Quality Improvement Guidelines for Percutaneous Nephrostomy

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PREAMBLE

Percutaneous nephrostomy is a well-established procedure dating back to the early 20th century. Since the publication of the Quality Improvement Guidelines for Percutaneous Nephrostomy in 2003, procedural indications have expanded. To accommodate the growing number of indications (eg, ureteral embolization, cooling pyeloperfusion), these indications have been grouped into three main categories: urinary drainage, urinary diversion, and provision of access to the collecting system. Moreover, based on recent literature and consensus, technical success thresholds and adverse event rates have been reexamined. This document provides guidance for quality improvement initiatives that ultimately lead to better patient outcomes.

The membership of the Society of Interventional Radiology (SIR) Standards of Practice Committee represents experts in a broad spectrum of interventional procedures from both the private and the academic sectors of medicine. Generally, Standards of Practice Committee members dedicate the vast majority of their professional time to performing interventional procedures; as such, they represent a valid, broad expert constituency of the subject matter under consideration for standards production.

METHODOLOGY

SIR produces its Standards of Practice documents by using the following process. Standards documents of relevance and timeliness are conceptualized by the Standards of Practice Committee members. A recognized expert is identified to serve as the principal author for the document. Additional authors may be assigned depending on the magnitude of the project.

An in-depth literature search is performed with use of electronic medical literature databases. Then a critical review of peer-reviewed articles is performed with regard to the study methodology, results, and conclusions. The qualitative weight of these articles is assembled into an evidence table, which is used to write the document such that it contains evidence-based data with respect to content, rates, and thresholds.

When the evidence of literature is weak, conflicting, or contradictory, consensus for the parameter is reached by a minimum of 12 Standards of Practice Committee members with use of a Modified Delphi Consensus Method (**Appendix A**). For the purpose of these documents, consensus is defined as 80% Delphi participant agreement on a value or parameter.

The draft document is critically reviewed by the Standards of Practice Committee members, in either a telephone conference call or a face-to-face meeting. The finalized draft from the Committee is sent to the SIR membership for further input/criticism during a 30-day comment period. These comments are discussed by the Standards of Practice Committee, and appropriate revisions are made to create the finished standards document. Before its publication, the document is endorsed by the SIR Executive Council.

These guidelines are written for use in a quality improvement program that monitors percutaneous nephrostomies. This document is not intended to include antegrade pyelography. In the construction of this standard, a literature search was performed with use of MEDLINE methodology, and an evidence table was constructed, which is available for review from the SIR office.

The most important processes of care are (*a*) patient selection, (*b*) performance of the procedure, and (*c*) patient monitoring. The outcome measures for these processes are indications, success rates, and complication rates. Outcome measures are assigned threshold levels.

DEFINITIONS

Percutaneous Nephrostomy: Image-guided placement of a catheter through a calyx into the renal collecting system. The collecting system can be localized by one or more cross-sectional techniques, such as ultrasonography, computed tomography (CT), or rotational fluoroscopic acquisition (cone-beam CT). The collecting system can also be localized fluoroscopically using anatomic landmarks or a radiopaque target (eg, stone, cranial loop of a double-J ureteral stent, contrast-opacified collecting system). Percutaneous nephrostomy can be performed independently or in combination with other percutaneous, endoscopic, or surgical techniques for diagnostic or therapeutic purposes in both native and transplanted kidneys.

Successful Percutaneous Nephrostomy: Placement of a catheter of appropriate diameter and course so that the desired outcome is achieved or the planned combined procedure is completed (eg, adequate urinary drainage, stone extraction, antegrade ureteral stent insertion).

