Urinary tract infections in the inpatient environment – testing close to the patient at the point of care

White paper as at 11/2023 – Art. No. MDQ-01.733-01-LoC-161

Invented for life

BOSCH

Facts and figures

Dear reader,

In Europe, around 5.5 percent of all hospitalized patients contract a nosocomial, i.e. hospital-acquired, infection. Of these, urinary tract infections (UTIs) account for a significant proportion of around 37 percent.[1] In absolute figures, more than 1.5 million of 78 million people who are hospitalized in Europe each year are affected by a nosocomial UTI. This is roughly equivalent to the population of Munich or Barcelona.

In the outpatient sector, UTIs occur significantly more frequently in women than in men and are therefore often perceived as a “female issue”. Although most of these infections are painful, they are generally easy to treat and fall into the category of uncomplicated urinary tract infections.

The picture in the inpatient sector is different: Here, it is not gender that plays the most important role as a risk factor, but age and, above all, urinary catheterization.[3] In this respect, the treatment of these complicated UTIs is part of everyday life in almost all hospital departments and specialist disciplines. Given that in approximately 5 to 20 percent of cases a UTI develops into urosepsis,[1] it is important that such urinary tract infections are not trivialized. Urosepsis is a life-threatening infection in which bacteria from the urinary tract have entered the bloodstream and trigger a systemic inflammatory reaction. In around 20 percent of cases, urosepsis is fatal.[4] In addition, its treatment is complex and expensive. Targeted therapy based on a rapid test result can positively influence the course of the disease and save a large proportion of up to EUR 34,000 in costs that a hospital can incur per sepsis case.[5]

Around 40 percent of complicated UTIs that predominate in inpatient settings are caused by the Escheria coli (E. coli) bacterium. However, other pathogens such as Klebsielle species (approx. 11 percent) or Pseudomonas aeruginosa (approx. 11 percent) also play a role. There are almost ten different bacterial species that cause the majority of nosocomial UTIs.[6] The resistance rates of the most common UTI pathogen (E. coli) vary greatly from region to region. In Europe, for example, the rate of multi-resistant E. coli pathogens ranges from 1.2 percent in Denmark to 14.8 percent in Bulgaria. As much as between 5.5 percent (Norway) and 37.3 percent (Bulgaria) of E. coli pathogens are resistant to the broad-spectrum antibiotic group of cephalosporins frequently used in the treatment of UTIs.[7]

The gold standard for UTI detection is urine culture, which usually requires between 48 and 72 hours to determine the bacterial species and load and obtain the antibiogram.[4, 8]

Due to the length of turnaround time, in suspected cases of UTI patients who are often treated with a broad-spectrum antibiotic, even before the pathogen is detected. However, in light of the lack of certainty about the causative pathogens and the growing resistance rates, this approach is likely to be increasingly ineffective – or even to contribute to further resistance. Yet rapid knowledge of the causative pathogen is required in order to be able to provide treatment in a timely and effective manner.

Whitepaper / Urinary tract infections in the inpatient environment: patient-oriented PCR rapid tests.

In addition to the urine culture, which is usually performed by central laboratories and, due to sample transportation and cultivation of the culture, with a wait of several days to obtain a result, there are now also a much need for rapid PCR tests at the point of care.

Bosch will soon be launching a rapid UTI test for its Vivalytic platform. This test can simultaneously analyze the most important pathogens and relevant resistances from a urine sample. All the necessary analysis steps for this are combined in a single compact device. This UTI multiplex test makes results rapidly available in PCR quality at the point of care. It can make it possible to detect or rule out the presence of common pathogens with just one sample collection.

Important in UTI diagnostics: speed

In UTI pathogen diagnostics, culture tests are the gold standard. To this end, a urine sample is placed on a culture medium in the laboratory, causing the bacteria in the sample to multiply. The culture usually needs around 48 hours to produce a result. Since the test has to be performed by trained personnel in a central laboratory, factors such as the absence of specialist staff and the time needed for sample transportation can cause considerable delays and extend the time-to-result to up to 72 hours. Modern rapid PCR tests for the point of care, on the other hand, are carried out quickly, do not require any laboratory experience and, due to their decentralized use, eliminate the time needed for sample transportation. In the future, these tests can therefore partially replace or supplement culture testing.

