



## **Avipoxvirus outbreak in captive Psittaciformes in southern Brazil<sup>1</sup>**

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**ABSTRACT.-** Sá JJS, Aranda VMPT, Withoeft JA, Marian L, Cordeiro LS, Baron AR, Cristo TG, Casagrande RA. **Avipoxvirus outbreak in captive Psittaciformes in southern Brazil.** *Pesquisa Veterinária Brasileira* 45:e07635, 2025. Laboratório de Patologia Animal, Centro de Ciências Agroveterinárias, Universidade do Estado de Santa Catarina, Av. Luiz de Camões 2090, Bairro Conta Dinheiro, Lages, SC 88520-000, Brazil. E-mail: [renata.casagrande@udesc.br](mailto:renata.casagrande@udesc.br)

Avian poxvirus is an infectious disease that affects domestic and wild birds. The etiologic agent is poxvirus, and there are two main clinical forms: cutaneous and diphtheritic. A breeding facility located in São José dos Pinhais/PR, in southern Brazil, housed 2,000 birds, including canaries (*Serinus canaria*), lovebirds (*Agapornis roseicollis*), rose-ringed parakeet (*Psittacula krameri*), gouldian finches (*Erythrura gouldiae*), red-rumped parrot (*Psephotus haematonotus*), rosella (*Platycercus eximius*), Venezuelan siskins (*Spinus cucullatus*), common waxbill (*Estrilda astrild*) and zebra finch (*Taeniopygia guttata*). Following the acquisition of lovebirds from a breeder in São Paulo, ocular lesions were initially observed in lovebirds, and later in rosellas and red-rumped parrots, resulting in the death of 200 birds. Rosellas were the most affected, accounting for 70 deaths of 100 birds existing in the facility. The clinical signs began with unilateral or bilateral periconjunctival infection, anorexia, weight loss and mortality. The average time to disease progression was approximately 10 days. In the necropsy of 65 birds, nodules covered by crusts were observed on the unilateral (37/65) or bilateral (5/65) periconjunctival skin, partially or completely occluding the eyeball, as well as on the beak (11/65), pelvic limb (2/65), and oral cavity (2/65). In the histopathological evaluation, in the conjunctiva, skin of the beak region, skin of the pelvic limb, and oral mucosa, there was multifocal or diffuse epithelial hyperplasia ranging from mild to marked, associated with eosinophilic intracytoplasmic inclusion bodies, as well as focally extensive to multifocal mucosal/epidermal necrosis and a mild to marked infiltrate of heterophils, macrophages, lymphocytes, and plasma cells. Based on the clinical history, it is suggested that Poxvirus was disseminated through the newly acquired batch of lovebirds. This virus is species-dependent, indicating that in this outbreak, it was specific to Psittaciformes, as only certain species in this order developed the illness. The predominant gross lesions are characteristic of the cutaneous form of the poxvirus, and the histological lesions with the presence of Bollinger bodies are pathognomonic for this condition.

INDEX TERMS: Bird, virus, infectious disease, pathology.

**RESUMO.- [Surto de poxvírus em Psittaciformes mantidos em cativeiro no Sul do Brasil.]** A boubá aviária é uma enfermidade infecciosa, que acomete aves domésticas e selvagens. O agente

etiológico é poxvírus e há duas formas clínicas predominantes: cutânea e diftérica. Um criatório localizado em São José dos Pinhais/PR, Sul do Brasil, apresentava 2.000 aves entre canários (*Serinus canaria*), agapornis (*Agapornis roseicollis*), periquito-de-colar (*Psittacula krameri*), diamante-de-gould (*Erythrura gouldiae*), red-rumped (*Psephotus haematonotus*), rosela (*Platycercus eximius*), pintassilgo-da-Venezuela (*Spinus cucullatus*), bico-de-lacre-comum (*Estrilda astrild*) e mandarim (*Taeniopygia guttata*). Após a aquisição de agapornis, de um