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Antegrade Nephrostogram: Injection of a contrast agent through a needle, catheter, or percutaneous nephrostomy into the renal collecting system under fluoroscopic visualization for diagnostic purposes.
Endoscopic Procedure: Procedure performed through the nephrostomy tract using rigid or flexible nephroscopes or ureteroscopes for visualization, usually in conjunction with a urologist. Flexible endoscopes require a 12-F to 16-F tract, whereas rigid nephroscopes require a 24-F to 30-F tract. Examples of endoscopic procedures include endopyelotomy (incision of a strictured ureteropelvic junction) and resection or fulguration of upper tract transitional cell carcinomas.
Percutaneous Nephrolithotomy (Nephrostolithotomy): Removal of renal stones from the proximal collecting system or ureter through a percutaneous tract that is dilated to sufficient size to allow placement of a nephroscope so that large stones can be fragmented (with ultrasonic, electrohydraulic, or laser lithotripsy) under direct endoscopic visualization before removal. Smaller stones may be removed without fragmentation. The targeted stones should be successfully removed through the percutaneous access tract. Multiple nephrostomy tracts and the use of flexible instruments are often necessary for complete stone removal (1,2).
Upper Urinary Tract Instillation: Administration of a medication into the renal collecting system, typically through a percutaneous nephrostomy, for therapeutic purposes.
Cooling Pyeloperfusion: Administration of cold sterile water or saline solution into the renal collecting system during renal ablations (eg, radiofrequency, microwave) to prevent thermal injuries to the renal collecting system.

Although practicing physicians should strive to achieve perfect outcomes (eg, 100% success, 0% complications), in practice, all physicians fall short of this ideal to a variable extent. Therefore, outcome measure thresholds may be used to assess the efficacy of ongoing quality improvement programs. For the purpose of these guidelines, a threshold is a specific level of an outcome measure that should prompt a review. Individual complications may also be associated with complication-specific thresholds. When indications or success rates fall below a minimum threshold or when complication rates exceed a maximum threshold, a review should be performed to determine causes and to implement changes, if necessary. Departmental thresholds may vary from those listed here because of local factors, such as referral patterns. Departments are urged to alter the thresholds to meet the individual needs of their quality improvement programs.

Complications can be stratified on the basis of outcome. Major complications result in admission to a hospital for therapy (for outpatient procedures), an unplanned increase in the level of care, prolonged hospitalization, permanent adverse sequelae, or death. Minor complications result in no sequelae; they may require nominal therapy or a short hospital stay for observation (generally overnight) (**Appendix B**). The complication rates and thresholds herein refer to *major* complications.

INDICATIONS

1. Urinary drainage. Percutaneous nephrostomy is indicated to treat intrinsic or extrinsic urinary tract obstruction. Etiologies include, but are not limited to, stones, malignancy, and iatrogenic conditions. Urinary tract obstruction may be present without or with infection.
   a. Noninfected urinary tract obstruction may account for 72%–97% of nephrostomies (3–9). It may manifest with renal colic, hematuria, or azotemia, but it may also be discovered incidentally on imaging studies (10–13). Isolated hydronephrosis without obstruction may manifest in pregnancy, overhydration, diabetes insipidus, or after diuretic administration and is not necessarily an indication for percutaneous nephrostomy.
   b. Infected urinary tract obstruction (pyonephrosis or infected hydronephrosis) may account for 3%–19% of nephrostomies (4,7,9,14–17). In addition to the above-mentioned symptoms of noninfected urinary tract obstruction, infected urinary tract obstruction may manifest with fever, chills, hemodynamic changes (eg, tachycardia, hypotension), leukocytosis, urinary sepsis (urosepsis), and evidence of urinary tract obstruction on imaging studies. Stones are the cause of obstruction in > 50% of cases. Emergent or urgent percutaneous nephrostomy is indicated because patients are at high risk of developing gram-negative sepsis. Timing of percutaneous nephrostomy depends on each patient's clinical condition.
2. Urinary diversion. Percutaneous nephrostomy is indicated to treat urinary leaks, urinary fistulae, and hemorrhagic cystitis (3,18–22). Urinary leakage or fistulae may be the indication for 1%–34% of nephrostomies (4,7–9,15–17,23). If the goal is permanent urinary diversion (eg, nonhealing vesicovaginal fistula), percutaneous nephrostomy may be combined with ureteral embolization (24–27).
3. Provision of access to the collecting system. Percutaneous nephrostomy is indicated to provide access to the proximal collecting system to perform other percutaneous or endoscopic procedures:
   a. Endoscopic procedures (eg, percutaneous nephrolithotomy or nephrostolithotomy) may account for 3%–50% of nephrostomies (1,2,9,15,16,20).
   b. Anterograde ureteral stent placement is indicated when the retrograde approach is unsuccessful or not feasible (28). It may account for 2%–3% of nephrostomies (5).
   c. Delivery of medications, such as in upper urinary tract instillations (eg, to treat fungus balls, upper tract transitional cell carcinomas, or stone dissolution) or cooling pyeloperfusion (29).
   d. Foreign body retrieval (eg, fractured or malpositioned ureteral stents).
   e. Other percutaneous diagnostic or therapeutic procedures, such as antegrade nephrostograms, the Whitaker test (30), brush biopsies, intrarenal cyst marsupialization (31), or fungus ball removal.