The resulting rapid, reliable diagnosis of the underlying uropathogens brings cumulative advantages. Specifically:

- Knowledge of the pathogen diagnostics, including information about the most important resistances, makes it possible to select the most suitable antibiotic in each individual case.
- Urosepsis can be prevented or treated more quickly.
- A rapid PCR test thus shortens the time to targeted therapy by a few days.
- This, in turn, can accelerate the healing process and thus shorten the length of stay – with a corresponding impact on hospital costs. Because every case of UTI in hospital leads to an increase in the length of stay of one to three days.[9]

What’s more, reliable PCR results are also possible with Vivalytic at off-peak times, at weekends, in the evening, at night, or even in the event of staff shortages. The possibility of on-site testing is particularly suitable for hospitals with no laboratory of their own. Data provided by the German Hospital Institute (DKI – Deutsches Krankenhausinstitut) shows, for example, that the majority of hospitals with fewer than 600 beds outsource molecular diagnostics to external laboratories,[10] delaying the time-to-result. For these hospitals, rapid PCR tests for the point of care can enable prompt pathogen diagnostics on any day and at any time, which is particularly valuable in cases of suspected urosepsis.

Risks and preoperative diagnostics

Reduce known risks

There are many reasons why patients can contract urinary tract infections during a stay in hospital.[11] This is compounded by the fact that urogenital pathogens do not always display symptoms immediately. It is therefore all the more important to rapidly detect risk groups with so-called bacteriuria, i.e. the asymptomatic presence of bacteria in the urine. The number of patients with bacteriuria, or even a symptomatic urinary tract infection, when they are taken into hospital is high. For example, up to 50 percent of patients who are admitted from care homes can be affected by bacteriuria. If symptoms do occur, they can be very similar for different pathogens, making it difficult to select a suitable, pathogen-specific antibiotic.

The following examples show where rapid PCR tests for the point of care can be meaningfully used as a screening measure or in the form of a syndromic test.

Risk factor urinary catheter

80 percent of urinary tract infections in the inpatient sector are associated with a urinary catheter, making catheters the greatest risk factor for a nosocomial UTI. Uropathogens on the surface of the urinary catheter can penetrate through to the bladder or the catheter can damage the mucous membranes of the urinary tract and thus allow the pathogens to enter the bloodstream.[12] Yet urinary catheters are an everyday procedure, with 12 to 16 percent of all hospital patients receiving one during an inpatient stay. On urology wards, this figure is around 75 percent and in intensive care units is as high as 80 percent. The risk of catheter-related bacteriuria is between 3 and 10 percent per catheterized day.[3] And again: In the worst-case scenario, urosepsis may develop.

If there is a concrete suspicion of a catheter-associated urinary tract infection, the guidelines recommend a urine culture for pathogen determination and resistance testing before starting treatment - with the corresponding time until the result is obtained. Rapid PCR tests provide prompt results and could also be used to screen asymptomatic patients with urinary tract catheters and certain risk factors (e.g. long catheterization time, intensive care unit). This would enable clinically relevant pathogen concentrations in the urine to be detected and treated before they become symptomatic or critical.

Whitepaper / Urinary tract infections in the inpatient environment: patient-oriented PCR rapid tests.

Preoperative diagnostics for urological procedures

Urological procedures are among the most common operations especially for older patients. UTIs account for a significant proportion of the possible subsequent complications resulting from urological surgical interventions. So-called transurethral procedures, where the instruments and catheter are introduced to the surgical site through the urethra.[12, 13]

These procedures are used very frequently in urology, for example in transurethral resection of the prostate (TURP) or of bladder tumors (TURBT). They come with an increased risk of contracting UTIs, because the catheters and instruments used can damage the mucous membranes of the urinary tract, allowing urogenital pathogens to enter the bloodstream and trigger what is known as bacteremia. Furthermore, the operation mainly affects male patients over the age of 65, who are more likely than younger men to present asymptomatic bacteriuria and therefore represent a risk group. For example, post-procedural bacteremia occurs in around 6 percent of patients who undergo TURP and do not receive targeted antibiotics before the operation [13] – a complication that can be the first step towards developing urosepsis.

