TauroLock™

ANTIMICROBIAL CATHETER LOCK SOLUTIONS
PATENCY MAINTENANCE AND INFECTION CONTROL

Prophylaxis against catheter-related bloodstream infections (CRBSI)

Central-venous catheters (CVC) serve as short- or long-term vascular access devices in haemodialysis, oncology, parenteral nutrition, and intensive care. But they also carry the risk of catheter-related infections (CRI) and CVC malfunctions. Those infections can be triggered by microbial colonisation of the catheter, from which the microorganisms might further spread into the bloodstream. CRI can lead to chronic activation of the immune system and to septic symptoms that require an immediate removal of the catheter.

DIALYSIS

Infection rate (per 1,000 catheter days)	**Product**	**Evidence level*/p-value / literature**
2.7	Citrate 4 %	1B / p=0.003 / Winnicki et al. (Lit. 3.1.3)
0.67	TauroLock™-HEP500 (2x) / TauroLock™-U25.000 (1x)	
1.08	Heparin 5000 IU/mL	2B / p=0.023 / Fontseré et al. (Lit.3.1.12)
0.04	TauroLock™-HEP500	
1.59	Heparin 5000 IU/mL	2B / p=0.004 / Murray et al. (Lit. 3.1.13)
0.69	TauroLock™-HEP500	
2.4	Heparin 5000 IU/mL	1B / p=0.1 / Solomon et al (2010, Lit. 3.1.7)
1.4	TauroLock™	
3.25	Heparin 5000 IU/mL	2B / p=0.001 / Solomon et al (2012, Lit. 3.1.8)
1.33	TauroLock™-HEP500	

PARENTERAL NUTRITION

Infection rate (per 1,000 catheter days)	**Product**	**Evidence level*/p-value / literature**
1.0	Heparin 100 IU/mL	1B / p=0.005 / Tribler et al (Lit. 3.2.8)
0.0	TauroLock™-HEP100	
1.44	Saline 0.9 %	1B / p=0.002 / Wouters et al (Lit. 3.2.21)
0.33	2 % Taurolidine (Citrate-free)	
6.58	Saline 0.9 %	2B / p<0.001 / Touré et al (Lit. 3.2.13)
1.09	TauroLock™	

PAEDIATRIC ONCOLOGY

Infection rate (per 1,000 catheter days)	**Product**	**Evidence level*/p-value / literature**
1.4	Heparin 100 IU/mL	1B / p=0.001 / Handrup et al (Lit. 3.2.1)
0.4	TauroLock™-HEP100	
1.3	Heparin 100 IU/mL	1B / p=0.03 / Dümichen et al (Lit. 3.2.3)
0.3	TauroLock™	
2.3	Heparin 200 IU/mL	2B / p=0.004 / Simon et al (Lit. 3.2.5)
0.5	TauroLock™	

Heparin · 4 % Citrate · Saline · as in **NutriLock™** · **TauroLock™** or variant

* Acc. to criteria from the Center of evidence-based medicine

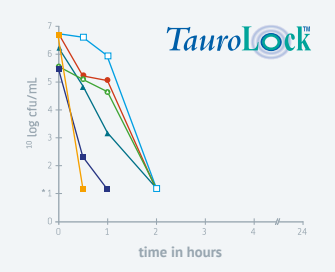
TauroPharm has developed catheter lock solutions to prevent CRI. The antimicrobial efficacy of **NutriLock™** and **TauroLock™** products is based on **taurolidine** – an active ingredient with a broad activity against bacteria and fungi (including MRSA and VRE). **TauroLock™** and **NutriLock™** solutions do not contain antibiotics.

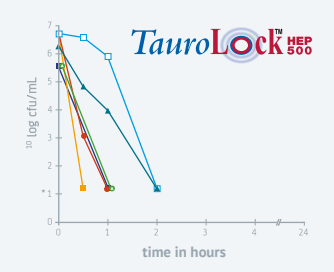
CDC and ERBP demand the use of antimicrobial lock solutions such as **TauroLock™**. More specifically, various national guidelines also recommend taurolidine-based lock solutions for dialysis, oncology, and parenteral nutrition (see literature 1).

TauroLock™, TauroLock™-HEP100/500, TauroLock™-U25.000, and NutriLock™ have been used successfully in regimens to reduce CRI.

