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Device Selection: A Critical Strategy in the Reduction of Catheter-Related Complications

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Medical science has made dramatic strides in the use of innovative drug therapies to improve the lives of patients with life-threatening and chronic illnesses. As new therapies have evolved, so has the way in which they are administered. The transition of care from hospital to home and cost competition forced the home infusion industry to find safe, cost-effective methods to deliver parenteral therapy. Medical device technology has met the challenge with several new devices alternatives. Almost at the same time, three new peripheral device options were introduced: the midline catheter, the peripherally inserted central venous catheter (PICC), and the peripheral port. While these devices are proving to be safe, cost-effective methods for delivery of parenteral therapy, confusion exists regarding the appropriate use, care and management among the various access devices.

Traditionally, device selection was based primarily on the need for short-term or long-term access. Peripheral intravenous catheters were used until venipuncture was no longer possible. Central venous catheters were used only for hemodynamic monitoring in the critically ill, when parenteral nutrition or chemotherapy required prolonged access, or when peripheral veins were exhausted. Now the issues are different; multiple drug regimens are administered in alternate care settings with variable lengths and frequencies of drug administration, multiple device options are available each with variable risks, non-medical caregivers provide care and administer parenteral drugs and solutions, and cost containment is a priority. A decision must be made between the device alternatives: short peripheral catheters, extended peripheral catheters (catheter tips terminating in peripheral vessels proximal to the superior vena cava), peripherally inserted central venous catheters, thoracic percutaneous catheters, tunneled catheters, implanted chest ports, or implanted peripheral ports. The multiple alternatives and issues require a more sophisticated approach to device selection than simply the parameter of short- or long-term needs, and it is no longer justifiable to destroy the peripheral vasculature with painful, repeated venipunctures.

Figure 1 demonstrates the author's algorithmic approach to the multifaceted and now complex process of device selection. It is a self-guided tool and instructions for each step are provided. The process is intended to guide practitioners in making the best device choice, for the best outcome, at the least cost.[1] The outcome of interest is the absence of complication, both in the insertion and the use of the device. The decision parameters focus on the prevention of the major catheter-associated complications; complications of insertion, and post-operative infection and thrombosis.

The first two columns are directed at determination of the position of the catheter tip. Continuous or repeated exposure of the endothelial lining of the vessel wall to caustic drug admixtures disrupts the integrity of the cell walls, exposing the subendothelial layer to initiate the intrinsic and extrinsic coagulation systems.[2] The osmolarity and pH of the drug admixture and the chemical structure of the drug are primary factors in cellular destruction associated with drug delivery.[3–5] A recent analysis of descriptive and experimental data demonstrates the correlation of thrombophlebitis and catheter-related thrombosis with tip position.[6,7] The incidence of thrombosis increases significantly as the tip is positioned more proximal in the superior vena cava and outside the vena cava irrespective of catheter type or therapy. Recent studies raise concern regarding the consequences of upper extremity and axillo-subclavian thrombosis.[8–11]

The peripheral approach offers a minimal risk of insertion complication since the vessels of the forearm and antecubital space are visible or palpable, and rare injury to non-vital adjacent structures is of minor consequence. Existing data suggest that the peripheral insertion site is associated with a lower risk of catheter-related infection than thoracic or jugular sites.[6,12] These considerations are particularly significant in the critically ill patient and other immunocompromised patients where pneumothorax or catheter-related bloodstream infection may result in mortality rather than increased morbidity. Low complication rates in several patient populations suggest that the peripheral approach should be considered first for central venous catheterization.[13–17]

The final decision among the resulting choices is made after careful assessment of the parameters specific to the individual patient. Careful consideration is given to the patient outside of the clini-

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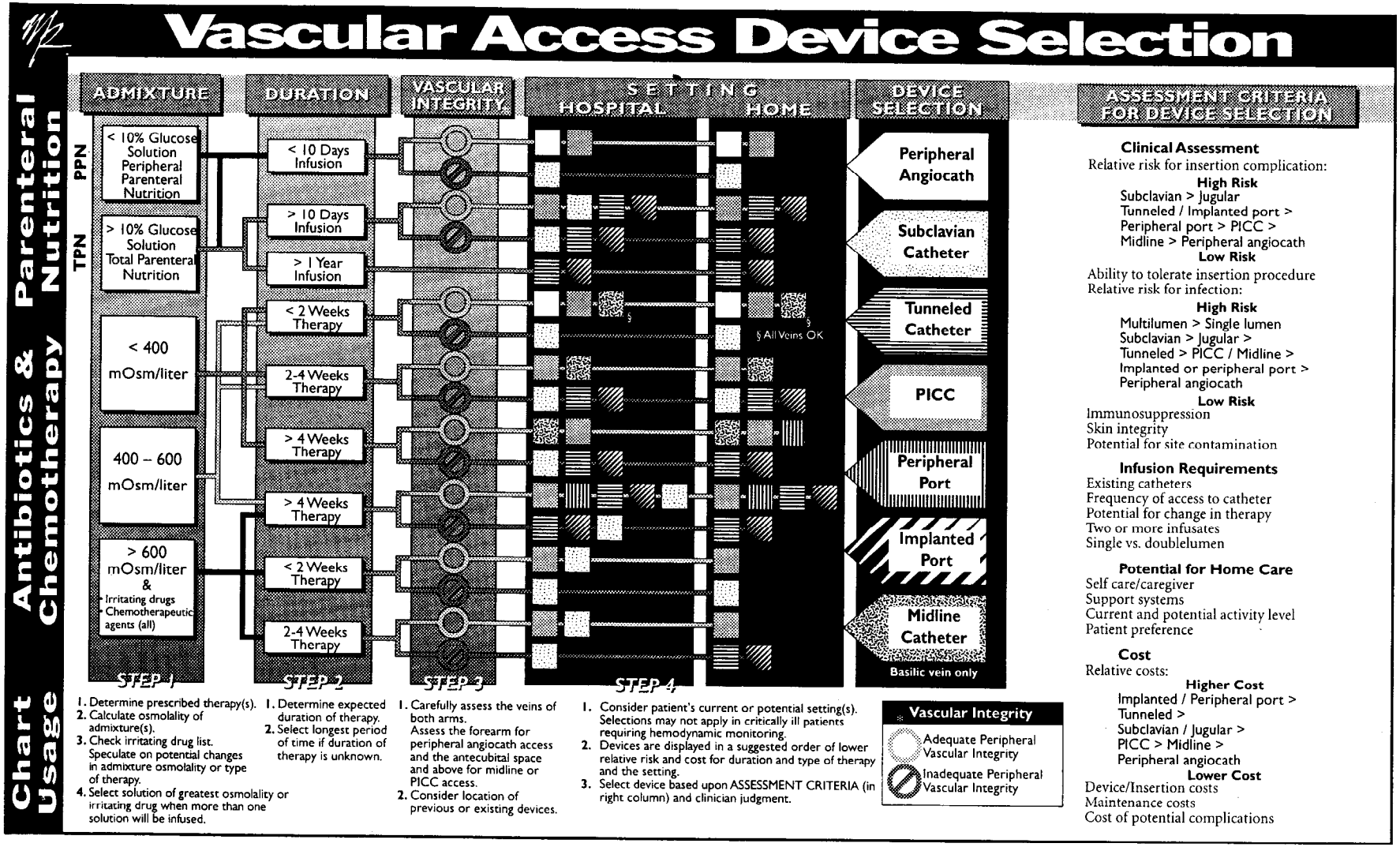

