Special Article
J Korean Neurosurg Soc 68 (5) : 501-510, 2025
https://doi.org/10.3340/jkns.2024.0056
pISSN 2005-3711 eISSN 1598-7876

Competency-Based Neurosurgical Residency Training Program in Korea

Kawngwoo Park,[1,2] Sang-Don Kim,[2,3] Seung-Won Choi,[2,4] Dae-Hyun Kim,[2,5] Eun-Kyung Park,[2,6] In-Suk Bae,[2,7] Jin-Uk Baek,[2,8] Kun Soo Lee,[2,9] Sun-Ho Lee,[2,10] Soo Bin Im,[2,11] Youngjin Jung,[2,12] Sung-Pil Joo,[2,13] Man Kyu Choi,[2,14] Bum-Joon Kim,[2,15] Hyun Ho Choi,[2,16] Junseok W Hur[2,17]

Department of Neurosurgery,[1] Gachon University Gil Medical Center, College of Medicine, Gachon University, Incheon, Korea
Training Education Committee,[2] The Korean Neurosurgical Society, Seoul, Korea
Department of Neurosurgery,[3] Bucheon St. Mary's Hospital, The Catholic University of Korea College of Medicine, Bucheon, Korea
Department of Neurosurgery,[4] Chungnam National University Hospital, Daejeon, Korea
Department of Neurosurgery,[5] Daegu Catholic University Hospital, Daegu, Korea
Department of Pediatric Neurosurgery,[6] Severance Children's Hospital, College of Medicine, Yonsei University, Seoul, Korea
Department of Neurosurgery,[7] Nowon Eulji Medical Center, College of Medicine, Eulji University, Seoul, Korea
Department of Neurosurgery,[8] Cheju Halla General Hospital, Jeju, Korea
Department of Neurosurgery,[9] Inje University Busan Paik Hospital, Busan, Korea
Department of Neurosurgery,[10] Spine Tumor Center and Special Cancer Center, Samsung Medical Center, Sungkyunkwan University School of Medicine, Seoul, Korea
Department of Neurosurgery,[11] Soonchunhyang University Hospital Bucheon, Soonchunhyang University College of Medicine, Bucheon, Korea
Department of Neurosurgery,[12] Yeungnam University Medical Center, College of Medicine, Yeungnam University, Daegu, Korea
Department of Neurosurgery,[13] Chonnam National University Hospital, Chonnam National University Medical School, Gwangju, Korea
Department of Neurosurgery,[14] Kyung Hee University Medical Center, Kyung Hee University College of Medicine, Seoul, Korea
Department of Neurosurgery,[15] Korea University Ansan Hospital, Korea University College of Medicine, Ansan, Korea
Department of Neurosurgery,[16] Chung-Ang University Hospital, Chung-Ang University College of Medicine, Seoul, Korea
Department of Neurosurgery,[17] Korea University Anam Hospital, Korea University College of Medicine, Seoul, Korea

A proposed program for competency-based neurosurgery training was presented for adaptation to a specialized project. The core of this training program is to reflect the contents of medicine that develop in the ordinary competency course necessary during the training period of residency and to systematize the training curriculum focused on competency. For that, the development project of the competency-based training program for neurosurgical residency was conducted under the leadership of the Training Education Committee under the Korean Neurosurgical Society (KNS), with the support of the Ministry of Health and Welfare. In this article, we introduce an educational program for a competency-oriented training system. The educational program sets the goal of the final competency that a neurosurgeon must possess and presents a list of core competencies and activities to perform for this purpose, called entrustable professional activity (EPA). The program structure includes the following domains : seven final competencies, four core competencies, 10 EPAs, and 12 neurosurgical procedures. These educational programs will be uploaded to the KNS website in the future, and we would like to encourage each training hospital to reflect on them.

Key Words : Competency-based education · Entrustable professional activities · Education committees · Residency programs.

• Received : March 6, 2024 • Revised : August 7, 2024 • Accepted : April 10, 2025
• Address for correspondence : **Sang-Don Kim**
Department of Neurosurgery, Bucheon St. Mary's Hospital, The Catholic University of Korea College of Medicine, 327 Sosa-ro, Wonmi-gu, Bucheon 14647, Korea
Tel : +82-32-340-2009, Fax : +82-32-340-2635, E-mail : kimsd@catholic.ac.kr, ORCID : https://orcid.org/0000-0002-2030-8489

INTRODUCTION

A special law for residents (Act on the Improvement of Training Conditions and Status of Medical Residents, Act No. 17216) was implemented in July 2019 to improve the training environment and residents' rights. Since then, many changes have occurred concerning resident training[1,2]. The most significant change is the reduction in training time. This was intended to encourage autonomous training by respecting the residents' basic human rights of and securing personal training time. However, the quality of resident education has been suboptimal due to both insufficient self-directed learning by residents and inadequate educational content provided by the Korean Neurosurgical Society (KNS).

