# [Pulmonary hemorrhage in children with Alagille syndrome undergoing cardiac catheterization.](https://www.ncbi.nlm.nih.gov/pubmed/31584246)

Adamson GT, Peng LF, Feinstein JA, Yarlagadda VV, Lin A, Wise-Faberowski L, McElhinney DB.

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**Take Home Points:**

* Patients with Alagille syndrome have a significant risk of pulmonary hemorrhage with both diagnostic and interventional cardiac catheterizations.
* A diagnosis of tetralogy of Fallot, higher RV to aorta pressure ratio, and PA angioplasty are associated with an increased risk of pulmonary hemorrhage.
* The exact etiology of this increased risk remains unknown and warrants further investigation.



***Commentary from Dr. Ryan Romans (Kansas City, MO), section editor of Congenital Heart Disease Interventions Journal Watch:*** Children with Alagille syndrome often have hemorrhagic complications during invasive procedures and are also at risk for spontaneous bleeds (particularly intracranial hemorrhage). This is thought to be a result of abnormalities in angiogenesis, hemostasis, and/or platelet function. Some have suggested that the bleeding risk is associated with the severity of congenital cardiovascular phenotype. This bleeding risk contributes significantly to morbidity and mortality in this patient population. The large majority (90%) of children with Alagille syndrome have congenital heart disease. This typically affects the branch pulmonary arteries (PA), though the disease severity is highly variable. It can range from mild branch PA stenosis to severe diffuse PA hypoplasia. Tetralogy of Fallot (TOF) is seen in ~ 15% of children [including TOF with pulmonary atresia and major aortopulmonary collateral arteries (TOF/PA/MAPCAs)]. Patients with Alagille syndrome who have the most severe cardiovascular disease are frequently referred to the cardiac catheterization lab for diagnostic catheterizations to assist in surgical planning or for interventional procedures (pulmonary angioplasty and/or stent implantation). Pulmonary hemorrhage is a known complication of branch PA intervention in general and has anecdotally been seen in higher frequencies in patients with Alagille syndrome.

Adamson et al report on their retrospective single center experience with 30 patients with Alagille syndrome who underwent a total of 87 cardiac catheterizations (median 2 per patient) over an 8 year period (2010-2018). The most common diagnosis was isolated branch PA stenosis/hypoplasia in 15 patients (50%) followed by TOF/PA/MAPCAs in 10 patients (33%), TOF in 4 patients (13%), and pulmonary atresia with an intact ventricular septum (PA/IVS) and MAPCAs in a single patient. Surgical intervention had been performed prior to the cardiac catheterization in 61% of cases. The cardiac catheterizations included branch PA interventions in 37% of the cases and were diagnostic cardiac catheterizations in the remaining 73%. All patients were systemically heparinized with an activated coagulation time maintained above 200 seconds.

Pulmonary hemorrhage occurred in 26/87 cardiac catheterizations (30%) and in 14/30 patients (46%). The majority of these (n=17, 65%) were mild hemorrhage (defined as mechanical ventilation <24 hours, no treatment other than a single packed red blood cell transfusion). There were 4 (15%) moderate hemorrhages (24-72 hours mechanical ventilation or >72 hours noninvasive positive pressure ventilation), and 5 (19%) severe hemorrhages (>72 hours mechanical ventilation, use of inotropic support, ECMO, or death). Only two of the hemorrhages were clearly due to a vessel tear from an intervention, though the source of bleeding was not always able to be identified on review of the medical records. Two hemorrhages were managed with venoarterial ECMO support without any major ECMO complications or deaths. No patients required intravascular closure devices or covered stents to treat the hemorrhage. All 9 moderate and severe hemorrhages occurred in 5 patients with TOF, three of whom had TOF/PA/MAPCAs.

The authors highlight that pulmonary hemorrhage occurred in approximately one third of procedures, including 44% of interventional and 22% of diagnostic cardiac catheterizations (incidence in patients without Alagille syndrome undergoing PA angioplasty 12-14% in two recent studies). Fortunately, the majority of these were mild. Two patient's required ECMO support but there were no deaths. Higher RV to aorta pressure ratio, intervention on the branch PAs, and a diagnosis of TOF were associated with pulmonary hemorrhage, with severe hemorrhage occurring primarily in patients with TOF/PA/MAPCAs. The authors note that the patient population they care for is not representative of a typical center’s given their expertise in surgical branch pulmonary arterioplasty (~12% of patients with Alagille syndrome have TOF with 1/3 of those TOF/PA/MAPCAs, nearly 50% with TOF and 2/3 of these with TOF/PA/MAPCAs in this cohort). Additionally, they may be less aggressive intervening in the cath lab given their centers preference for surgical intervention when possible and thus may be underestimating the risk of pulmonary hemorrhage.