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criatório de São Paulo, foi observado lesões oculares inicialmente em agapornis, após em roselas e red-rumped, com óbito de 200 aves, sendo as roselas as mais afetadas com 70 óbitos de 100 aves existentes no criatório. O quadro clínico iniciou com infecção unilateral ou bilateral em pele periconjuntival, anorexia, emagrecimento e óbito. O tempo médio de evolução da doença era de aproximadamente 10 dias. Na necropsia de 65 aves observou-se nodulações recobertas por crostas em pele periconjuntival unilateral (37/65) ou bilateral (5/65) que ocluía parcialmente ou totalmente o globo ocular, em bico (11/65), em membro pélvico (2/65) e cavidade oral (2/65). No exame histopatológico, em conjuntivas, pele da região do bico, pele do membro pélvico e mucosa oral havia hiperplasia do epitélio multifocal ou difusa de discreta a acentuada associado a corpúsculos de inclusão intracitoplasmática eosinofílica, além de necrose da mucosa/epiderme focalmente extensa a multifocal e infiltrado de heterófilos, macrófagos, linfócitos e plasmócitos de discreto a acentuado. Devido ao histórico, sugere-se que houve disseminação do poxvírus pelo novo lote de agapornis adquirido. Esse vírus é espécie-dependente, indicando que neste surto o vírus era específico de Psittaciformes, pois apenas algumas espécies dessa ordem adoeceram. As lesões macroscópicas predominantes são características da forma cutânea de poxvírus e as lesões histológicas com a presença dos corpúsculos de Bollinger são patognômicos da enfermidade.

TERMOS DE INDEXAÇÃO: Ave, vírus, doença infecciosa, patologia.

## INTRODUCTION

Avian pox is an infectious and contagious disease caused by viruses of the genus *Avipoxvirus*, which belongs to the subfamily Chordopoxvirinae, family Poxviridae. This genus currently includes 12 described species: *Canarypox*, *Fowlpox*, *Juncopox*, *Mynahpox*, *Pigeonpox*, *Psittacinepox*, *Quailpox*, *Sparrowpox*, *Starlingpox*, *Turkeypox*, *Flamingopox* and *Penguinpox*. *Peacockpox*, *Penguinpox*, and *Crowpox* are also other species currently being studied for classification within this family (ICTV 2024). *Avipoxvirus* is an enveloped, linear, double-stranded DNA virus with a genome that can reach up to 350 thousand base pairs (kbp), and it has an ovoid shape. Its replication occurs in the cytoplasm of the host cell (Tripathy & Reed 2013).

*Avipoxvirus* is species-specific and presents two common clinical manifestations: the cutaneous form, which involves proliferative skin lesions that can generally be nodular or crusty, primarily in featherless areas such as the periconjunctival skin, nostrils, around the beak, and on the pelvic limbs; and the diphtheritic form, which causes fibrinonecrotic and proliferative lesions in mucosal areas, such as the oral cavity, upper respiratory tract, and digestive tract (Calabuig et al. 2011, Gholami-Ahangaran et al. 2014, Ferreira et al. 2018). Both lesions can be present simultaneously in the same bird, resulting in a mixed form (Ferreira et al. 2018). There is also a third, uncommon form: the systemic infection, which affects the respiratory tract with acute signs, leading to pneumonia, cyanosis, and faster death in birds (Shaib & Barbour 2018).

In Brazil, the disease has been reported in subsistence poultry, such as free-range chickens (Sousa 2019), and in production poultry such as turkeys (Kunert-Filho et al. 2016, Ferreira et al. 2018). Among wild birds in free-living

conditions, it has been described in the barn owl (*Tyto alba*) (Vargas et al. 2011), the great horned owl (*Bubo virginianus*) (Echenique et al. 2016), and the white-faced whistling duck (*Dendrocygna viduata*) (Braga et al. 2020). It has also been reported in captive birds such as rosellas (*Platycercus eximius*) and red-rumped parrots (*Psephotus haematonotus*) (Murer et al. 2018).

Worldwide, there have been reports of *Avipoxvirus* in wild birds such as the berthelot's pipit (*Anthus berthelotii*) and the lesser short-toed larks (*Calandrella rufescens*) in Spain (Smits et al. 2005), peregrine falcons (*Falco peregrinus*) in Germany (Krone et al. 2004), and sanderlings in Florida (Kreuder et al. 1999). Additionally, outbreaks have been reported in psittacine birds, such as agapornis in Mexico (Sánchez-Godoy et al. 2023) and rosellas (*Platycercus elegans*) in Australia (Slocombe et al. 2013). This study aims to report the epidemiological and clinicopathological findings of *Avipoxvirus* infection in psittacine birds held in a commercial breeding facility in southern Brazil.

