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Meeting the evolving demands of neurointervention: Implementation and utilization of nurse practitioners

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Abstract

Growth in the neurointerventional field, as a result of the emergence of thrombectomy as the gold standard treatment for large vessel occlusions, has created complex challenges. In an effort to meet evolving demands and fill workflow gaps, nurse practitioners have taken on highly specialized roles. Neurointerventional care has rapidly evolved similarly to interventional cardiac care, in that nurse practitioners are successfully being incorporated as procedural assistants in catheterization laboratories. Similar utilization of nurse practitioners in interventional neuroradiology holds the capacity to decrease physician workload, mitigate stresses contributing to burn-out, and reallocate more physician time to procedures. Nurse practitioner practice faces procedural, clinical, legal and interpersonal barriers. Despite calls for expanded practice by the Institutes of Medicine, a paucity of nurse practitioner training opportunities exists. Fragmented privileging processes contribute to environments where nurse practitioners must navigate hurdles without established interventional neuroradiology-specific precedent. Increased nurse practitioner mentorship, fluoroscopy law standardization, physician support surrounding nurse practitioner autonomy, and role consistency is imperative for optimal nurse practitioner utilization. Nurse practitioners are uniquely equipped to bridge evolving gaps through the provision of safe, efficacious care, and generating revenue at lower costs. Discussion surrounding nurse practitioner use to bridge workflow gaps is an exciting opportunity for future practice development.

Keywords

Demands, interventional neuroradiology, nurse practitioners, practice development, thrombectomy

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Background

Evidence-based treatment for ischemic stroke has largely shifted towards minimally invasive endovascular approaches. The MR CLEAN, ESCAPE, EXTEND IA, SWIFT PRIME and THERAPY trials provided overwhelming evidence of the efficacy of thrombectomy, leading to a drastic increase in endovascular stroke treatment. After the publication of positive trials such as MR CLEAN, endovascular acute stroke treatment jumped at a growth rate of 151% per year and reached 4.7% of all stroke hospitalizations by 2015, from 1.5% in 2009.¹ The increasing number of large vessel occlusions (LVOs) going for thrombectomy has resulted in a marked increase in the demand for interventional neuroradiology (INR) in an age in which minimally invasive endovascular management has become the standard of care.² While neurointerventional surgeons were previously available for diagnostic procedures, their increasing need in acute cases has

diverted their time and given rise to significant workflow gaps.³

Meeting the evolving needs of INR practice requires greater support and manpower to relieve the work burdens of neurointerventionalists and provide critical and often emergent care to cerebrovascular patients.² The recently published DAWN trial, which expanded the treatment window for patients from 6 to 24 hours, demonstrated that functional independence at 90 days was better with thrombectomy plus standard medical care compared to standard medical care alone.⁴ It is

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evident that the rapid rise in thrombectomies performed demands a greater need for manpower. As part of the solution to bridge these voids, Nurse practitioners (NPs), providers who have traditionally favoured a holistic healthcare model that ensures safe, effective and continuous care to improve patient experience and outcomes, have been ushered in. Their implementation in neurology and stroke teams has decreased door-to-needle time in thrombolytic stroke therapy, increasing the number of patients treated with intravenous tissue plasminogen activator. They have proved to be facilitators of fast, evidence-based care, with the capacity significantly to impact patient outcomes.⁵ In addition, they possess the capability to generate income and provide billable services for neuroscience departments. NPs, in contrast to fellows and residents, will generally stay within a department for many years and contribute to future fellow training.⁶ This makes NPs uniquely qualified to meet the new and complex needs of the neurointerventional field in a way that is both cost-effective and patient-centered. We will review multiple factors affecting NP implementation in INR practice.

Procedural training

The foundation of neurointerventional practice is the diagnostic cerebral angiogram. Optimal practice requires the technical training and capacity to perform these diagnostic procedures. The role of NPs in interventional radiology has been significantly reported, but with little detail on NP intraprocedural roles.³ One of the major challenges of privileging and credentialing NPs is implementing procedural training and establishing proficiency, especially in the absence of measured standards for evaluating that competence. As in many procedure driven fields, a methodology for granting NPs privileges to perform invasive procedures has yet to be defined.⁷ To perform procedural tasks, NPs must first create a process by which they can be authorized to perform said tasks. In order to develop policies surrounding procedures, nursing-specific protocols, privileges and competency checklists must be developed.

