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Infectious Diseases in Children and Adolescents with Type 1 Diabetes Mellitus

The relationship between diabetes and infections is complex and bidirectional. On one hand, when a child or adolescent with diabetes develops an infection, it directly affects their metabolic control. On the other hand, living with type 1 diabetes predisposes individuals to more frequent—and, in

some cases, more severe—infections than those seen in the general population¹. This means that throughout childhood and adolescence, patients with diabetes may experience more infectious episodes than other children, and these infections may also evolve with more complications.

HOW DO INFECTIONS AFFECT DIABETES CONTROL?

Whenever the body faces an infection, a stress reaction is triggered. This response results in the release of counter-regulatory hormones (such as glucagon, growth hormone, catecholamines, and glucocorticoids) and inflammatory substances known as cytokines, including tumor necrosis factor alpha (TNF- α) and interleukin-1 (IL-1). These molecules act in opposition to insulin, leading patients to present higher blood glucose levels during infectious episodes, which further complicates disease management (1).

WHY DOES DIABETES PREDISPOSE TO MORE INFECTIONS?

Diabetes affects the body's first natural barriers. The skin and intestinal mucosa may become altered, increasing the risk of skin and intestinal infections. In addition, the gut microbiota may be modified, and the skin can become colonized by more virulent pathogens (1, 3).

Furthermore, **persistent hyperglycemia and large glucose fluctuations alter blood vessel function and impair the immune system**. From childhood, reduced production of proinflammatory cytokines, decreased complement activity, and reduced lymphocyte migration to tissues can be observed. Altogether, this results in a weaker defense mechanism against infections (2).

MOST COMMON INFECTIONS IN CHILDHOOD AND ADOLESCENCE WITH DIABETES

1. Respiratory Infections

Respiratory infections are a major concern in children and adolescents with type 1 diabetes mellitus. These patients are known to have a higher predisposition to **pneumonia**, especially due to *Streptococcus pneumoniae* (pneumococcus). They not only acquire the infection more easily but also more frequently experience complications and require hospitalization compared with the general population (2).

Influenza is another clear example. While influenza infection is often self-limited in many individuals, it can develop more se-

verely in patients with diabetes. The risk of complications is higher, making annual influenza vaccination not just recommended, but essential for this high-risk group.

Tuberculosis, although less common in our setting than in low-resource countries, remains a public health concern and is especially relevant in people with diabetes. After exposure, the infection typically remains latent, without causing symptoms. However, latency does not guarantee long-term safety: the infection may reactivate at any time, particularly during adolescence or adulthood. In this context, the risk of developing active tuberculosis among patients with diabetes is approximately three times higher than in the general population¹. Prognosis is also worse, especially if metabolic control is suboptimal, something the infection itself further complicates.

Therefore, the World Health Organization recommends screening for tuberculosis infection in patients with diabetes coming from high-prevalence areas, those presenting compatible symptoms, or when poor glycemic control has no apparent cause⁴. In children with latent infection, preventive treatment is advised to reduce the risk of developing active disease.

Regarding **COVID-19**, evidence accumulated since the pandemic has confirmed that diabetes is a risk factor for developing severe forms of the disease and for increased mortality. Moreover, SARS-CoV-2 infection has been associated with an increase in new diabetes diagnoses and cases of severe ketoacidosis. This dual relationship reinforces the need to prioritize vaccination against COVID-19 in patients with diabetes.

2. Urinary Tract Infections

Urinary tract infections occur more frequently in people with diabetes, although the association is clearer in adults, where poor metabolic control and microangiopathy play an important role. In pediatric patients, some studies have shown that the urine of children and adolescents with diabetes is colonized more often by bacteria. This could translate into an increased risk of urinary infection, although its clinical significance is not yet fully clarified.

