

# Patency durability of non-tunneled hemodialysis

*by Yan Efrata Sembiring*

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**Submission date:** 11-May-2024 06:33AM (UTC+0800)

**Submission ID:** 2376376338

**File name:** Patency\_durability\_of\_non-tunneled\_hemodialysis.pdf (318.24K)

**Word count:** 4415

**Character count:** 24399

## REVIEW

# Patency durability of non-tunneled hemodialysis' catheter in adult patients with chronic kidney disease stadium 5 with diabetes mellitus and non-diabetes mellitus

I Gusti PUTRA <sup>1</sup>, Heroe SOEBROTO <sup>2</sup> \*, Yan E. SEMBIRING <sup>2</sup>, Artaria TJEMPAKASARI <sup>3</sup>

<sup>1</sup>Department of Thoracic, Cardiac and Vascular Surgery, Dr. Soetomo Academic General Hospital, Airlangga University, Surabaya, Indonesia; <sup>2</sup>Department of Thoracic, Cardiac and Vascular Surgery, Faculty of Medicine, Dr. Soetomo General Academic Hospital, Airlangga University, Surabaya, Indonesia; <sup>3</sup>Department of Internal Medicine, Faculty of Medicine, Dr. Soetomo Academic General Hospital, Airlangga University, Surabaya, Indonesia

\*Corresponding author: Heroe Soebroto, Department of Thoracic, Cardiac and Vascular Surgery, Faculty of Medicine, Dr. Soetomo General Academic Hospital, Airlangga University, Surabaya, Indonesia. E-mail: [heroesurgeon@yahoo.com](mailto:heroesurgeon@yahoo.com)

## ABSTRACT

**INTRODUCTION:** Chronic kidney disease (CKD) is a condition of kidney that causes the need for kidney replacement therapy in the form of hemodialysis or kidney transplantation. One of the prerequisites and things that are very essential in the care of patients with hemodialysis is the existence of adequate hemodialysis vascular access. Temporary and short-term use usually use a non-tunneled hemodialysis catheter (NTHC) often be used in emergency cases. In patient with diabetic, complication often occurs as the occurrence of thrombosis in patients with the use of vascular access in DM is twice as high as those without comorbid DM.

**EVIDENCE ACQUISITION:** Literatures reviewed in our study were gathered from PubMed and Google Scholar. Advanced search was conducted on both Google Scholar and PubMed Builder, with the keywords used were ("Patency" AND "catheter" AND "durability" AND "hemodialysis;" "non-tunneled hemodialysis catheter" AND "chronic kidney disease" AND "diabetic") also words "patency of tunneled catheters in hemodialysis patients;" "patency of tunneled catheters in diabetic chronic kidney disease underwent hemodialysis". We reviewed the articles cited within the literatures to broaden the search results.

**EVIDENCE SYNTHESIS:** Non-tunneled hemodialysis catheters (NTHCs) are typically used when vascular access is required for urgent renal replacement therapy (RRT). Metabolic conditions in DM patients damage blood vessels and can induce abnormalities such as thrombosis and can be prevented by administering antithrombotic prophylaxis Maintenance of patency in diabetic patients related to the durability of NTHC by administration of the thrombolytic agents or anticoagulant.

**CONCLUSIONS:** A non-tunneled hemodialysis catheter may be used as a temporary catheter while waiting for a placement of an arteriovenous fistula. However, NTHCs have several disadvantages. Diabetes Mellitus significantly increase the risk of recurrent catheter-related thrombosis and infection site of catheter, which lead to more thrombosis and infection cases of NTHC in diabetic patients than non-diabetic.

(Cite this article as: Putra IG, Soebroto H, Sembiring YE, Tjempakasari A. Patency durability of non-tunneled hemodialysis' catheter in adult patients with chronic kidney disease stadium 5 with diabetes mellitus and non-diabetes mellitus. Ital J Vasc Endovasc Surg 2023;30:15-9. DOI: 10.23736/S1824-4777.22.01568-6)

