80mmol/L), plasma prothrombin time at 11.30 seconds (9–15 seconds), thrombin time at 36.50 seconds (14–21 seconds), and D2 polymer at 452 $\mu$ g/L (0–550 $\mu$ g/L). Angiography and balloon dilatation were performed to open occlusive blood vessels and recanalize an autogenous arteriovenous fistula. After local anesthesia, the catheter was placed, and venography was performed on the right upper limb. The soft "J" tip (6 cm in length, 1.6 mm in diameter) was not found in the 5F catheter after angiography (Fig. 1A). Immediate radiography indicated that it had fallen off into the main left inferior lobular artery (Fig. 1B). During this process, the patient did not complain of any clinical symptoms. Her blood pressure was 110/65 mmHg, her heart rate was 78/min, and her breathing rate was 18/min.

To avoid a pulmonary embolism, low molecular weight heparin calcium at a dose of 4000 U was injected subcutaneously, and to take out of the foreign body through the right femoral vena cava interventional route. The location of the foreign body was reconfirmed by angiography, but retrieval with the vena cava filter recovery device and vascular recovery forceps failed due to the insufficient length of the instruments. Subsequently, repeated attempts were made to wrap the catheter tip through the pigtail catheter and guide wire. The foreign body was briefly left in the right middle lung artery (Fig. 1C), but it eventually moved to the posterior basal segment branch of the right lower pulmonary artery (Fig. 1D). During the operation, an intraoperative intravenous infusion of heparin sodium at a dose of 3125 units was administered to achieve systemic heparinization. One hour later, the oxygen saturation decreased to 89%, accompanied by chest pain, dyspnea, and hemoptysis. Her blood pressure gradually began to drop to 93/62 mmHg, her heart rate increased to 112/min, and her breathing rate was 29/min. Angiography revealed that the pulmonary artery was not shown, suggesting a pulmonary embolism (Fig. 1E). Urokinase (500,000 units), heparin sodium (5000 units) and 30 ml Iodofol were administered in a



**Fig. 1.** A: Angiographic catheter (5F). The blue "J" segment is the intravascular foreign body, which is marked in red. B: A residual foreign body in the main left inferior lobe artery, and the foreign body is marked by a red arrow. C: The foreign body had moved to a branch of the right middle lung artery, as indicated by the arrow. D: The foreign body was displaced to the posterior basal segment of the right lower pulmonary artery. E: Angiography revealed extensive filling defects in the right pulmonary artery, indicating pulmonary embolism. F: After intraductal thrombolysis, angiography indicated pulmonary artery and branch development. G: The remaining catheter tips in the vessel had migrated in the order indicated in the figure.

single dose via a high-pressure syringe. During the infusion, angiography indicated that blood flow had gradually resumed in the main and large branches of the pulmonary artery, and the foreign body had not moved (Fig. 1F–G). Gradually, the patient experienced a slow reversal of symptoms.

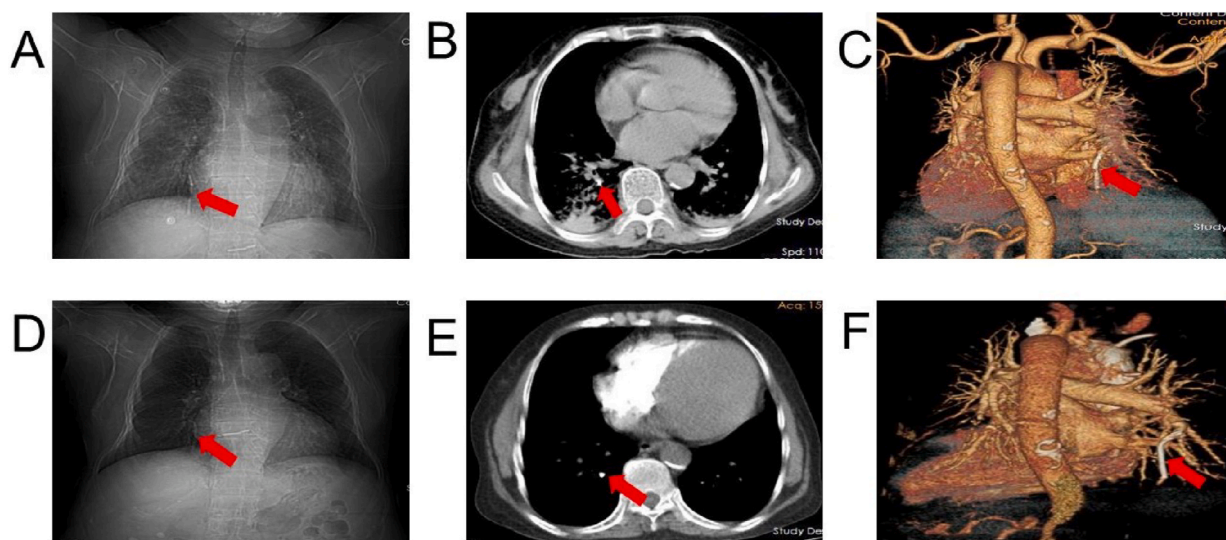
Thirty minutes later, the patient's hemoptysis symptoms worsened, oxygen saturation decreased to 80 %, blood pressure dropped to 82/54 mmHg, heart rate was 134/min, respiration rate was 32/min, blood laboratory test results showed that hemoglobin decreased from preoperative 88g/L to a minimum of 45g/L, and the patient experienced a loss of consciousness, indicating pulmonary hemorrhage after the development of a pulmonary embolism and hemorrhagic shock. The operation to remove the foreign body had to be stopped immediately, endotracheal intubation was performed, ventilator-assisted ventilation was performed, light red bloody secretions were aspirated from the endotracheal catheter, rapid fluid infusion was performed to maintain blood pressure, red cell suspension(8U) was transfused to correct anemia, fresh plasma(2000ml) and coagulation factor(20U) were transfused to correct coagulation dysfunction, the above abnormal indicators were corrected, and then, continuous renal replacement therapy (CRRT) was given. The bleeding was successfully halted through the implementation of symptomatic treatment. The patient exhibited a gradual return to consciousness, with a measured blood pressure of 107/50 mmHg, a heart rate of 68 beats/min, and a blood oxygen saturation level of 98 %. Furthermore, her symptoms and vital signs demonstrated a gradual improvement.