## MATERIALS AND METHODS

**Ethical approval.** This study was not submitted to the Ethics Committee on the Use of Animals (CEUA) of the "Universidade do Estado de Santa Catarina" (UDESC), since it was conducted as retrospective research based on necropsy records and the processing of samples from animals that were already deceased. According to the current legislation, ethical approval is required only for studies involving live animals used in experimentation.

**Epidemiological data.** In July 2017, during the winter, a technical visit was conducted to a commercial breeding facility located in São José dos Pinhais/PR, in the South region of Brazil, which housed approximately 2,000 birds of various species, including psittacine species such as lovebirds (*Agapornis roseicollis*), rosellas (*Platycercus eximius*), rose-ringed parakeet (*Psittacula krameri*), English budgerigars (*Melopsittacus undulatus*), Australian budgerigars (*Melopsittacus undulatus*), red-backed parrots (*Neophema chrysogaster*), and red-rumped parrots (*Psephotus haematonotus*). There were also species of passerines, including Belgian canaries (*Serinus canaria*), common waxbill (*Estrilda astrild*), zebra finches (*Taeniopygia guttata*), Venezuelan siskins (*Spinus cucullatus*), and Gouldian finches (*Chloebia gouldiae*).

**Samples collection.** The death of the birds in this study occurred either naturally or following euthanasia (*in extremis*). A total of 65 necropsies were performed on rosellas, agapornis, and red-rumped parrots, from which samples of the brain, conjunctiva, skin, lungs, trachea, air sacs, thyroid, heart, liver, spleen, kidneys, adrenal glands, ventriculus, proventriculus, intestines, pancreas, and skeletal muscle were collected. These samples were preserved in 10% buffered formalin for routine histological processing, embedded in paraffin blocks, and then stained with hematoxylin and eosin (HE) for evaluation of histological lesions. Microscopic lesions were classified according to their intensity as mild (+), moderate (++), and severe (+++)

## RESULTS

Psittacine species, including lovebirds, rosellas, and red-rumped parrots, exhibited anorexia, weight loss, and crusty nodules on the periconjunctival skin, which initially appeared unilaterally and sometimes progressed to both eyes, as well as crusty nodules at the mouth commissure, beak, and on

the pelvic limbs. The time from the appearance of lesions to death averaged about 10 days. In total, approximately 200 birds died, with rosellas being the most affected group, with 70% (70/100) of the population of this species dying. Agapornis had 63.5% (127/200) of the individuals dying, and red-rumped parrots had three deaths.

The first affected birds were 200 agapornis acquired from São Paulo. These birds were introduced directly into the breeding facility without a quarantine period. Approximately seven days after the animals' arrival, the first clinical signs were observed. Ocular lesions were observed in the agapornis, followed by lesions in the rosellas and red-rumped parrots. Other psittacine species, as well as passerines, were not affected. Of the total 65 birds necropsied, 72.30% (47/65) were agapornis, 23.07% (15/65) were rosellas, and 4.61% (3/65) were red-rumped parrots, with 44.61% (29/65) being males and 41.53% (27/65) females, in addition to nine

(13.84%) of indeterminate sex, with ages ranging from six months to five years. Out of the 65 necropsies performed, 57 birds exhibited macroscopic and histological lesions, as shown in Table 1.

The macroscopic lesions predominated on the periconjunctival skin, characterized by nodules covered with crusts measuring approximately 0.3 to 0.8 cm, either unilaterally or bilaterally, partially or totally obscuring the ocular globe (Fig. 1). In other birds, thickening of the conjunctiva were noted, either unilaterally or bilaterally, partially or totally obscuring the eye, accompanied by caseous material (Fig. 2). In the choana, diphtheritic plaques measuring 0.6 cm with irregular surfaces ranging from whitish to yellowish were observed (Fig. 3). At the commissure of the beak, below the nostril, there were crusty nodules measuring approximately 0.4 cm. Between the ocular globe and the beak, at the mouth commissure, crusty nodules of approximately 0.3 cm were observed.