NPs have proved to be capable of safely and effectively performing angiography.⁸ Cardiac catheterization underwent a paradigm shift when the door-to-balloon protocol was established. Cardiac catheterization nurses in interventional cardiology have since demonstrated the capability to perform diagnostic angiographic procedures with similar outcomes, and lower contrast doses and fluoroscopy times than interventionists in their first year of training, at a financial cost far less than their physician counterparts.⁹ INR is undergoing a similar shift, and is being presented with an immense opportunity through the incorporation of NPs into the procedural arena.¹⁰ Although cardiac catheterization and cerebral angiograms differ and cannot necessarily be comparable, a high percentage of the skills required to perform them is shared.

Clinical training

The lack of formal NP residency and training programs within the field of INR is a significant barrier contributing to the small number of trained NPs capable of practising. A 2010 Institute of Medicine (IOM) report recognized the benefits of formal residency programs to NPs as they evolve to meet the new and complex demands of practice. In particular, this detailed a call to action that encompasses four key solutions (Table 1) to increase access to care and improve workflow gaps across healthcare fields.¹⁰ Its implementation in INR holds the capacity to facilitate cost-effective care and offer a rapid solution to the quickly evolving demands of the field. Stroke time is crucial and NPs play a fundamental role in stroke care by providing appropriate, adequate and efficacious care to the patients. NPs offer the opportunity to alleviate neurointerventionalists' procedural workload by performing consultations, responding to stroke codes, and performing diagnostic catheter angiography. Establishing opportunities for obtaining the resources, mentorship, established protocols, and skills is crucial not only for successful management of INR patients, but also for providers to train incoming NPs and fellows. Equipping NPs to do this would allow for them to take on consultative roles, in which they could be crucial team members involved in patient monitoring, ordering of diagnostic tests, and patient education.

Despite efforts and interest, there are still challenges to initiating such training programs. Stringent hospital credentialing policies, state regulations, and lack of funding have further complicated training NPs in INR to their full potential.³ Credentialing bodies have

Table 1. Institute of Medicine recommendations, 2010.

Remove scope-of-practice barriers. Advanced practice registered nurses should be able to practice to the full extent of their education and training, and should be full partners, with physicians in the United States.
Expand opportunities for nurses to lead and diffuse collaborative improvement efforts. Private and public funders, healthcare organizations, nursing education programs, and nursing associations should expand opportunities for nurses to lead and manage collaborative efforts to redesign and improve practice environments and health systems. These entities should also provide opportunities for nurses to diffuse successful practices.
Implement nurse residency programs. State boards of nursing, accrediting bodies, the federal government, and healthcare organizations should take actions to support nurses' completion of a transition-to-practice program (nurse residency) after they have completed a pre-licensure or advanced practice degree program or when they are transitioning into new clinical practice areas.
Prepare and enable nurses to lead change to advance health. Nurses should assume leadership positions across all levels, while public, private, and governmental healthcare decision-makers should ensure that leadership positions are available to and filled by nurses.

created ambiguity about what the NP role encompasses within INR. The 2010 IOM report recognizes that state boards of nursing, accrediting bodies, the federal government, and healthcare organizations should take action to support nurses.¹⁰ For example, this encourages agencies to allocate funding to initiate and sustain residency programs across all practice settings, including critical access regions.¹¹ Finally, no INR-specific guidelines currently exist; therefore, protocols must be created by the individual practice.³ Protocol development and sharing is a key piece of the overall goal to formulate these residency programs and train providers. Through interdisciplinary collaboration, appropriate training, development of performance protocols, adherence to strict clinical standards, and development and completion of credentialing criteria, NPs have an immense capability to reallocate interventionalists' time.