**KEY WORDS:** Patency; Durability; Hemodialysis; Catheter; Non-tunneled hemodialysis catheter; Diabetes.

## Introduction

Chronic kidney disease (CKD) is a condition of kidney that causes the need for kidney replacement therapy in the form of hemodialysis or kidney transplantation.<sup>1</sup> One of the treatments for CKD is hemodialysis. As a form of renal replacement therapy, the need for hemodialysis continues to increase from year to year with the number of ac-

tive hemodialysis patients as many as 77,892 patients with the addition of new patients in 2017 as many as 30,831. Hemodialysis is a treatment used for kidney function as an excretory organ to remove excess water filtrate, toxins, and other solutes. Hemodialysis can also maintain the physiology of the kidneys.<sup>2</sup> Hemodialysis has access to blood vessels. This access is a transcutaneous channel that is used as access to the intravascular space for renal replacement

therapy and is in the form of a central venous catheter. This hemodialysis therapy has a broad spectrum such as hemodialysis, hemofiltration, hemodiafiltration or ultrafiltration. One of the prerequisites and things that are very essential in the care of patients with hemodialysis is the existence of adequate hemodialysis vascular access. The use of a central venous catheter is used in various cases that require extracorporeal procedures. In cases of emergency, temporary and short-term use usually use a non-tunneled hemodialysis catheter (NTHC) and in the medium and long term use a tunneled hemodialysis catheter (THC) before the use of arteriovenous fistula.<sup>3</sup> Diabetes mellitus (DM) is a multipathological degenerative disease so that complications that occurred previously will continue and can only be controlled by the rate of progression. This vulnerability triggers conditions related to treatment methods related to DM itself. One of them is a temporary hemodialysis catheter which is a vascular access in patients with CKD.<sup>4</sup> DM conditions can affect the duration of hemodialysis catheter placement due to the occurrence of immunopathology and the coagulation cascade. These comorbidities lead to infection and thrombosis so that catheter patency is compromised. Impaired catheter patency causes repositioning or reimplantation of the catheter before an arteriovenous fistula can be performed.<sup>5</sup> The use of NTHC in DM patients is more likely to experience thrombotic conditions than non-DM patients. The occurrence of thrombosis in patients with the use of vascular access in DM is twice as high as those without comorbid DM. Thrombotic conditions lead to catheter reimplantation conditions. Based on research, patients with DM who use temporary vascular access are considered more susceptible to infection and sepsis.<sup>6</sup> Installation of NTHC is an action that is often done in RSUD Dr. Soetomo Surabaya and there has been no study on the duration of the hemodialysis catheter patency installed in RSUD Dr. Soetomo, Surabaya. Data collection and publications related to the condition of existing patients are limited in RSUD Dr. Soetomo, Surabaya. The factors that influence the duration of this patent were not clear at the time of this study. The femoral vein is the preferred location for insertion to reduce the risk of infection for staff. Selection of the insertion site in the femoral vein is not recommended despite the fact that there is a hypercoagulable condition.

## Evidence acquisition

### Search strategy

This study reviewed the literatures gathered from two major databases, PubMed, and Google Scholar. Advanced

search was conducted on PubMed with the keywords used were (“Patency” AND “catheter” AND “durability” AND “hemodialysis;” “non-tunneled hemodialysis catheter” AND “chronic kidney disease” AND “diabetic”). Advanced search was also conducted on Google Scholar with all the words “patency of tunneled catheters in hemodialysis patients;” “patency of tunneled catheters in diabetic chronic kidney disease underwent hemodialysis”. The showed literatures were further selected based on the publication year, by which we set a 10-year-study, starting from 2012 until 2022. This attempt resulted in 59 and 312 literatures gathered from PubMed and Google Scholar, respectively. We also reviewed the articles cited on the references within the article to broaden the search results.

### Data extraction

The information reviewed from the articles consisted of: author (with study location and publication year); study design; population age (in years, with the format as mean±SD or median (IQR), except stated otherwise within the table); insertion site(s); duration of catheterization (in days, same format as population age, except stated otherwise); evaluation/measurement of catheter tip recirculation; location of the tip; and brief discussion regarding the results. The results are showed as in Table 1.<sup>7-13</sup>

## Evidence synthesis

### 15 Chronic kidney disease

16 Chronic kidney disease (CKD) is defined as a state of kidney damage or an estimated glomerular filtration rate (eGFR) of less than 60 mL/minute/1.73 m<sup>2</sup> that persists for three months or more regardless the causes. CKD patients should be assessed for risk factors of kidney disease, including prior exposure to potential nephrotoxins (e.g., nonsteroidal anti-inflammatory drugs [NSAIDs], phosphate-based bowel preparations, herbal remedies such as those containing aristolochic acid, antibiotic therapies such as gentamicin, and chemotherapies), history of nephrolithiasis or recurrent urinary tract infections, presence of comorbidities (e.g., hypertension, diabetes, autoimmune disease, chronic infections), family history of kidney disease, and, if available, other known genetic risk factors.<sup>14</sup> Management of patients with CKD should include decreasing the rate of progression of CKD with regular monitoring of renal function, management of complications in CKD such as anemia and electrolyte disturbances as well as cardiovascular complications, preparation for

TABLE I.—Characteristics of the literatures reviewed.