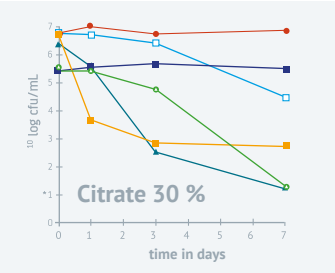
The basic formulation of TauroLock™ (consisting of 1.35 % taurolidine and 4 % citrate) was proven to significantly reduce catheter-associated bloodstream infections (see literature 2.2 and 2.3) and significantly reduce CRBSIs in paediatric oncology (see literature 3.2.1 and 3.2.3).

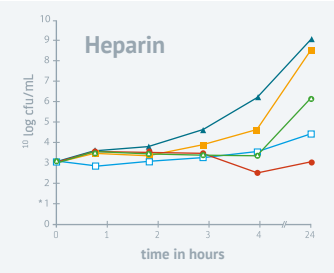
TauroLock™ is bactericidal and fungicidal within 2 hours**:





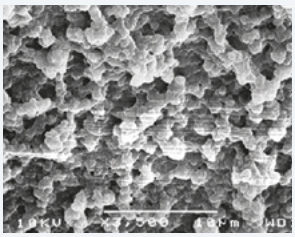
For comparison: activity of citrate** 30 % and heparin***

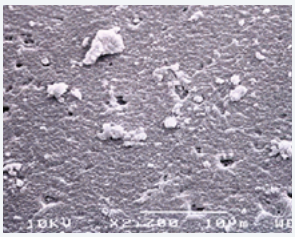




* Detection limit (10 cfu/ml) ** Own data *** See literature 4.4.

S. epidermidis S. aureus E. coli P. aeruginosa A. niger C. albicans





Heparin Lock
S. epidermidis biofilm *

Taurolidine-Citrate Lock
No colonisation*
* See literature 3.1.14

Prophylaxis against biological occlusion

TauroLock™ solutions ensure a threefold prophylaxis against occlusion within the catheter.

All variants contain **4 % citrate** as an anticoagulant. This concentration removes calcium safely and effectively from the clotting cascade.

For dialysis patients, we recommend **TauroLock™-HEP500** as the standard lock solution. Its efficacy regarding the patency rate is comparable to 5,000 IU/ml of heparin (see literature 3.1.8). This optional use of low concentrated **heparin** fosters an anticoagulative effect, as heparin binds to antithrombin.

Combining **TauroLock™-HEP500** and **TauroLock™-U25.000** (which contains 5,000 IU/ml of **urokinase**) can significantly reduce the rate of patency problems. Four clinical studies found that the **TauroLock™** 2+1 protocol yielded better outcomes than 4 % citrate or **TauroLock™-HEP500** alone (see literature 3.1.3 and 3.1.4).

TauroLock™ products and NutriLock™ are clinically safe

TauroLock™ products and **NutriLock™** have demonstrated good biocompatibility.

The concentration of 4 % citrate in all **TauroLock™** variants is safe and efficient, see recommendations in FDA Warning Letter, April 2000, ERBP, and various national guidelines (see literature 1.5 and 1.6).

Instillation of TauroLock™

For other products visit **taurolock.com**

1. Flush the device with 10 ml of saline.
2. Withdraw **TauroLock™** from the container, using a suitable syringe.
3. Instill **TauroLock™** slowly (not more than 1 ml per second, infants and children less than two years of age not more than 1 ml per 5 seconds) into the access device in a quantity sufficient to fill the lumen completely. Consult the manufacturer's instructions for the specific fill volume or specify fill volume during implantation. The volume has to be strictly respected. **TauroLock™** will remain inside the access device until the next treatment (up to a maximum of 30 days).
4. Prior to the next treatment **TauroLock™** must be aspirated and discarded in accordance with the institution's policy for infectious waste disposal.
5. Flush the device with 10 ml of saline.

Please follow the manufacturer's instructions for the venous vascular access device at hand. Each device requires a specific catheter lock volume.