Legal factors

Lack of state regulations regarding fluoroscopy administration is one of the largest legal challenges NPs face in INR. The Consumer–Patient Radiation Health and Safety Act (CPRHSA) of 1981 called for states to set educational and certification guidelines regarding

fluoroscopy use based on federal radiation safety standards for individuals who execute radiology procedures.¹² This has significantly impacted current NPs' practice. Seventeen states (Table 2) currently have specific regulations about who can perform fluoroscopy, while 25 do not. In addition, six states have educational or certification requirements that need to be completed to perform fluoroscopy.¹²

Uncertainty about the role of NPs in fluoroscopic procedures has been a significant issue.¹³ Standardized regulations provide specific parameters to ensure safe and efficient fluoroscopy in NP practice, as well as to promote further NP training and education. The ACR–ASNR–SIR–SNIS 2016 practice parameter states that physicians, radiology assistants, and radiology technicians are those authorized to perform fluoroscopy during cerebral angiography.¹⁴ The Consistency, Accuracy, Responsibility and Excellence in Medical Imaging and Radiation Therapy (CARE) Bill was proposed to enhance the Consumer–Patient Radiation Health and Safety Act (CPRHSA) of 1981 by setting federal guidelines about fluoroscopy education and certification, defining and standardizing fluoroscopy performance and performers. However, the bill did not formally include NPs, which affects the scope of practice and institutional policy.¹²

Table 2. State licensing requirements for performing fluoroscopy. Johnson, 2010.

State	Fluoroscopy regulation	State	Fluoroscopy regulation
Alabama	No licensure	Montana	Does not identify practitioners
Alaska	No licensure	Nebraska	Identifies practitioners
Arizona	No licensure	Nevada	Does not identify practitioners
Arkansas	Does not identify practitioners	New Hampshire	Does not identify practitioners
California	Does not identify practitioners	New Jersey	Identifies practitioners
Colorado	Specific criteria	New Mexico	Identifies practitioners
Connecticut	Does not identify practitioners	New York	Identifies practitioners
Delaware	Does not identify practitioners	North Carolina	No licensure
Florida	Identifies practitioners	North Dakota	Does not identify practitioners
Georgia	Identifies practitioners	Ohio	Identifies practitioners
Hawaii	No licensure	Oklahoma	Does not identify practitioners
Idaho	No licensure	Oregon	Identifies practitioners
Illinois	Does not identify practitioners	Pennsylvania	Does not identify practitioners
Indiana	Does not identify practitioners	Rhode Island	Does not identify practitioners
Iowa	Identifies practitioners	South Carolina	Does not identify practitioners
Kansas	Does not identify practitioners	South Dakota	No licensure
Kentucky	Specific criteria	Tennessee	Does not identify practitioners
Louisiana	Does not identify practitioners	Texas	Identifies practitioners
Maine	Does not identify practitioners	Utah	Does not identify practitioners
Maryland	Specific criteria	Vermont	Specific criteria
Massachusetts	Identifies practitioners	Virginia	Does not identify practitioners
Michigan	Does not identify practitioners	Washington	Does not identify practitioners
Minnesota	Specific criteria	West Virginia	Specific criteria
Mississippi	Does not identify practitioners	Wisconsin	Does not identify practitioners
Missouri	No licensure	Wyoming	Does not identify practitioners

In addition, there is significant inconsistency among specialties regarding fluoroscopy performance. The 2012 American College of Cardiology Foundation and Society for Cardiac Angiography and Interventions expert consensus document was created and called for NPs to serve as secondary operators during cardiac catheterization.¹⁵ Since 2012, properly credentialed NPs have served as first assistants for cardiac catheterization in Massachusetts.¹⁶ In addition, studies have shown that NP utilization in cardiac catheterization is efficacious, cost-effective, and safe.⁸ Although a small pilot study, using one experienced nurse specialist and preselected low-risk patients, it is a formative study that sets a precedent for future research. Nevertheless, additional research is necessary to strengthen the argument that NP use for angiography is feasible, safe, and translatable from interventional cardiology to INR. Ultimately, there is significant opportunity for the field of INR to benefit from the history of interventional cardiology to support NP fluoroscopy utilization.

Interpersonal factors

The lack of both state and federal regulations for NP work and standardization of clinical training has resulted in confusion regarding NP scope of practice. NPs are licensed independent practitioners, yet there is still a lack of consensus among state boards of nursing, legislators, third-party payers, hospital administrators, physicians, healthcare workers, and even NPs themselves about what autonomy in NP practice really means.¹⁷ This type of variability and lack of consensus greatly lends to role confusion. The title 'nurse practitioner' caused further misunderstandings because it included the term 'nurse'.¹⁸ Within specialty fields, especially in radiology, the scope of activity and responsibilities of NPs are separate from those of staff radiology nurses. This simple classification has required repetitive explanation to protect and prevent 'dilution of the skills' NPs possess.¹⁸ NPs scope expansion to provide relief and offer a solution to meet specialty specific demands has introduced significant interpersonal challenges.