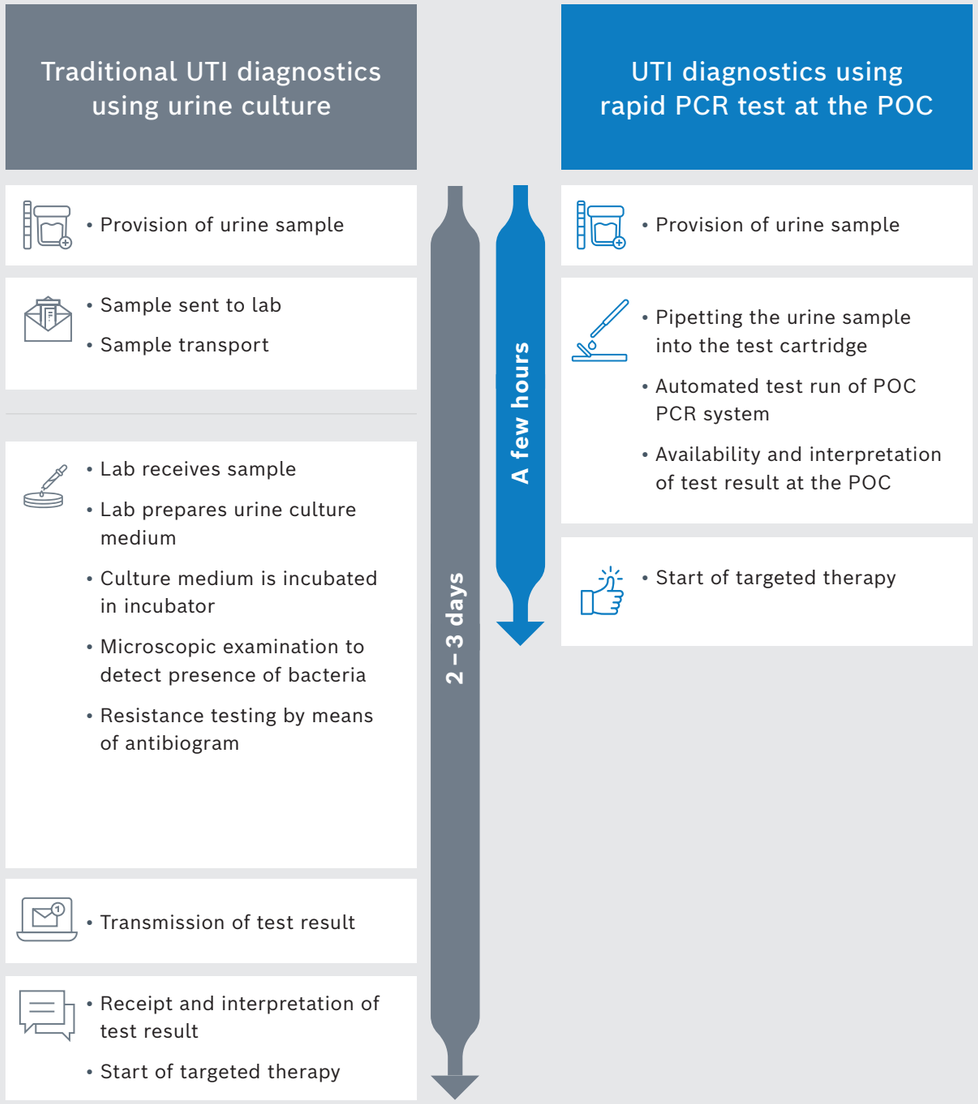
Urine culture testing is also considered the gold standard for the preoperative detection of pathogens, and both the US-American and the European guidelines recommend pathogen screening using a culture prior to a transurethral procedure.[12, 13] Given the time-to-result of up to 72 hours, it stands to reason that, contrary to the guidelines, there is not always time to carry out preoperative urine culture testing including antibiogram for all patients. The global GPUI study openly reveals, for example, that of those urology patients who receive antibiotics, only around 26 percent of cases receive targeted therapy based on microbiological pathogen identification. The majority of patients received broad-spectrum antibiotics as a prophylaxis or on the basis of clinical symptoms.[14] Rapid PCR testing for UTIs ahead of an operation can quickly identify at the point of sampling whether and which pathogens are present in the urine, allowing a targeted decision as to whether and which antibiotics should be administered.

In a nutshell

UTIs in the inpatient sector are a problem to be taken seriously because they ...

- ... have an impact on patient well-being and carry the risk of potentially fatal urosepsis.
- ... have an impact on increasing resistance to antibiotics.
- ... have an impact on the length of hospital stays and costs.
- ... begin as unidentified, asymptomatic bacteriuria and, for example, as a result of placing a urinary catheter or a urological procedure can trigger an infection and, in the worst case, urosepsis.
- ... are diagnosed by means of a urine culture as the current gold standard, which is both time-consuming and requires laboratory experience and equipment.

Rapid PCR tests for the point of care can in future shorten the time to targeted therapy by several days thanks to rapid test results and the possibility of simple, decentralized use.



Advantages: **rapid PCR test at the point of care**

Rapid result
+ Rapid certainty for patients
+ Fast start of therapy
+ Prevention of further resistances

Multiplex result
+ Certainty for patients regarding many relevant pathogens
+ Targeted therapy adapted to detected pathogens

Ease of use, automated test process

Vivalytic analyzes different patient samples, such as swabs or urine. All that is required are the test cartridges and the Vivalytic Analyser, which automates the entire test process. Depending on the test complexity, test results in PCR quality are available in under half an hour. Thanks to the ease of use, staff can use the Vivalytic system reliably and safely, regardless of their individual experience with laboratory diagnostics. Test results produced using Vivalytic can be automatically transmitted to patient files. Via an HL7 interface, Vivalytic devices can be linked up to the hospital information service (HIS) or laboratory information service (LIS).