The indications for percutaneous nephrostomy in renal transplants are similar as for native kidneys (32,33). Occasionally, percutaneous nephrostomy may be performed as a therapeutic trial to differentiate renal failure caused by urinary tract obstruction from renal failure related to rejection.

Radiation management guidelines specific for pregnancy should be followed when placing percutaneous nephrostomies in pregnant patients (34). Before percutaneous nephrostomy, severe metabolic imbalances, such as hyperkalemia or metabolic acidosis, should be corrected, if possible, to decrease the risk of complications that may result from these profound electrolyte abnormalities (eg, arrhythmias or cardioplegia). In addition, because percutaneous nephrostomy is considered a clean-contaminated or contaminated procedure, antibiotic prophylaxis is recommended (35). Common antibiotic choices include (*i*) 1 g cefazolin intravenously, (*ii*) 1 g ceftriaxone intravenously, (*iii*) 1.5–3 g ampicillin/sulbactam intravenously, (*iv*) 2 g ampicillin intravenously and 1.5 mg/kg gentamicin intravenously, and (*v*) vancomycin or clindamycin and an aminoglycoside if allergic to penicillin. Device manipulation in infected collecting systems should be minimized to decrease the risk of septicemia.

Percutaneous nephrostomy can be performed on an outpatient basis in selected patients (12,13,18). Patients who live alone or at high risk of complications (eg, staghorn calculi, uncorrected hypertension, or coagulopathic) are best treated as inpatients for appropriate monitoring after procedures (12,13,18).

Indication rates should be reported based on the number of patients treated because in nearly all bilateral nephrostomy cases the indication is the same for both kidneys. In the rare instance in which bilateral nephrostomies have different indications for each kidney, this should be reported. The threshold for the main indications of urinary drainage, urinary diversion, and access to the collecting system is 95%. When < 95% of procedures are performed for one of these indications, the department will review the process of patient selection.

RELATIVE CONTRAINDICATIONS TO PERCUTANEOUS NEPHROSTOMY

1. Uncorrectable severe coagulopathy (eg, patients with liver or multisystem failure).
2. Terminal illness; imminent death.

SUCCESS

The technical success rate for percutaneous nephrostomy should be reported based on the number of kidneys treated and the number of patients treated. It should not be reported based only on the number of patients treated given that a single patient may need bilateral percutaneous nephrostomies, and the operator may be successful in placing both or only one.