N.	Author	Study design	Population	Vascular access	Outcome
1	Biesen <i>et al.</i> <sup>7</sup>	Systematic literature review	Diabetes (type I or II) of end-stage renal disease or a superimposed condition	Tunneled catheters, grafts, or autogenous fistulas placed in any position	AVF appears to be the access of choice for younger and healthier HD diabetic patient
2	Cholewa <sup>8</sup>	Retrospective analysis	Patient with permanent venous catheter thrombosis treated with urokinase	Right and left internal jugular vein, right and left femoral vein and inferior vena cava	The occurrence of DM significantly increases the risk of recurrent catheter-related thrombosis and its consequence decrease one-year catheter survival.
3	Clark <i>et al.</i> <sup>9</sup>	Literature review	Patient with non-tunneled temporary hemodialysis catheter (NTHC)	Femoral site	The complications of NTHC insertion are frequent and can be fatal. Infection-control “bundles” of specific evidence-based practices to reduce the risk of CLABSIs and exit-site infections should be implemented in all settings in which NTHCs are inserted and used. The femoral site may not be associated with a higher risk of infection and is possibly even preferable in patients with diabetes
4	Tahir <i>et al.</i> <sup>10</sup>	Observational (retrospective)	Patients with diabetes or hypertension or hypothyroidism or IHD received tunnel dialysis catheter	Right internal jugular vein, left internal jugular vein, right femoral vein, right subclavian vein	TDCs are the best available alternative for short to intermediate term use for hemodialysis when all preventive measures are taken to avoid catheter related complications either infectious or noninfectious until permanent dialysis access is achieved or renal transplant is done.
5	Halbert <i>et al.</i> <sup>11</sup>	Systematic literature review and meta-analysis	Diabetic and non-diabetic hemodialysis patients who underwent arteriovenous graft placements	ePTFE arteriovenous graft placements	Although fistulas are currently the gold standard for dialysis access, in part because of their low infection rates, certain subgroups of dialysis patients are burdened with higher use of ePTFE grafts and catheters. The observed rate of 9% infection per patient-year is consistent with other data sources pointing to worsened infectious outcomes in patients, especially women, who utilize ePTFE grafts for dialysis.
7	Cambria <i>et al.</i> <sup>12</sup>	Systematic literature review and meta-analysis	Patency, mortality, access infection, and maturation of vascular access in adults requiring long-term dialysis	Arteriovenous grafts (AVGs) and catheters (tunneled and non-tunneled)	Autogenous access is the best approach when feasible. This study provides incidence rates in various subgroups to inform shared decision making and facilitate the conversation with patients about access planning
8	Liemarto <sup>13</sup>	Observational analytic research	Hemodialysis patient at Dr. Soetomo Surabaya	Arteriovenous fistula (AVF)	In routine HD patients with DM, there is an increased risk factor for AVF. patent failure

renal replacement therapy, and immunization, especially hepatitis B.<sup>14</sup> The KDIGO guidelines recommend that patients with CKD be referred to a nephrologist when eGFR falls below 30 mL/min/1.73 m<sup>2</sup> (stage G4) and/or urine ACR increases above 300 mg per 24 hours (stage A3). Additional indications for referral include the following: presence of greater than 20 red blood cells per high-power field of unclear etiology, red blood cell casts on urine microscopy or other indication of glomerulonephritis, CKD with uncontrolled hypertension despite 4 or more antihypertensive medications, persistent hypokalemia or hyperkalemia, anemia requiring erythropoietin replacement, recurrent or extensive kidney stones, hereditary kidney disease, acute kidney injury, and rapid CKD progression

(a decrease in eGFR ≥ 25% from baseline or a sustained decline in eGFR > 5 mL/min/1.73 m<sup>2</sup>).<sup>14</sup>

#### Diabetes mellitus in CKD and hemodialysis

Diabetes mellitus is a disease of inadequate control of blood levels of glucose. It has many subclassifications, including type 1, type 2, maturity-onset diabetes of the young (MODY), gestational diabetes, neonatal diabetes, and steroid-induced diabetes. Type 1 and 2 DM are the main subtypes, each with different pathophysiology, presentation, and management, but both have a potential for hyperglycemia.<sup>15</sup> Diabetes mellitus (DM) is the most common cause of chronic kidney disease and has been identi-