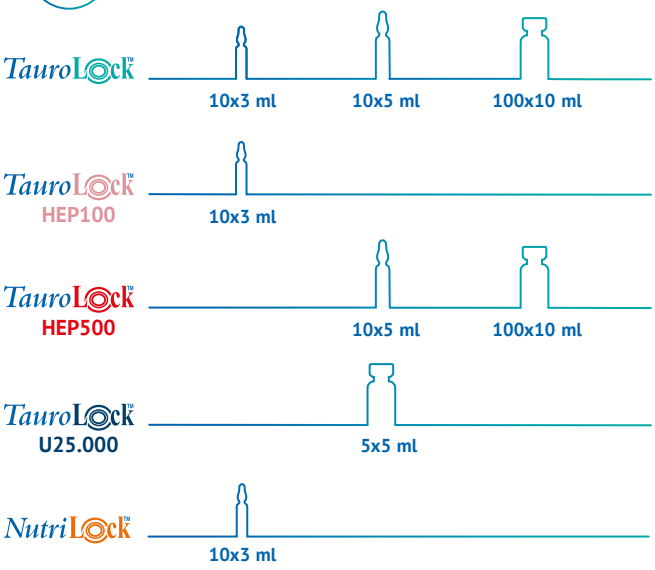
This protocol does not replace the manufacturer's instruction for use.

Instructions for use

TauroLock™

The right product for each patient	DIALYSIS	PARENTERAL NUTRITION	ONCOLOGY
TauroLock™	✓	✓ ✓ ✓	✓ ✓ ✓
TauroLock™ HEP100		✓ ✓ ✓	✓ ✓ ✓
TauroLock™ HEP500	✓ ✓ ✓		
TauroLock™ U25.000	✓ ✓ ✓	✓ ✓	✓ ✓
NutriLock™		✓ ✓ ✓	

Package sizes of TauroLock™/NutriLock™ catheter lock solutions:



Manufacturer:

TauroPharm GmbH
August-Bebel-Straße 51
D-97297 Waldbüttelbrunn

Tel. +49 931 30 42 99 0
Fax +49 931 30 42 99 29

More information on **taurolock.com**

85100EN/49/23

Publications on safety and efficacy

1. GUIDELINES AND RECOMMENDATIONS

1.1. Guidelines for the Prevention of Intravascular Catheter-related Infections
O'Grady et al. and the Healthcare Infection Control Practices Advisory Committee *(HICPAC). Clin Infect Dis* 2011. DOI: 10.1093/cid/cir138

1.2. Infusion Standards of Practice (INS)
Gorski et al. *Journal of Infusion Nursing / Infusion Nurses Society* 2021. DOI: 10.1097/NAN.0000000000000396

1.3. Prevention of infections associated with implantable catheter/port systems for venous access (SF2H)
Hygienes */ French Society for Hospital Hygiene (SF2H)* 2012. Print.

1.4. Prevention of infections that originate in blood vessel catheters; Part 1 – Non-tunneled central-venous catheters (KRINKO)
Recommendation of the Commission for Hospital Hygiene and Infection Prevention (KRINKO) at Robert Koch Institute. *Bundesgesundheitsblatt* 2017. DOI: 10.1007/s00103-016-2487-4

1.5. FDA issues warning on tricitrasol dialysis catheter anticoagulant.
Food and Drug Administration / U.S. Department of Health and Human Services. FDA Talk Paper 2000

1.6. Diagnosis, prevention and treatment of haemodialysis catheter-related bloodstream infections (CRBSI): a position statement of European Renal Best Practice (ERBP)
Vanholder et al. *NDT Plus* 2010. DOI: 10.1093/ndtplus/sfq041

1.7. Clinical Practice Guidelines for Vascular Access (NKF/KDOQI)
Guideline 6, Table III-2: Protocols for Urokinase Administration. *Kidney Disease Outcomes Quality Initiative (KDOQI), National Kidney Foundation (NKF)* 2000. DOI: 10.1016/s0272-6386(01)70007-8

1.8. Dialysis standard of the German Society of Nephrology 2022
German Society of Nephrology (Deutsche Gesellschaft für Nephrologie, DGfN) 2022. Print.

1.9. Guideline for infection prevention and hygiene 2019 in addition to the German dialysis standard
German Society of Nephrology (Deutsche Gesellschaft für Nephrologie, DGfN) 2019. Print.