Two days after surgery, CRRT therapy and ventilator-assisted ventilation were discontinued, and thoracic computed tomography angiography (CTA) revealed no embolus in the pulmonary artery, and the patient refused to undergo foreign body removal again (Fig. 2A–C).

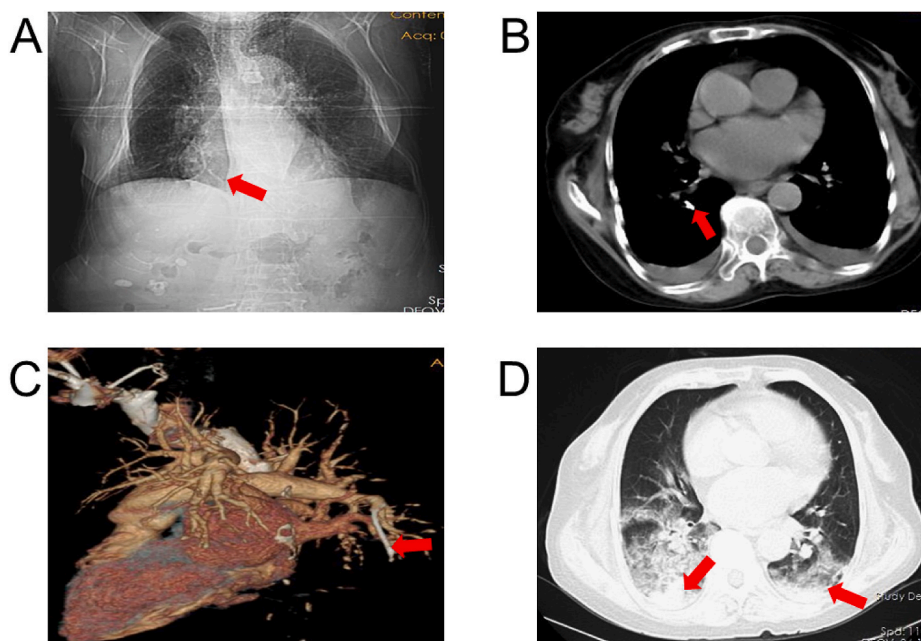
The patient presented with intermittent hemoptysis and sputum, accompanied by dyspnea. The results of the sputum culture and drug susceptibility test indicated an infection caused by *Klebsiella pneumoniae*. Piperacillin and tazobactam were identified as effective antibiotics, with a prescribed dosage of 2.25g administered three times daily for a duration of seven days. Additionally, the patient received high flow oxygen therapy at a rate of 6L/min for four days, followed by low flow oxygen therapy at 2L/min for eleven days. Inhalation of budesonide (1mg) and salbutamol (5mg) via atomization was prescribed twice daily for a week. Furthermore, the patient underwent heparin-free kidney dialysis and orally consumed bifidobacterium to regulate intestinal flora. The patient's diet gradually returned to normal, without hemoptysis and normal shortness of breath. Eleven days after surgery, no pulmonary embolus was found (Fig. 2D–F , Fig. 3D), and 19 days after surgery, her condition improved, and she was discharged. Outpatient dialysis was performed twice a week after discharge, enoxaparin sodium (3000 units) was injected intravenously during dialysis, and aspirin enteric-coated tablets (100 mg) were taken orally once a day on nondialysis days for 1 month. No pulmonary embolus, secondary pulmonary embolism or pulmonary infarction were found in the outpatient follow-up 6 months after surgery (Fig. 3A–C).