A percutaneous nephrostomy catheter can be successfully placed in 84%–99% of kidneys (3–6,8,9,17,21,23,42,43,51–57). The success rate is lower in nondilated collecting systems, complex stone disease, or staghorn calculi. The technical success rate may vary depending on the clinical scenario, as shown in **Table 1**. The ability to render a patient stone-free depends on factors beyond the placement of an optimal percutaneous nephrostomy tract. Variables such as stone composition, stone burden (eg, solitary calculus, staghorn calculus), patient anatomy, number of access tracts, use of flexible or rigid instruments, and performance of adjunctive procedures (eg, extracorporeal shock wave lithotripsy) affect the degree to which renal stones can be removed (1,2,21). The success of other endoscopic procedures is similarly affected by factors other than the creation of an optimal percutaneous nephrostomy tract. However, if the intent of a percutaneous nephrostomy is to provide access for stone removal, and the tract precludes accessing the stone, that percutaneous nephrostomy is considered unsuccessful because the desired outcome cannot be achieved or the planned combined procedure cannot be completed.

COMPLICATIONS

Complication rates should be calculated based on the number of patients treated. When minor and major complications are considered together, they occur in approximately 10% of patients (1–3,18,20,21,38,44–46,48–50,58–67). For the purposes of this document, the thresholds in **Table 2** are for major complications only. The departmental thresholds apply to all complications that occur in the department. Individual thresholds apply to all complications that each practitioner encounters.

Published rates for different types of complications are highly dependent on patient selection and are, in some cases, based on series comprising several hundred patients, which is a larger volume than most individual practitioners are likely to treat. Also, a single complication can cause a rate to cross above a complication-specific threshold when the complication occurs in a small volume of patients (eg, early in a quality improvement program).

APPENDIX A. METHODOLOGY

Reported complication-specific rates in some cases reflect the aggregate of major and minor complications. Thresholds are derived from critical evaluation of the literature.

Consensus on statements in this document was obtained with use of a modified Delphi technique (68,69).

Technical documents specifying the exact consensus and literature review methodologies as well as the institutional affiliations and professional credentials of the authors of this document are available

Table 1. Technical Success Rates (%) for Percutaneous Nephrostomy

Clinical Scenario	Reported Success Rate	Threshold
Obstructed dilated system (with or without stones)	96–100	96
Obstructed system in renal transplant (33)	98–100	98
Nondilated collecting system (7,16,36,37)	82–96	80
Complex stone disease, staghorn calculi	82–85	80

Table 2. Thresholds (%) for Major Complications of Percutaneous Nephrostomy

Complication	Reported Rate	Threshold
Septic shock (fever, chills with hypotension, requiring major increase in level of care) (3–5,7,15,17,38–41)	1–10	4
Septic shock in setting of pyonephrosis	7–9	10
Hemorrhage requiring transfusion		
PCN alone (3–7,15–17,21,31,36,38,42,43)	1–4	4
With PCNL (44,45)	12–14	15
Vascular injury requiring embolization or nephrectomy (4,5,7,16,17,46,47)	0.1–1	1
Bowel transgression (7,15,48)	0.2–0.5	1
Pleural complications (pneumothorax, empyema, hydrothorax, hemothorax)		
PCN alone (3,4–6)	0.1–0.6	1
With PCNL or endopyelotomy (intercostal puncture for upper pole access for endoscopic procedures) (49,50)	8.7–12	15
Individual threshold complications that result in unexpected transfer to intensive care unit, emergency surgery, or delayed discharge from hospital (3,4,15–17,31,41–43,51)	1–7	5

PCN = percutaneous nephrostomy; PCNL = percutaneous nephrolithotomy.

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APPENDIX B. SOCIETY OF INTERVENTIONAL RADIOLOGY STANDARDS OF PRACTICE COMMITTEE CLASSIFICATION OF COMPLICATIONS BY OUTCOME

Minor Complications

A. No therapy, no consequence, or

B. Nominal therapy, no consequence; includes overnight admission for observation only.

Major Complications

C. Require therapy, minor hospitalization (< 48 h),

D. Require major therapy, unplanned increase in level of care, prolonged hospitalization (> 48 h),

E. Have permanent adverse sequelae, or

F. Result in death.

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