1.10. Clinical Practice Guideline – Vascular Access for Haemodialysis.
Kumwenda et al. *UK Renal Association* 2015. Print

1.11. Evidence-based criteria for the choice and the clinical use of the most appropriate lock solutions for central venous catheters (excluding dialysis catheters): a GAVeCeLT consensus
Pittiruti et al. *J Vasc Access* 2016. DOI: 10.5301/jva.5000576

1.12. ESPEN guideline on home parenteral nutrition
Pironi et al. *Clin Nutr* 2020. DOI: 10.1016/j.clnu.2020.03.005

1.13. ESPGHAN/ESPEN/ESPR/CSPEN guidelines on pediatric parenteral nutrition: Venous access
Kolacek et al. / ESPGHAN/ESPEN/ESPR/CSPEN working group on pediatric parenteral nutrition. *Clin Nutr* 2018. DOI: 10.1016/j.clnu.2018.06.952

1.14. Guidelines of the Italian Association of Pediatric Hematology and Oncology for the management of the central venous access devices in pediatric patients with oncohematological disease (AIEOP)
Cellini et al. *J Vasc Access* 2022. DOI: 10.1177/1129729820969309

1.15. Prevention of infections related to central-venous catheters – for patients, adults and children, receiving short- or long-term parenteral nutrition (SFNCM)
Schneider et al. *French Society for Clinical Nutrition and Metabolism (SFNCM)* 2019. Print.

1.16. Evidence-based recommendations for the use of permanent CVADs in paediatric oncology (GPOH)
Simon et al. *On behalf of the Society for Paediatric Oncology and Haematology (GPOH)* 2018.Print.xsw

1.17. S3-Guideline of the German Society for Nutritional Medicine (DGEM) in Cooperation with the AKE, the GESKES and the DGVS
Lamprecht et al. with the DGEM Steering Committee. *Clinical Nutrition in the Gastroenterology (Part 3) – Chronic Intestinal Failure. German Society for Nutritional Medicine (DGEM)* 2014. Print.

2. META-ANALYSES, REVIEW, SURVEY

2.1. Meta-analysis of the efficacy of taurolidine in reducing catheter-related bloodstream infections for patients receiving parenteral nutrition
Vernon-Roberts et al. *J Parenter Enteral Nutr* 2022. DOI: 10.1002/jpen.2363

2.2. Taurolidine lock solution for catheter-related bloodstream infections in pediatric patients: A meta-analysis
Sun et al. *PLoS ONE* 2020. DOI: 10.1371/journal.pone.0231110

2.3. Taurolidine lock solutions for the prevention of catheter-related bloodstream infections: a systematic review and meta-analysis of randomized controlled trials
Liu et al. *PLoS One* 2013. DOI: 10.1371/journal.pone.0079417

2.4. Review and update of the use of urokinase in the prevention and management of CVAD-related complications in pediatric oncology patients
Simon et al. *Am J Infect Control* 2008. DOI: 10.1016/j.ajic.2007.02.007

2.5. A multi-national survey of experience and attitudes towards managing catheter related blood stream infections for home parenteral nutrition
Joly et al. *Clin Nutr* 2023. DOI: 10.1016/j.clnesp.2023.06.032

3. CLINICAL STUDIES

3.1. Dialysis

3.1.1. Effect of taurolidine citrate and unfractionated heparin on inflammatory state and dialysis adequacy in hemodialysis patients
Ezzat et al. *J Vasc Access* 2023. DOI: 10.1177/11297298211023295

3.1.2. Prevention of tunneled cuffed catheter dysfunction with prophylactic use of a taurolidine urokinase lock: A randomized double-blind trial
Bonkain et al. *PLoS One* 2021. DOI: 10.1371/journal.pone.0251793

3.1.3. Taurolidine-based catheter lock regimen significantly reduces overall costs, infection, and dysfunction rates of tunneled hemodialysis catheters Winnicki et al. *Kidney Int* 2018. DOI: 10.1016/j.kint.2017.06.026

3.1.4. Safety and efficacy of taurolidine/urokinase versus taurolidine/heparin as a tunneled catheter lock solution in hemodialysis patients: a prospective, randomized, controlled study
Al-Ali et al. *Nephrol Dial Transplant* 2018. DOI: 10.1093/ndt/gfx187

3.1.5. Prevention of dialysis catheter-related sepsis with a citrate-taurolidine-containing lock solution
Betjes et al. *Nephrol Dial Transplant* 2004. DOI: 10.1093/ndt/gfh014

3.1.6. Approaches to prolong the use of uncuffed hemodialysis catheters: results of a randomized trial
Filiopoulos et al. *Am J Nephrol* 2011. DOI: 10.1159/000324685