## 2. Discussion and conclusion

At present, with the innovation of interventional techniques and instruments, the use of catheters or guide wires in the vascular lumen has significantly increased [5,6]. Therefore, the risk of foreign bodies remaining in the vascular lumen for various reasons has increased correspondingly, according to the literature [4]. According to published data, these foreign bodies are usually found in the subclavian vein, superior vena cava, right atrium, inferior vena cava, and pulmonary artery. In a few cases, the patients (4.2 %) showed



**Fig. 2.** CTA results were examined at 2 and 11 days after surgery. A–B: CT re-examination showed the location of the foreign body. C: No filling defect was observed on CTA, no pulmonary embolism image was observed, and the red arrow indicates that the foreign body was located in the posterior basal segment of the right inferior lobe artery. D–F: The results of CTA re-examination at 11 days after surgery were similar to those at 2 days, with no foreign body movement and no pulmonary embolism.



**Fig. 3.** Follow-up radiographic results. A–B: The red arrow shows the location of the foreign body, and the foreign body had not moved since the surgery. C: The CTA results indicated that there was no filling defect at the distal end of the vessel where the foreign body was located, and no pulmonary embolism image was observed. D: Enhanced chest CT examination 11 days after surgery showed flocculation and ground glass shadows in the lower lobes of both lungs, mainly on the right side.

no clinical symptoms due to adhesion and calcification of the foreign body residues to adjacent tissues, and most of these patients presented with corresponding organ dysfunction, arrhythmia, pulmonary symptoms and septic syndrome, with a mortality rate of 1.8 % [7]. Mohammed Hamad reported only one case of a patient with end-stage renal disease in which intravascular foreign bodies remained at the junction of the right subclavicular and innominate veins, and the foreign bodies were then pulled through a venous incision with a snare [8]. Ciarrocchi A P reported a case of a 7 cm long and 1.5 mm diameter wooden foreign body that had exfoliated into the basal segment of the right lower pulmonary artery. The patient suffered from repeated coughing and massive hemoptysis. During surgery, it was revealed that there was partial necrosis of the lower lobe of the right lung, and pathological examination revealed lymphoplasmacytic cell infiltration and fibrin in the necrotic area of the lung parenchyma. The patient's symptoms were relieved after the foreign body was removed from the pulmonary artery [9].

Intravascular foreign bodies reported in the literature include venous line fragments, bullets, coil springs, stents, inferior vena cava filters, guide wires, vascular sheath fragments, and pacemaker leads [10–12]. To eliminate the risks of vascular stenosis, embolism, rupture, infection, and displacement of foreign bodies caused by intravascular foreign bodies, the methods that have been used mainly include intraperitoneal intervention or combined surgical incision and removal of foreign bodies, which are mainly selected according to the nature of the foreign bodies, such as the X-ray penetration, softness and residual location [13]. If there is failure to remove a foreign body, it can be moved to a smaller vessel and then fixed by stent insertion. If the foreign body is a stent and cannot be removed, it can be compressed to one side of the vessel wall using a dilated balloon and then anchored to the wall with a new stent [14,15].

In our case, the foreign body dragged was the tip of the 5F angiography catheter with a hollow structure, and the foreign body was approximately 6 cm in length and 1.6 mm in external diameter. It was a small and soft material. Theoretically, it had little effect on the blood flow of large vessels, and the patient may have avoided clinical symptoms of a series of complications, such as pulmonary embolism, pulmonary hemorrhage and hemorrhagic shock. However, the guide wire and catheter had repeatedly stimulated the pulmonary artery during the operation, which may lead to pulmonary artery injury and pulmonary hemorrhage in 0.5 % of patients, according to the literature reports [16]. Furthermore, thrombolysis and anticoagulation therapy followed by pulmonary embolism resulted in 13.8 % of hospitalized patients with pulmonary embolism, and laboratory results confirmed prolonged clotting time [17,18]. In addition, 2 and 11 days after surgery, enhanced chest CT showed flocs and ground glass opacities in the lower lobes of both lungs, mainly on the right side (Fig. 3D), which was consistent with the imaging features of pulmonary hemorrhage reported by Reisman S et al. [19]. Hence, the repetitive extraction of foreign objects may serve as the primary etiology for pulmonary embolism. Moreover, the administration of substantial quantities of urokinase and heparin sodium emerges as the principal precipitating factors for pulmonary hemorrhage. In summary, the presence of foreign bodies within the pulmonary arteries, lacking clinical manifestations during the surgical procedure, may be more appropriately monitored rather than extracted.