FIG. 1. Vascular access device selection algorithm. (Copyright ©1994, Marcia Ryder; with permission). A demonstration of this algorithm as a part of a continuous quality improvement process can be reviewed on the Internet @ http://www.wc.com.

cal setting where the care and management of the catheter is less controlled. An evaluation is made of the relative risk of insertion and infection for the devices in consideration, patient considerations and preferences, the infusion requirements, and costs. It is important to consider not only the cost of the device, but the cost of the insertion of the catheter, costs associated with care and maintenance, and the potential costs of complications related to that device.

The selection process requires a collaborative, interdisciplinary approach among the physician, the nurse, the pharmacist, the case manager, and the patient when appropriate. A popular trend in the United States has been the establishment of vascular access teams by specially trained nurses and (interventional) radiologists.[18,19] The nurse makes the initial assessment, coordinates the selection process, and places a peripheral device if appropriate. The role of the radiologist is to insert catheters under fluoroscopic guidance when venous access is protracted or bedside insertion is unsuccessful, insert surgically placed devices, and reposition malpositioned catheters. The insertion of tunneled or implantable devices is usually accomplished more cost-effectively in the radiology department than the operative suite.

The implications of inappropriate device selection are often unappreciated and unrecognized. In the face of healthcare "redesign" and "restructuring" many ill-thought attempts at cost reduction may result in higher costs and poor outcomes. The following is an exemplar to this effect noted on the "Internet."

A home health agency received orders to place a midline catheter for an elderly man with peripheral vascular disease requiring six weeks of antibiotic therapy for an infected foot ulcer. A seven inch midline catheter was inserted into the basilic vein at the antecubital space. Medicare would not reimburse for the specified drug if administered in the home. To save the patient money, the drug (Monocid 500 mg) was to be administered in the Dr's office, and as an additional savings the drug would be admixed in a syringe instead of a minibag. The patient received the drug once a day and the home health nurse made intermittant [sic] office visits to monitor the catheter and perform dressing changes. On the third day, the patient complained of pain at the tip of the catheter. On evaluation of the syringe admixture, it was determined that the osmolarity of the drug was almost 2000 mOsm/L. Arrangements were made to provide a more dilute infusion, however they continued to administer the concentrated mixture. A resulting severe chemical phlebitis necessitated removal of the catheter. Forty-eight hours later the patient was admitted to the hospital with chest pain. Diagnostic exams demonstrated femoral, coronary and cerebral arterial emboli. An echocardiogram demonstrated a septal defect allowing passage of venous thrombus. Lower limb origin of thrombus was ruled out. The patient was sucessfully treated and returned home after three weeks of hospitalization.

Meticulous care is required following catheter insertion regardless of the type of device selected; however, making the best choice for the best outcome at the least cost is a critical strategy in the reduction of catheter-related complications. Careful assessment and prospective interdisciplinary planning are essential in the device selection process.

The American Society for Parenteral and Enteral Nutrition's (ASPEN) Standards of Practice for Nutrition Support Nurses specifies the role of the Nutrition Support Nurse in the implementation of feeding formulations as: implementing nursing interventions collaboratively with other health care professionals to ensure that the individual receives the prescribed therapy in a safe, accurate, and cost-effective manner using an appropriate delivery system and access device.[20] Many patients receiving parenteral nutrition require other intravenous therapies which parenteral nutrition usually outlasts. Nutrition support nurses have a unique opportunity to educate, coordinate, facilitate, and directly participate in device selection and management.

This introductory column is the first of a series to be devoted to issues related to nutrition support nursing. Since vascular access is a primary focus of most nutrition support nurses, future articles will address topics related to vascular access devices and the delivery of parenteral nutrition in the hospital and home.

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