3.1.7. A randomized double-blind controlled trial of taurolidine-citrate catheter locks for the prevention of bacteremia in patients treated with hemodialysis
Solomon et al. *Am J Kidney Dis* 2010. DOI: 10.1053/j.ajkd.2009.11.025

3.1.8. Observational study of need for thrombolytic therapy and incidence of bacteremia using taurolidine-citrate-heparin, taurolidine-citrate and heparin catheter locks in patients treated with hemodialysis
Solomon et al. *Semin Dial* 2012. DOI: 10.1111/j.1525-139X.2011.00951.x

3.1.9. Efficacy of systematic catheter locks solution of taurolidine/heparin versus taurolidine/urokinase in end-stage renal insufficiency stage 5D
Fontseré et al. *Nefrologia* (Engl Ed) 2021. DOI: 10.1016/j.nefro.2021.02.004

3.1.10. The best solution down the line: an observational study on taurolidine- versus citrate-based lock solutions for central venous catheters in hemodialysis patients
Van Roeden et al. *BMC Nephrology* 2021. DOI: 10.1186/s12882-021-02519-3

3.1.11. A new haemodialysis catheter-locking agent reduces infections in haemodialysis patients
Taylor et al. *J Ren Care* 2008. DOI: 10.1111/j.1755-6686.2008.00027.x

3.1.12. Tunneled catheters with taurolidine-citrate-heparin lock solution significantly improve the inflammatory profile of hemodialysis patients
Fontseré et al. *Antimicrob Agents Chemother* 2014. DOI: 10.1128/AAC.02421-14

3.1.13. Taurolidine-citrate-heparin catheter lock solution reduces staphylococcal bacteraemia rates in haemodialysis patients
Murray et al. *QJM* 2014. DOI: 10.1093/qjmed/hcu128

3.1.14. Prevention of Hemodialysis Catheter-Related Bloodstream Infection Using an Antimicrobial Lock Quarello et al. *Blood Purif.* 2002. *DOI:10.1159/000046990*

3.2. Oncology and parenteral nutrition

3.2.1. Central venous catheters and catheter locks in children with cancer: a prospective randomized trial of taurolidine versus heparin
Handrup et al. *Pediatr Blood Cancer* 2013. DOI: 10.1002/pbc.24482

3.2.2. Taurolidine/Citrate Lock Therapy for Primary Prevention of Catheter-Related Infections in Cancer Patients: Results of a Prospective, Randomized, Phase IV Trial (ATAPAC)
Longo et al. *Oncology* 2017. DOI: 10.1159/000470911

3.2.3. Randomized controlled trial of taurolidine citrate versus heparin as catheter lock solution in paediatric patients with haematological malignancies
Dümichen et al. *J Hosp Infect* 2012. DOI: 10.1016/j.jhin.2012.01.003

3.2.4. Taurolidine-citrate lock solution for the prevention of central lineassociated bloodstream infection in paediatric haematology-oncology and gastrointestinal failure patients with high baseline central-line associated bloodstream infection rates
Chong et al. *J Paediatr Child Health* 2020. DOI: 10.1111/jpc.14506

3.2.5. Taurolidine-citrate lock solution (TauroLock) significantly reduces CVAD-associated grampositive infections in pediatric cancer patients
Simon et al. *BMC Infect Dis* 2008. DOI: 10.1186/1471-2334-8-102

3.2.6. Taurolidine-Citrate Line Locks Prevent Recurrent Central Line-Associated Bloodstream Infection in Pediatric Patients
Clark et al. *Pediatr Infect Dis J* 2019. DOI: 10.1097/INF.0000000000002191

3.2.7. Taurolidine lock in the treatment of colonization and infection of totally implanted venous access devices in cancer patients
Brescia et al. *J Vasc Access* 2023. DOI: 10.1177/11297298211026453

3.2.8. Taurolidine-citrate-heparin lock reduces catheter-related bloodstream infections in intestinal failure patients dependent on home parenteral support: a randomized, placebo-controlled trial
Tribler et al. *Am J Clin Nutr* 2017. DOI: 10.3945/ajcn.117.158964

3.2.9. Effects of prophylactic use of taurolidine-citrate lock on the number of catheter-related infections in children under 2 years of age undergoing surgery
Łyszkowska et al. *J Hosp Infect* 2019. DOI: 10.1016/j.jhin.2019.04.022