The patient presented with chest pain, dyspnea, hemoptysis and other clinical manifestations during the removal of the foreign body. A pulmonary embolism was confirmed by angiography. After urokinase thrombolysis, the symptoms of chest pain and dyspnea were almost completely relieved, and the amount of hemoptysis was reduced. However, after a short time, the patient developed

dyspnea again, had aggravated hemoptysis symptoms, and had no chest pain symptoms, and the patient progressed to having hemorrhagic shock. Repeated pulmonary angiography was performed on the pulmonary artery, and the blood flow in the main and larger branches of the pulmonary artery was smooth, so a diagnosis of pulmonary hemorrhage was considered. According to the pulmonary embolism risk score, the D2-polymer fluctuated between 1236 and 8496  $\mu\text{g/L}$  after thrombolysis, and the patient had symptoms of hemoptysis and was older than 65 years [20,21]. Therefore, the Revised Geneva system score was 6 points, and the probability of recurrent pulmonary embolism was more than 40 % [22]. In this case, no embolus was found in the pulmonary artery CTA 2 days after surgery, but enhanced chest CT indicated ground glass shadows and rope shadows in the middle lobe of the right lung and lower lobe of both lungs and fan-shaped consolidation in the lower lobe of the right lung. This is consistent with the imaging features of pulmonary embolism complicated with infarction that was reported by Torres P et al. [23].

Based on Kevin Lu's comprehensive literature review, the extraction of foreign bodies from the pulmonary artery is advised in the presence of symptoms, whereas conservative management with continuous observation is deemed appropriate for asymptomatic cases. Nevertheless, it is noteworthy that a considerable proportion of patients may encounter complications, such as infection and lung abscess, during the later stages. Consequently, the decision regarding the necessity of removal remains a subject of ongoing controversy [24].

The patient's D2-polymers were consistently higher than 1000  $\mu\text{g/L}$  from the time of surgery to discharge. Due to the patient's persistent hemoptysis and sputum, continuous anticoagulation therapy was not implemented. The results of a half-year follow-up examination indicated that the foreign body in the basal segment of the right inferior lobular artery did not cause pulmonary embolism or pulmonary infarction, which may be related to the characteristics and structure of foreign bodies in the blood vessels, anchoring site, and individual characteristics of patients. According to studies, the clearance rate of anticoagulants in patients undergoing dialysis due to kidney failure is lower than that of normal people, and the effect of anticoagulants in the body lasts longer [25]. Therefore, patients receiving routine hemodialysis retain certain concentrations of anticoagulants in the body, which may have a certain preventive effect on pulmonary embolism.

Despite the patient's survival, there remained certain deficiencies in their treatment. Specifically, the administration of anticoagulants was not appropriately adjusted for this individual undergoing dialysis with impaired renal function, leading to abnormal coagulation function and subsequent pulmonary hemorrhage. Furthermore, it is noteworthy that the surgical preparation employed for the extraction of foreign bodies within the blood vessels exhibited insufficiency. Additionally, the length of both the vena cava filter and snare proved insufficient for effectively capturing the foreign bodies, ultimately resulting in surgical failure. Moreover, the guide wire and catheter frequently induced stimulation within the pulmonary artery, thereby precipitating the occurrence of pulmonary embolism.

In conclusion, we report a case of an intravascular foreign body in a patient with end-stage renal disease who was undergoing long-term dialysis, and the patient developed pulmonary hemorrhage and hemorrhagic shock after pulmonary embolism during interventional foreign body removal, and propose an alternative approach to extracting a foreign object from the pulmonary artery by locating at the distal end of the blood vessel, avoiding the need for forced removal. Additionally, patients with renal failure experiencing pulmonary embolism necessitate a reduced dosage of thrombolytic and anticoagulant medications, thereby mitigating the potential risks of pulmonary embolism and bleeding.

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#### Additional information

No additional information is available for this paper.

#### CRediT authorship contribution statement

**Liangwei Xiong:** Writing – original draft, Methodology. **Li Zhuo:** Methodology, Data curation. **Jianhua Zhang:** Methodology, Conceptualization. **Shaoyong Liang:** Writing – original draft, Supervision. **Zongding Wang:** Writing – review & editing, Writing – original draft, Validation, Supervision, Project administration, Conceptualization.

#### Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

## Abbreviations

CTA	computed tomography angiography
CRRT	continuous renal replacement therapy
CT	computed tomography

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