3. Digestive Infections

Patients with diabetes have a higher suscep- ➤

POOR GLYCEMIC CONTROL IS A RISK FACTOR FOR MORE FREQUENT AND SEVERE INFECTIONS IN CHILDHOOD



» tibility to fungal infections, especially **candidiasis**. Oral and genital candidiasis are the most common forms, and their risk increases when glycemic control is deficient or after treatment with antibiotics or corticosteroids. In adolescents, vaginal candidiasis is a relatively common complication.

Another finding observed is a higher frequency of *Helicobacter pylori* infection.

This microorganism is involved in gastritis, ulcers, and other intestinal diseases. In this case, the factor that appears most influential is not metabolic control but the number of years since diabetes onset.

4. Skin and Soft Tissue Infections

The skin is a frequent site of infection in patients with diabetes, particularly if poor glycemic control and obesity

coexist. Common infections include candidal infections in skin folds and mucosal areas (vagina, vulva, glans), as well as dermatophytoses such as athlete's foot and tinea corporis.

Regarding bacterial infections, patients with diabetes have a higher predisposition to colonization by resistant strains of *Staphylococcus aureus*. This favors the development of folliculitis, impetigo, »

TYPE OF INFECTION	COMMON SIGNS	ASSOCIATED RISK FACTORS
RESPIRATORY	Pneumococcal pneumonia, influenza-related complications, tuberculosis, COVID-19.	Poor glycemic control, lack of vaccination.
URINARY	Recurrent urinary tract infections, asymptomatic bacteriuria.	Microangiopathy, poor metabolic control.
DIGESTIVE	Oral and genital candidiasis, <i>Helicobacter pylori</i> infection.	Poor glycemic control, use of antibiotics/corticosteroids.
SKIN AND SOFT TISSUE	Fungal infections, athlete's foot, folliculitis, abscesses.	Obesity, <i>Staphylococcus aureus</i> colonization, subcutaneous devices.
ORAL	Candidiasis, gingivitis, dental caries.	Salivary alterations, poor glycemic control.

Summary Table of the Most Relevant Infections

» abscesses, and even more severe conditions such as osteomyelitis or septic arthritis (3).

A particular issue in recent years has been the increased use of glucose monitoring devices and insulin pumps. Although these represent major advances in diabetes management, they have also been associated with infections at insertion sites. These are usually mild infections caused by common skin bacteria, but proper hygiene during handling and placement of these devices is essential to reduce this risk.

5. Oral Infections

Diabetes alters both the quantity and composition of saliva, which leads to changes in oral microbiota and favors infection. As a result, these patients more frequently develop oral candidiasis, dental caries, and gingivitis. Once again, poor glycemic control plays a decisive role, increasing both the likelihood and severity of these complications (5).

HOW TO PREVENT INFECTIONS

The first pillar of prevention is maintaining adequate glycemic control. Good diabetes management has been shown to reduce both the frequency and severity of infections. It is important to remember that infections themselves—and sometimes the medications used to treat them—can make glucose control more difficult.

Furthermore, basic hygiene measures—frequent handwashing, avoiding close contact with sick individuals, wearing masks during epidemic periods, and reducing exposure to crowded indoor spaces—are as useful for diabetic patients as for the general population.

Oral care, including daily dental hygiene and regular dental check-ups, along with skin care (especially of the genital area and device insertion sites), is equally important.

Finally, **vaccination is an essential component of prevention.** All recommended immunizations for children and adolescents should be followed. Vaccination schedules in Spain vary by autonomous community. To these, it is advisable to add the vaccines recommended by the Advisory Committee on Vaccines of the Spanish Association of Pediatrics, even if they are not included in the regional schedule.

In addition, annual influenza vaccination from 6 months of age using the inactivated injectable vaccine, COVID-19 vaccination, pneumococcal vaccination using mixed schemes that include PCV13, PCV15, or PCV20, and PPSV23 (the latter only if PCV20 has not been received or is unavailable) should be included⁶.

Screening and treatment of latent tuberculosis should also be considered in at-risk patients, especially at the time of diabetes diagnosis. **D**

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