3.2.10. Pediatric Home Parenteral Nutrition in France: A six years national survey
Goulet et al. *Clin Nutr* 2021. DOI: 10.1016/j.clnu.2021.08.002

3.2.11. Cost-effectiveness of taurolidine locks to prevent recurrent catheter-related blood stream infections in adult patients receiving home parenteral nutrition: a 2-year mirror-image study
Lannoy et al. *Clin Nutr* 2021. DOI: 10.1016/j.clnu.2021.01.017

3.2.12. The incidence and management of complications of venous access in home parenteral nutrition (HPN): A 19 year longitudinal cohort series
Leiberman et al. *Clin Nutr ESPEN* 2020. DOI: 10.1016/j.clnesp.2020.03.025

3.2.13. Taurolidine lock solution in the secondary prevention of central venous catheter-associated bloodstream infection in home parenteral nutrition patients
Touré et al. *Clin Nutr* 2012. DOI: 10.1016/j.clnu.2012.01.001

3.2.14. Taurolidine-Citrate Lock: Risk Factors Associated with a Failure of Catheter-Related Bloodstream Infection Prevention in Home Parenteral Nutrition in Adults
Lauverjat et al. *Clin Nutr* 2017. DOI: 10.1016/S0261-5614(17)30669-6

3.2.15. Taurolidine locks significantly reduce the incidence of catheter-related blood stream infections in high-risk patients on home parenteral nutrition
Saunders et al. *Eur J Clin Nutr* 2015. DOI: 10.1038/ejcn.2014.32

3.2.16. Significant reduction in central venous catheter-related bloodstream infections in children on HPN after starting treatment with taurolidine line lock
Chu et al. *J Pediatr Gastroenterol Nutr* 2012. DOI: 10.1097/MPG.0b013e31825bb0ae

3.2.17. Efficacy of taurolidine on the prevention of catheter-related bloodstream infections in patients on home parenteral nutrition
Al-Amin et al. *J Vasc Access* 2013. DOI: 10.5301/jva.5000168

3.2.18. Taurolidine lock - experience from the West of Scotland
Cullis et al. *Clin Nutr* 2011. DOI: 10.1016/j.clnu.2010.12.008

3.2.19. Effectiveness of Taurolock™ in preventing recurrent catheter-related bloodstream infections in patients on home parenteral nutrition
Taniguchi et al. *Proc Nutr Soc* 2009. DOI: 10.1017/S0029665109001992

3.2.20. Taurolidine lock is highly effective in preventing catheter-related bloodstream infections in patients on home parenteral nutrition: a heparin-controlled prospective trial
Bisseling et al. *Clin Nutr* 2010. DOI: 10.1016/j.clnu.2009.12.005

3.2.21. Randomised clinical trial: 2% taurolidine versus 0.9% saline locking in patients on home parenteral nutrition
Wouters et al. *Clin Nutr* 2018. DOI: 10.1111/apt.14904

3.2.22. Taurolidine lock is superior to heparin lock in the prevention of catheter related bloodstream infections and occlusions
Olthof et al. *PLoS One* 2014. DOI: 10.1371/journal.pone.0111216

3.2.23. Prophylactic urokinase in the management of long-term venous access devices in children: a Children's Oncology Group study
Dillon et al. *J Clin Oncol* 2004. DOI: 10.1200/JCO.2004.07.019

4. IN VITRO AND BIOFILM STUDIES

4.1. In Vitro Approach for Identification of the Most Effective Agents for Antimicrobial Lock Therapy in the Treatment of Intravascular Catheter-Related Infections Caused by Staphylococcus aureus
Hogan et al. *Antimicrob Agents Chemother* 2016. DOI: 10.1128/AAC.02885-15

4.2. Antimicrobial activity of a novel catheter lock solution
Shah et al. *Antimicrob Agents Chemother* 2002. DOI: 10.1128/AAC.46.6.1674-1679.2002

4.3. Activities of taurolidine in vitro and in experimental enterococcal endocarditis
Torres-Viera et al. *Antimicrob Agents Chemother* 2000. DOI: 10.1128/AAC.44.6.1720-1724.2000

4.4. Superior antimicrobial activity of trisodium citrate over heparin for catheter locking Weijmer et al. *Nephrol. Dial. Transplant.* 2002. DOI: 10.1093/ndt/17.12.21891

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