**Table 1. Main macroscopic and histological lesions in an outbreak of Avipoxvirus in psittacine birds held in captivity in southern Brazil**

Species	Macroscopic lesions			Nodular crusted dermatitis of the pelvic limb	Diphtheritic plaques in the oral cavity	Histological lesions		Necrosis and inflammatory infiltrate
	Unilateral blepharitis	Bilateral blepharitis	Nodular crusted beak dermatitis			Epithelial hyperplasia	Bollinger bodies	
<i>Agapornis roseicollis</i>	25	3	6	2	1	+ / + / + + +	++	++
<i>Platycercus eximius</i>	9	2	4	0	1	++ / + + +	+ / ++	++
<i>Psephotus haematonotus</i>	3	0	1	0	0	++	+	++
TOTAL	37	5	11	2	2			

Lesion intensity = + mild, ++ moderate, +++ severe.



Fig. 1. Rosella (*Platycercus eximius*) with unilateral crusty blepharitis completely obscuring the left ocular globe (arrow).



Fig. 2. Lovebird (*Agapornis roseicollis*) with unilateral swollen left periconjunctival skin and caseous deposition (arrow).

In the histopathological evaluation of the conjunctiva, skin at the commissure of the beak, pelvic limb skin, and choana, the main observed lesions were multifocal to coalescent epithelial hyperplasia, ranging from mild to severe, associated with vacuolar degeneration and eosinophilic intracytoplasmic bodies (Bollinger bodies), ranging from discrete to moderate (Fig. 4). Additionally, there was necrosis of the epidermis and/or mucosa, either focally extensive or multifocal, associated with a predominantly moderate infiltrate of heterophils, macrophages, lymphocytes, and plasma cells.

## DISCUSSION

The findings of this study demonstrate the high capacity for spread and lethality of the *Avipoxvirus* genus in psittacines kept in captivity, especially in exotic species such as *Platycercus eximius*, in which a high mortality rate was observed (Williams et al. 2021). The absence of clinical signs and mortality in cohabiting passerines suggests a possible infection caused by a strain with specificity for psittacines, such as Psittacine poxvirus. However, viral characterization was not performed (Sánchez-Godoy et al. 2023).

The genus *Avipoxvirus* has strains with different levels of specificity. *Fowlpox virus* (FWPV) preferentially infects chickens and turkeys, causing skin lesions and affecting egg production, with low mortality (Haller et al. 2014). *Canarypox*

*virus* (CNPV) is specific to passerines, with a preference for canaries (*Serinus canaria*) (Shivaprasad et al. 2009, Shaib & Barbour 2018). CNPV causes severe and often lethal infections in passerines (Haller et al., 2014). However, when experimental infections were conducted in chickens and turkeys, localized and self-limiting reactions were observed. In contrast, infections in sparrows (*Zonotrichia*), house sparrows (*Passer domesticus*), and canaries (*S. canaria*) led to 100% mortality (Giddens Jr et al. 1971, Haller et al. 2014). In the present outbreak, no passerines kept in the aviary became ill, and only certain species of psittacines were affected, with high mortality observed in rosellas.

In a study, seven days after introducing 25 lovebirds from another aviary in Chile, 85 lovebirds developed unilateral or bilateral blepharitis, along with nodular, crusty lesions at the beak commissure and periconjunctival skin. Therefore, according to epidemiology, the recent arrival of an infected group of birds may have introduced the virus into the remaining population of psittacines (González-Hein et al. 2008), as occurred in the present report. Similarly, in a study conducted in California (USA), an outbreak of *Avipoxvirus* occurred after 14 canaries were introduced to a flock of around 450 canaries