Extensive, growing test portfolio for low- and multiplex applications

A single target in a singleplex test or many parameters in a multiplex test – Vivalytic can do both. With Vivalytic, Bosch is creating the technological basis for developing and bringing new tests to market maturity in collaboration with specialized reagent developers.

The test portfolio is extensive: Vivalytic identifies nosocomial pathogens such as MRSA, thus supporting hygiene management and isolation decisions.

For hospitals, however, respiratory pathogens also play a role in two respects. Firstly, in times of flu epidemics, often reflected in the capacity utilization of emergency departments, and secondly in the context of hospital infections. SARS-CoV-2, influenza A/B and respiratory syncytial virus (RSV) can all be detected using Vivalytic from a single swab. The same system can also be used to detect ten different sexually transmitted infections (STI) simultaneously from a single swab or urine sample. Further tests are currently under development, including a multiplex test for UTI pathogens and a test for bacterial meningitis pathogens.

The current Vivalytic test portfolio can be viewed online:
www.bosch-vivalytic.com/tests

[1] https://www.eurosurveillance.org/content/10.2807/1560-7917.ES.2019.24.46.1900135; abgerufen am 08.11.2023
[2] https://www.oecd-ilibrary.org/sites/898c9182-en/index.html?itemId=/content/component/898c9182-en; https://data.worldbank.org/indicator/SP.POP.TOTL?locations=EU; abgerufen am 08.11.2023
[3] Empfehlungen zur Prävention und Kontrolle Katheter-assoziierter Harnwegsinfektionen, Aktualisierte Empfehlung der KRINKO vom Juni 2015, Bundesgesundheitsbl 2015 58:641–650, DOI 10.1007/s00103-015-2152-3
[4] Davenport et al. (2017) Nat Rev Urol. 2017 May ; 14(5): 296–310.
[5] Hospital-related costs of sepsis around the world: A systematic review exploring the economic burden of sepsis; https://doi.org/10.1016/j.jcrc.2022.154096
[6] Wagenlehner et al. The Global Prevalence of Infections in Urology Study: A Long-Term, Worldwide Surveillance Study on Urological Infections. Pathogens. 2016 ;doi: 10.3390/pathogens5010010. PMID: 26797640
[7] ECDC Surveillance Atlas of Infectious diseases, https://atlas.ecdc.europa.eu/public/index.aspx; abgerufen am 08.11.2023
[8] Sabih A, Leslie SW. Complicated Urinary Tract Infections. [Updated 2023 Jan 18]. In: StatPearls [Internet]. Treasure Island (FL): StatPearls Publishing; 2023 Jan-. Available from: https://www.ncbi.nlm.nih.gov/books/NBK436013
[9] Medina-Polo J, Naber KG, Bjerklund Johansen TE. Healthcare-associated urinary tract infections in urology. GMS Infect Dis. 2021 Aug 30;9:Doc05. doi: 10.3205/id000074. PMID: 34540531; PMCID: PMC8422970
[10] Löffert et al. Die Bedeutung der Labordiagnostik für die Krankenhausversorgung, Deutsches Krankenhausinstitut e.V., 2014
[11] Robert Koch-Institut, Anzahl nosokomialer Ausbrüche, Fälle und Todesfälle in Deutschland nach Erreger im Jahr 2019, In Statista. https://de.statista.com/statistik/daten/studie/582853/umfrage/anzahl-nosokomialer-ausbrueche-faelle-und-todesfaelle-in-deutschland/; abgerufen am 08.11.2023
[12] EAU Guidelines on Urological infections, 2023. ISBN 978-94-92671-19-6, https://uroweb.org/guidelines/urological-infections
[13] Lindsay E Nicolle et al, Clinical Practice Guideline for the Management of Asymptomatic Bacteriuria: 2019 Update by the Infectious Diseases Society of America, Clinical Infectious
[14] Wagenlehner et al. The Global Prevalence of Infections in Urology Study: A Long-Term, Worldwide Surveillance Study on Urological Infections. Pathogens. 2016 Jan 19;5(1):10. doi: 10.3390/pathogens5010010. PMID: 26797640; PMCID: PMC4810131. Download .nbib

Click here to learn more about the current Vivalytic test portfolio

Bosch Healthcare Solutions GmbH

Stuttgarter Straße 130
71332 Waiblingen
Deutschland

www.bosch-healthcare.com