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fied as a contributing factor to vascular access dysfunction, so it is very important to know the effect of DM and AVF patency in the HD patient population. DM conditions in CKD patients can be caused by diabetic kidney disease (DKD) conditions.<sup>13</sup> DM could lead to a kidney complications and complications due to the installation of temporary access to a central venous catheter. It is associated with macrovascular damage, microvascular and immune deficiency in patients with DM. Metabolic conditions in DM patients damage blood vessels and can induce abnormalities such as thrombosis and this can be prevented by administering antithrombotic prophylaxis. Uncontrolled diabetes mellitus is also a risk factor for infection. Infection occurs in DM patients due to decreased immune cell function. This occurs due to dysregulation of the innate immune system, namely defects in the function of neutrophils and macrophages.<sup>16</sup>

#### Non-tunneled hemodialysis catheter

Non-tunneled hemodialysis catheters (NTHCs) are typically used when vascular access is required for urgent renal replacement therapy (RRT). In the setting of acute and chronic kidney injury, when the duration of RRT is difficult to predict, NTHCs are the recommended initial vascular access.<sup>14</sup> However, due to an increased risk of complications, NTHCs are the least preferred access for chronic hemodialysis patients.<sup>17</sup> Types of NTHC can be distinguished by design, purpose, and duration of use. The catheter can be divided into short term/non-cuffed (temporary) and long term/tunneled cuffed. Designs are distinguished according to their curvature, namely straight or precurved and tip types; namely staggered, split, and symmetric.<sup>18</sup> Patients who use temporary vascular access in patients with CKD have a schedule for hemodialysis. The number of cycles is dependent on the target, the hemodialysis capability of the machine, and the patient's associated condition. The number of cycles or the frequency of hemodialysis does not affect the durability of existing vascular access. Maintenance of patency is related to the durability of NTHC by administration of thrombolytic agents or anticoagulants.<sup>19</sup>

#### Complications of NTHCs

Non-tunneled catheters for short-term extracorporeal RRT are preferentially inserted under ultrasound guidance, as this allows subcutaneous structures to be visualized and reduces the complication rates. Mechanical complications related to NTHC insertion are common with vascular inju-

ry or hematoma occurring in up to 5% of insertions. Other mechanical complications such as pneumothorax, pneumopericardium, and air and guidewire embolism occur less often but can be fatal. Although the life-threatening complications of NTHC insertion are typically related to insertions at the internal jugular site, fatal complications related to femoral NTHC insertion have been reported. Severe bleeding, typically retroperitoneal, occurs in approximately 0.5% of femoral insertions.<sup>20</sup> Infection in the vascular access is an infection that occurs as a primary infection that occurs in the vascular access as evidenced by clinical signs of fever >38.0 °C, chills or, hypotension accompanied by evidence of infection in the blood that is not associated with infection elsewhere. Infection can occur due to various factors whose relationship has not been explained, but it is known that DM is also a factor that influences the occurrence of infection in temporary catheters.<sup>20</sup> Obstruction due to thrombosis is a problem that occurs in various types of vascular access, both permanent and temporary. Thrombosis occurs due to various factors, especially the activation of platelets around the lumen of the catheter. Clinical signs of obstruction include pain and swelling in the distal area but no sign of infection. Impaired patency can be overcome by giving heparin flush and anticoagulant therapy.<sup>20</sup>

#### Conclusions

1 A non-tunneled hemodialysis catheter may be used as a temporary catheter while waiting for a placement of an arteriovenous fistula, a peritoneal dialysis catheter, or a tunneled catheter. Compared to TDCs, NTDCs have several disadvantages such as a 5-fold higher rate of infection than TDCs and a greater likelihood of inadequate blood flow rate. Diabetes mellitus significantly increase the risk of recurrent catheter-related thrombosis and infection site of catheter, which lead to more thrombosis and infection cases of NTHC in diabetic patients than non-diabetic.

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*Conflicts of interest.*—The authors certify that there is no conflict of interest with any financial organization regarding the material discussed in the manuscript.

*Authors' contributions.*—All authors equally contributed to the manuscript, read and approved the final version of the manuscript.

*History.*—Manuscript accepted: November 29, 2022. - Manuscript received: November 7, 2022.

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