Catlab Informa

Butlletí Nº 154

Artificial Intelligence in Urinary Tract Infections: Experience with UCA Software

Introduction

Urinary tract infections (UTIs) represent one of the main reasons for consultation in Primary Care Centers and account for 20–30% of hospital-acquired infections. Their prevalence is higher in women than in men.

Urine culture is the reference technique for the microbiological diagnosis of UTIs; however, the diagnosis of these infections should not be based exclusively on this technique and also requires appropriate clinical assessment. This technique consists of inoculating a small urine sample (1 o 10µl) on to a specific culture medium that allows the growth of the most common microorganisms. Currently, chromogenic culture media are used, in which each microorganism forms colonies with a characteristic color, facilitating their identification (Figure 1).

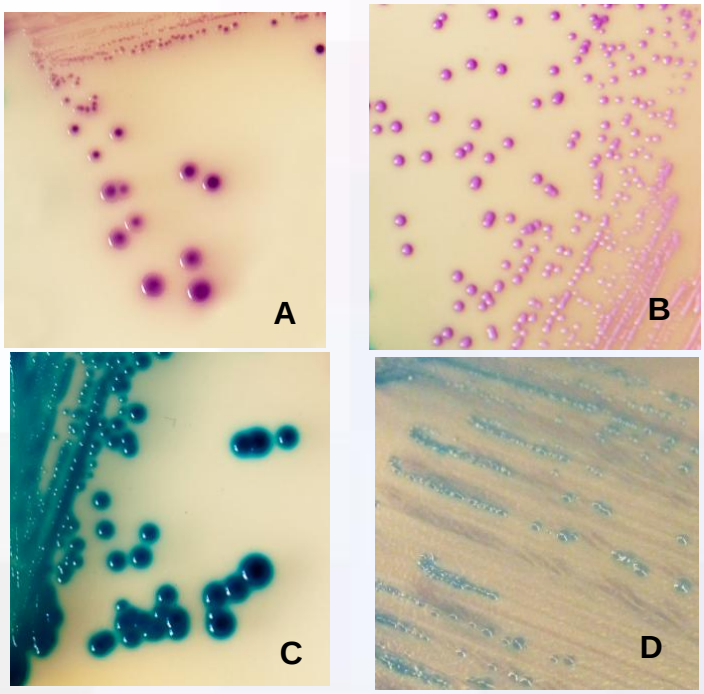

Figure 1. Growth of different microorganisms on chromogenic medium. *(A) Escherichia coli, (B) Staphylococcus saprophyticus, (C) Klebsiella spp., (D) Streptococcus agalactiae.*

In addition to urine culture, other complementary tests help confirm the diagnosis, such as reagent strips or urinary sediment analysis. The combined interpretation of these tests, in conjunction with clinical evaluation, allows a more precise diagnosis. When bacterial growth is present on the culture plate, it is necessary to investigate the specific pathogen. Although the color and morphology of bacterial colonies provide a presumptive identification, definitive identification must sometimes be confirmed using other laboratory techniques, such as mass spectrometry (MALDI-TOF) or a battery of biochemical tests (VITEK). Depending on the identified microorganism, antibiotics to be tested in an antibiogram are selected. Based on these results, antibiotic treatment can be tailored according to whether the microorganism is ultimately classified as sensitive or resistant to each drug.

The most frequent causative pathogen of UTIs is *Escherichia coli* (E. coli), accounting for approximately 60–70% of cases. Other common pathogens include *Klebsiella* spp., *Proteus* spp., *Enterococcus* spp., among others. Figure 2 shows the most relevant pathogens in our healthcare area.

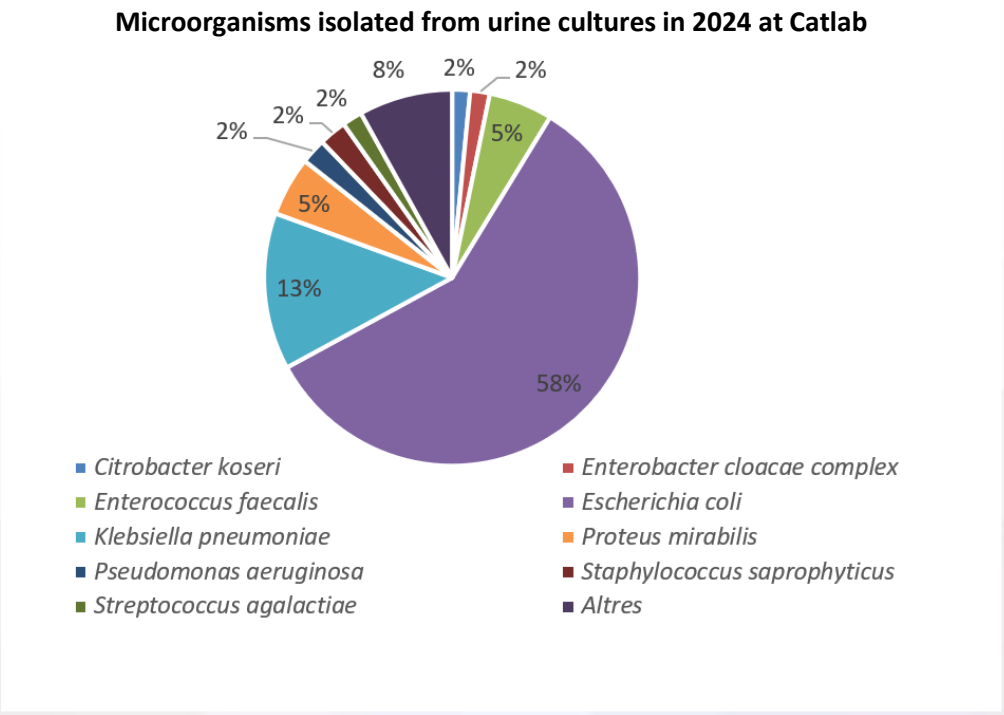

Figure 2. Distribution of UTI-causing pathogens in 2024 from all urine cultures processed at CATLAB.