NPs in specialty fields have much closer working relationships with fellows, and share many of the same clinical responsibilities. However, a view that NPs are encroaching on their training is additionally a major obstacle in specialty practice.⁹ This drives the fear that NPs overstep professional boundaries as they become autonomous.¹⁹ If duties and responsibilities can be appropriately apportioned, non-physician providers can relieve some of the excess clinical duties for both attending and trainee radiologists. A shift in perspective, to view NPs as collaborators, and a method to help enact the newly published CAST guidelines, allows for medical fellows to be staffed in more emergency and treatment cases, and helps allocate more time for interventionalists to train fellows.⁶

Discussion

INR NPs have shown the capability to learn how to participate and assist in interventional procedures, as well as demonstrate the capacity to deliver safe and efficacious preoperative and postoperative care. Their ability to maximize neurointerventionalists' time in the interventional radiology suite, and generate revenue through 'incident-to' billing brings significant cost savings to departments. NPs are uniquely qualified to meet the evolving demands of practice, and procedural, clinical, and legal barriers should be addressed to resolve workflow gaps. Investing in NP hiring and training can contribute to outpatient practice growth and development; it holds the opportunity to foster a community that is dedicated to the creation of nursing practice standards and protocols in both educational and clinical settings. NP utilization can significantly contribute to onboarding fellow training, and the delivery of consistent care, in which variability of care is minimized. Finally, NP utilization holds the most potential in community centers, where lack of fellows and residents place a greater work burden on staff physicians which contributes to higher rates of burnout. The current healthcare environment and process of healthcare delivery in the field of INR is a major contributor to emotional exhaustion, major medical errors, and an increased risk of being named in a malpractice lawsuit.²⁰ NPs have the potential to decrease and alleviate the growing pressures placed on neurointerventionalists.

In addition, recent criticism regarding the over-saturation of the specialty with medical fellows has been expressed; as a result, temporarily suspending INR fellowship programs should be considered, in order to facilitate neurointerventional programs to train and graduate high quality fellows.²¹ The new CAST guidelines, have made stricter requirements for neurointerventional fellowship programs. In response, NPs are uniquely capable of facilitating these recommendations, by contributing to training programs in academic facilities, and filling roles in facilities that cannot meet the requirements to maintain training programs.

In the process of equipping NPs to relieve the evolving and growing workflow burdens on neurointerventionalists, key issues surrounding autonomy have proved to be significant road blocks. Development of inter-professional relationships and NP education fosters the acceptance of attitudes towards NPs, and has the opportunity to create a collaborative, interdisciplinary working culture, as well as positively impact patient outcomes and costs.²² Collaboration between physicians and NPs is instrumental in meeting the needs as healthcare evolves, and is key in achieving common goals in INR. Because NP angiography performance has been utilized with success in cardiac catheterization,^{8,16} there is a significant opportunity through the creation of standardized practices for fluoroscopy use for NPs to do the same in INR. Finally, while the advanced practice nursing model used to train NPs is well established in the

United States (USA), the employment of NPs in areas of the world where the profession exists is feasible. Establishing a model in the USA and translating it to areas such as the United Kingdom, Canada, and Australia could allow for further evolution and wider impact in the field. Defining and standardizing autonomy and scope of practice for the INR NP is an exciting path for future practice development.

Conclusion

NPs administer safe and efficacious care while benefiting the healthcare economy through billing and generating revenue for medical institutions at a significant cost saving to the INR department. These providers have a reputation for staying on for much longer periods of time, fostering a need for permanency on the INR team, and decreasing costs associated with employee turnover. NP integration clinically and perioperatively is a significant opportunity for the field of neurointerventional radiology.

