Catheter-associated urinary tract infections (CAUTIs) are one of the most common nosocomial infections. Half of the patients experience bacteriuria in the first 10-14 days of catheterization and the risk is significantly higher in long-term catheterization. In patients with more than 28 day of catheterization the risk of infection approaches to 100%. Proteus mirabilis is a gram negative bacterium commonly associated with CAUTI. It can cause complicated urinary tract infection (UTI). They can express several virulence factors that are related with infection as fimbriae, flagella, immune-avoidance, damage in host cells and biofilm formation. We used a clinical P. mirabilis 2921 strain and an isogenic mutant strain for an efflux protein (P. mirabilis 40) which make them inefficient to form biofilm. We assessed the capability to swarm over latex and silicone catheters (Sylkolatex 2 way Foley catheter, Teleflex Medical, USA and Silkomed @Teleflex Medical, Germany) with both strains. The experiment was performed 10 times. Scanning electron microscopy (SEM) and energy dispersive spectroscopy (EDS) was performed in the different catheters.

The strains were divided in 3 groups according to the results obtained: (0) non-crossing, (1) swarming but not able to bridge the catheter and (2) able to bridge the catheter. The results show that wild type P. mirabilis 2921 was able to bridge in all cases (10/10) in both types of catheter. In silicone, P. mirabilis 40, 50% of bacteria were non-crossing, 30 % were swarming but not able to bridge and 20 % were able to bridge the catheter. Moreover in latex, 60% of them were able to swarm but not to bridge while 40 % were able to bridge the catheter. This results show that the mutant is affected in their capability of crossing the catheter but there are also differences related to the catheter material.

EDS revealed that latex has an 8.27% of zinc among other components while silicone has mainly silicone (36.5%) and no other metals were found (Fig.1 and 2). Zinc is an essential transition metal in all organisms; bacteria are predicted to incorporate zinc into 5-6% of all proteins. Zinc proteins are involved in DNA replication, glycolysis, pH regulation and the biosynthesis of amino acids, extracellular peptidoglycan and low molecular thiols. Probably, the accessibility of zinc allows the mutant cross better the latex than the silicone catheters. SEM images revealed that wild type P. mirabilis 2921 form biofilm over the surface (Fig. 3 and 4) while the mutant only appear in small groups.

The results obtained in the present work will contribute to the understanding of CAUTI and should be taking into account in clinical practice.
Fig. 1: Latex catheter surface without bacteria. The structure in the image resembling a ball is in the internal surface of the catheter.

Fig. 2: Silicon catheter surface without bacteria.

Fig. 3: P. mirabilis 2921 over latex catheter. It is possible to recognize the “balls” in the latex surface (*). Bacterial biofilm is indicated by two **.

Fig. 4: P. mirabilis 2921 over silicon.