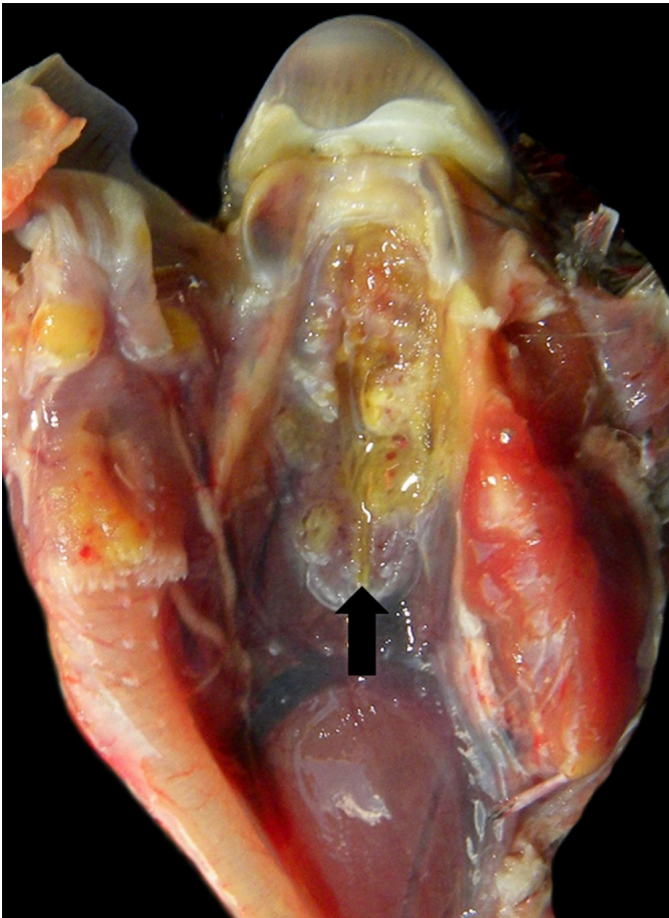


Fig. 3. Rosella (*Platycercus eximius*) with a bilaterally focally extensive fibrinonecrotic lesion (diphtheritic plaque) in the choana (arrow).



Fig. 4. Severe diffuse epithelial hyperplasia in the conjunctiva of a lovebird (*Agapornis roseicollis*) with vacuolar degeneration and eosinophilic intracytoplasmic inclusion bodies (Bollinger bodies) (arrows). HE, obj. 40x.

(*S. canaria*) without undergoing quarantine. After two weeks, the birds began to show clinical signs, resulting in 255 deaths (Shivaprasad et al. 2009).

Outbreaks of *Avipoxvirus* in psittacines typically occur in breeding facilities and aviaries, where the release or excretion of the virus through scabs, skin scales, and feathers can facilitate transmission (Tsai et al. 1997, Murer et al. 2018, Sánchez-Godoy et al. 2023). Most outbreaks occur during the summer months, when there is a higher presence of insects, whose bites can aid in the dissemination of the virus among captive birds, as well as free-ranging birds in contact with them (González-Hein et al. 2008, Slocombe et al. 2013). The outbreak reported in this study occurred during the winter, which makes it unlikely that the virus was spread through these vectors, whose populations are substantially reduced during this time of year. Wild or ornamental birds, such as canaries and psittacines, tend to be more susceptible due to the absence of vaccination, which poses a risk to free-ranging bird populations that may eventually come into direct or indirect contact with captive animals (Akey et al. 1981, Sánchez-Godoy et al. 2023). In this report, the birds were not vaccinated against the virus. Reports of *Avipoxvirus* with skin lesions in rosellas may be influenced by factors such as age, the immune status of the birds, the pathogenicity of the virus, secondary infections, and environmental conditions, including high population density in aviaries, inadequate cleaning, and disinfection of facilities (Slocombe et al. 2013).

In the present outbreak, the morbidity rate was not reported; however, the overall mortality rate within the aviary was 10%, with rosellas being the group that experienced the highest mortality, at 70% of their population. In a separate outbreak involving canaries (*S. canaria*), 100% morbidity and 65% mortality were reported (Shivaprasad et al. 2009). In an outbreak involving lovebirds, mortality was 37.5% in young birds and 3% in adult birds (Tsai et al. 1997). In an outbreak affecting 10 species of psittacines (*Pionus fuscus*, *Pionites leucogaster*, *Guaruba guarouba*, *Derophtus accipitrinus*, *Ara ararauna*, *Ara macao*, *Amazona aestiva*, *Amazona brasiliensis*, and *Anodorhynchus hyacinthinus*), the morbidity rate was 28.7% and the mortality rate was 3.2% (Esteves et al. 2017). An outbreak reported in a breeding facility in Mexico that housed passerines and psittacines showed a morbidity rate of 8.9% (339/3,800) specifically in the lovebird population (*Agapornis fischeri* and *Agapornis personatus*). Among the affected birds, 58.4% (198/339) died, highlighting the significant impact of *Avipoxvirus* on these species (Sánchez-Godoy et al. 2023).