The microbiology laboratories of Catlab process a large volume of urine, reaching 64.063 urine cultures in 2024, which come from Primary Care and are processed at the central laboratory located in Viladecavalls. This laboratory may process more than 250 urine samples in a single day.

Although urine cultures are one of the most frequent tests performed in the laboratory, they have a low positivity yield (34%). A high percentage of samples present negative (51%) or contaminated results (15%), and processing large workloads delays the reporting of positive samples. For this reason, early and selective detection and processing of positive samples helps provide useful results for clinical management and allows for timely adjustments to antibiotic treatment, if necessary.

Given the magnitude and complexity of this process, it is of great interest to have automated tools that support and optimize the inoculation, reading, and interpretation of urine cultures.

Since 2021, the Microbiology Department has been equipped with an automated inoculation system (BD Kiestra™) (Figure 3), capable of inoculating a wide variety of samples and distributing them into different incubators according to culture requirements. In addition, the automatic inoculator incorporates a camera that allows images to be obtained at different incubation times and viewed on a computer using software called Synapsis. This software enables visualization of bacterial growth on culture plates without the need to physically handle them (Figure 4).

Figure 3. BD Kiestra™ system.

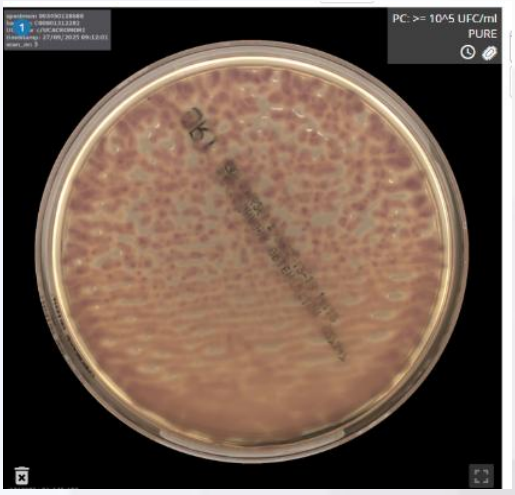

Figure 4. Example of detection of >10^5 CFU/mL pure *E. coli*.

What Is Artificial Intelligence (AI) and how can it be applied in Microbiology?

Artificial intelligence (AI) is a tool that allows computers and other machines to simulate human learning, problem-solving, and decision-making autonomously. Advances in AI technology offer unprecedented opportunities to revolutionize healthcare. Artificial intelligence can help achieve more accurate diagnoses and detect health problems at earlier stages; for example, it can identify signs of disease in radiographs or laboratory tests before they are evident to the human eye.

In the Microbiology Department at Catlab, this technology is used to more efficiently analyze urine cultures and improve the microbiological UTI diagnosis. For this purpose, an AI-based image recognition software called **UCA** (Urine Culture Application) from BD Kiestra has been implemented. This AI enables automated reading, streamlines urine culture validation, and standardizes result interpretation, thus contributing to accurate and reliable urine culture diagnoses.

As a major innovation, in 2025 the UCA software was integrated into the automatic inoculation system, automating both inoculation and reading of urine cultures. This automation significantly accelerates the process of bacterial identification and quantification, reduces margins of error, and improves efficiency in result reporting. The implementation of UCA addresses the need to manage a high volume of samples and ensures a higher level of accuracy and traceability, contributing to faster and safer clinical decision-making in patient management.

How does UCA work?

The UCA software analyzes images obtained during incubation through the automatic inoculator's cameras and determines whether bacterial growth is present. When growth is detected, the software performs a presumptive identification based on colony color and counts bacterial colonies, providing a quantitative result expressed in CFU/mL (colony-forming units per milliliter).
Pictures:

UCA is capable of integrating patient data (age and sex) and sample data (urine dipstick and/or urinary sediment) and correlating them with identification, quantification, and culture purity.
Microbiology personnel can design customized workflow algorithms based on a rule-creation system using parameters required to interpret a urine culture (type of

microorganism growing in the culture, patient age and sex, degree of purity, and quantification of the urine culture, etc.), which UCA can interpret and act upon.
Actions that UCA can perform:

- **Sending cultures to worklists**, where UCA requests additional tests such as MALDI-TOF identification, antibiograms, re-isolations, and all types of manual biochemical tests.

- **Classifying images into reading lists** while plates continue incubating. These lists mainly contain complex cultures that require review and evaluation by experienced personnel.

- **Sending contaminated or negative results to the laboratory information system and discarding the plate.** In this case, results always require subsequent validation.

Conclusions

UCA is a precise and reliable AI tool that allows automated interpretation of urine cultures. This automation reduces manual workload, standardizes urine culture interpretation, and decreases turnaround time, especially for negative cultures.

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