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References

- Guterman E, Threlkeld ZD, Smith WS, et al. National trends in the use of endovascular stroke treatment at academic medical centers (2009–2015). *Stroke* 2016; 47: AWMP9.
- Shams T, Zaidat O, Yavagal D, et al. Society of Vascular and Interventional Neurology (SVIN) Stroke Interventional Laboratory Consensus (SILC) Criteria: a 7M management approach to developing a stroke interventional laboratory in the era of stroke thrombectomy for large vessel occlusions. *Intervent Neurol* 2016; 5: 21–28.
- Taylor K, Sansiviero GE and Ray CE. The role of the nurse practitioner in interventional radiology. *J Vasc Interv Radiol* 2012; 23: 347–350.
- Nogueira RG, Jadhav AP, Haussen DC, et al. Thrombectomy 6 to 24 hours after stroke with a mismatch between deficit and infarct. *N Engl J Med* 2018; 378: 11–21.
- Sung S-F, Huang Y-C, Ong C-T, et al. A parallel thrombolysis protocol with nurse practitioners as coordinators minimized door-to-needle time for acute ischemic stroke. *Stroke Res Treatment*. Epub 7 December 2011. DOI: 10.4061/2011/198518.
- Hawkins MC, Bowen MA, Gilliland CA, et al. The impact of nonphysician providers on diagnostic and interventional radiology practices: operational and educational implications. *J Am Coll Radiol* 2015; 12: 898–904.
- Jalloh F, Tadlock MD, Cantwell S, et al. Credentialing and privileging of acute care nurse practitioners to do invasive procedures: a statewide survey. *Am J Crit Care* 2016; 25: 357–361.
- Boulton BD, Bashir Y, Ormerod OJ, et al. Cardiac catheterisation performed by a clinical nurse specialist. *Heart* 1997; 78: 194–197.
- Yasin G, Firoozan S and Clifford P. Safety, effectiveness and quality of nurse angiography. *Eur Heart J* 2016; 37: 396–396.
- Institute of Medicine; Committee on the Robert Wood Johnson Foundation initiative on the future of nursing. *The future of nursing: leading change, advancing health*. Washington, DC: National Academies Press, 2010.
- Wiltse Nicely KL and Fairman J. Postgraduate nurse practitioner residency programs: supporting transition to practice. *Acad Med* 2015; 90: 707–709.
- Johnson M. *Fluoroscopy: regulation and radiation protection*. 2010. http://fellowiki.wikispaces.com/file/view/Fluoro_Regulation.pdf (accessed 21 March 2017).
- The Iowa Supreme Court. *Iowa Medical Society and Iowa Society of Anesthesiologists vs. Iowa Board of Nursing, and Iowa Association of Nurse Anesthetists and Iowa Nurses Association, and Iowa Osteopathic Medical Association*. (No. 11-1977). 31 May 2013. https://nursing.iowa.gov/sites/default/files/documents/2018/03/supreme_court_decision_2013_05_31.pdf (accessed 21 March 2017).
- ACR–ASNR–SIR–SNIS. *ACR–ASNR–SIR–SNIS Practice parameter for the performance of diagnostic cervicocerebral catheter angiography in adults*. 2016. <https://www.acr.org/-/media/ACR/Files/Practice-Parameters/cervicocerebralcatthangio.pdf?la=en> (accessed 21 March 2017).
- Bashore TM, Balter S, Barac A, et al. 2012 American College of Cardiology Foundation/Society for Cardiovascular Angiography and Interventions expert consensus document on cardiac catheterization laboratory standards update. *J Am Coll Cardiol* 2012; 59: 2221–2305.
- Massachusetts Board of Registration in Nursing. *Nurse practitioner as first assistant in cardiac catheterization*. <https://www.mass.gov/files/documents/2016/07/wz/np-firstassist-memo-3-16.pdf> (accessed 10 September 2018).
- Weiland S. Understanding nurse practitioner autonomy. *J Am Assoc Nurse Pract* 2015; 27: 95–104.
- Bowen MA, Torres WE and Small WC. Nonphysician providers in radiology: the Emory University experience. *Radiology* 2007; 245: 3–6.
- Dempster J. The nurse practitioner and autonomy: contributions to the professional maturity of nursing. *J Am Assoc Nurse Pract* 1991; 3: 75–78.
- Fargen KM and Hirsch JA. Neurointerventionalists, stroke and burnout. *J Neurointervent Surg* 2018; 10: 811–812.
- Fiorella D, Hirsch JA, Woo HH, et al. Should neurointerventional fellowship training be suspended indefinitely? *J Neurointervent Surg* 2012; 4: 315.
- Reeves S, Perrier L, Goldman J, et al. (2013). Interprofessional education: effects on professional practice and healthcare outcomes (update). *Cochrane Database Syst Rev* 2013; 3: 10.