The macroscopic nodular and crusty lesions associated with the genus *Avipoxvirus* in its cutaneous form typically occur in areas devoid of feathers, such as the periconjunctival skin, the commissure of the beak/nostrils, and the pelvic limbs (Hess et al. 2011, Echenique et al. 2016, Ferreira et al. 2018). In an outbreak that affected commercial turkeys, the primary alterations were observed in the commissure of the beak, on the head, and in the craniocervical region, presenting as multifocal to coalescent brownish nodular crusted lesions (Ferreira et al. 2018). Another study involving *Avipoxvirus* in turkeys reported that the predominant lesions were nodular crusty skin lesions located on the head and in the craniocervical region (Hess et al. 2011).

Nodular, crusty, irregular lesions were observed on the dorsal surface of the pelvic limbs in a raptor (*Accipiter gentilis*)

(Schoemaker et al. 1998). In a report on *Avipoxvirus* affecting rosellas in Australia, the main lesions were found on the pelvic limbs, characterized by multifocal, whitish, crusty lesions (Slocombe et al. 2013). In contrast, the present study found that the lesions predominantly affected the periconjunctival skin, which differs from previous studies, where lesions mainly occurred on the pelvic limbs and the commissure of the beak. However, in reports from Mexico and Chile involving lovebirds, the lesions were primarily localized to the periconjunctival skin and the commissure of the beak (González-Hein et al. 2008, Sánchez-Godoy et al. 2023). Additionally, in the present study, two birds exhibited lesions of the diphtheritic form in the oral cavity, similar to an outbreak that occurred in Iran, which affected 328 subsistence birds, with 214 chickens presenting diphtheritic lesions in the oral cavity and respiratory tract (Gholami-Ahangaran et al. 2014).

Regarding histological findings, an outbreak of *Avipoxvirus* occurred in 115 turkeys (Ferreira et al. 2018) and similar cases reported in Hawaiian crows (*Corvus hawaiiensis*) in Hawaii (Tripathy et al. 2000) exhibited epithelial hyperplasia associated with hydropic degeneration, along with the presence of Bollinger bodies, as well as multifocal epithelial necrosis with infiltrates of heterophils, macrophages, and lymphocytes. These lesions are characteristic of the genus *Avipoxvirus* and show similarities to those found in the present study.

The presumptive macroscopic diagnosis is supported by histopathological examination, characterized by proliferative dermatitis with eosinophilic intracytoplasmic inclusion bodies compatible with Bollinger bodies (Hess et al. 2011). Bollinger bodies are characteristic of *Avipoxvirus* and can be detected 72 hours after infection in epithelial tissue (Randall et al. 1961, Giddens Jr et al. 1971, Smits et al. 2005). The inclusion bodies found in the cytoplasm of infected cells are formed by an aggregate of viral particles, making histological examination one of the most effective tools for diagnosing *Avipoxvirus* (Giddens Jr et al. 1971, Shivaprasad et al. 2009, Braga et al. 2020).

Molecular tests such as polymerase chain reaction (PCR) and genetic sequencing enable the confirmation and classification of the genus *Avipoxvirus*, optimizing diagnosis accuracy (Kunert-Filho et al. 2016), as seen in studies on turkeys (Hess et al. 2011, Kunert-Filho et al. 2016, Ferreira et al. 2018) and in wild birds (Tripathy et al. 2000). Other studies have been based on clinical, histopathological, and molecular diagnostics, such as those conducted during an outbreak in a psittacine breeding facility in Rio Grande do Sul (Murer et al. 2018), in lovebirds in Mexico (Sánchez-Godoy et al. 2023), and in rosellas in Australia (Slocombe et al. 2013). In this study, PCR analysis could not be performed due to the lack of refrigerated or frozen samples, which limited the outbreak to a histopathological diagnosis only. However, based on the characteristics, it appears to be an outbreak of psittacine pox.

## CONCLUSION

The diagnosis of *Avipoxvirus* was determined based on the epidemiology, along with the clinical signs associated with necropsy and histopathological findings. Macroscopic lesions such as unilateral or bilateral blepharitis and diphtheritic plaques in the oral cavity are characteristic of the cutaneous and diphtheritic forms of the disease. Histological lesions, such as epithelial hyperplasia associated with Bollinger bodies, are pathognomonic of the disease.

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**Conflict of interest statement.**- The authors declare that there are no conflicts of interest.

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**Data availability statement.**- The authors declare that all data used are available in this article.

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