To address the challenges posed by the shortened residency training period, there is a pressing need for a competency-based training program for residents. The previous residency system primarily focused on the number of cases handled, with the number of cases serving as the main performance indicator for residency qualification. Residents were evaluated based on how many cases they had managed rather than the quality of their clinical skills and overall competency.

However, merely experiencing many patient cases does not necessarily equate to having the necessary clinical proficiency. This approach does not guarantee that a resident, even after obtaining specialty certification, possesses the independent clinical skills required for effective practice as a neurosurgeon. The traditional model's emphasis on case volume rather than on the comprehensive development of clinical abilities meant that many newly certified specialists might lack the nuanced skills and judgment necessary for complex patient care. Additionally, it has become difficult to experience many patient cases with the previous training system in the current situation where the training time for residents is significantly reduced.

In response to these limitations, there is an emerging need for a revised residency system that emphasizes competency over case quantity. The new competency-based training model aims to make better use of the condensed training period by focusing on specific learning outcomes and the development of core clinical competencies. Instead of merely documenting the number of cases handled, the new system sets clear, measurable objectives for residents to achieve.

This competency-based approach includes establishing specific, measurable goals that residents must achieve in various clinical skills and decision-making areas. These goals are designed to ensure that residents develop the necessary skills to perform independently and competently. The model also emphasizes regular, objective assessments of residents' clinical abilities to ensure they meet the predefined competency goals. These assessments include direct observations, simulations, and evaluations by supervisors.

Additionally, the approach involves providing targeted training that addresses the areas where residents need the most improvement, rather than a broad exposure to a high volume of cases. Continuous feedback mechanisms are incorporated to help residents understand their strengths and areas for improvement, allowing them to refine their skills throughout the training period. Competency-based milestones are established to reflect residents' progress in developing independent clinical judgment and technical skills, rather than just tracking the number of cases they have participated in.

By adopting this competency-based approach, the residency training program aims to ensure that all graduates are not only exposed to a sufficient number of cases but also develop the critical skills needed for independent practice. This shift will help address the gaps identified in the previous system and better prepare residents for their roles as specialists.

Today, residency programs are judged by a "minimum threshold" according to their compliance with the standards of the Training Education Committee (TEC) under the KNS. Residents are evaluated to determine whether they comply with the requirements of the TEC. For example, programs are checked to see whether they have established objectives, organized training programs, good teaching faculty, and a process that evaluates the program and residents, i.e., "Structure and Process on Training Environment."

However, these evaluation methods do not directly measure educational quality but merely the potential of programs that educate doctors. In other words, the hypothesis that a good training environment can create good doctors is not always correct. Therefore, evaluating medical education has changed not to rely on structure and process but to improve the individual competencies of the residents and to show the achievements expected by evaluation.

The training program we present will focus on evaluating actual performance in competency-oriented education. This will be accomplished using professional core competencies and associated learning objectives.

 https://doi.org/10.3340/jkns.2024.0056

DEVELOPMENT OF A COMPETENCY-BASED TRAINING CURRICULUM

The training goal for KNS residents is to acquire integrated knowledge and skills to independently diagnose and treat neurological diseases, including trauma and pain occurring in the brain, spinal cord, peripheral nerves, skull, spine, and musculoskeletal system. To this end, we presented a training program that systematized and specified the final, core, and minimum annual competencies according to the residents' educational goals. Each final and core competency was developed as an Entrusted Professional Activity (EPA) that reflected the mission and vision of neurosurgery and could be applied during the training process (Fig. 1). EPAs are units of professional practice defined as tasks or responsibilities that can be assigned to a trainee for unsupervised execution once they have achieved adequate specific competence[3]. We attempted to supplement the insufficient educational time for residents by improving the quality of education through the inclusion of EPAs.

COMPETENCY AND ENTRUSTABLE PROFESSIONAL ACTIVITY (EPA)

We convened advice from each subcommittee (Spinal Neurosurgery Society, Cerebrovascular Surgeon Society, Pediatric Neurosurgery Society, Stereotactic and Functional Neurosurgery Society, Brain Tumor Society, Neurotraumatology Society, Neuroendovascular Society, Geriatric Neurosurgery Society, Neuropain Society, Peripheral Nervous System Society, Neurointensive Care Society, and Neurosurgical Ultrasound Society) to coordinate their opinions and presented the following six competencies.

The seven final competencies are 1) systemic management and treatment of neurosurgery (severe) patients can be performed; 2) basic neurosurgery and surgery can be performed; 3) neurosurgery patients can be managed before and after surgery; 4) it is possible to make judgements on emergency and trauma patients; 5) they must have the ability to communicate and cooperate; 6) professional professionalism and ethical awareness should be cultivated; and 7) it is necessary to cultivate a lifelong learning attitude through self-directed learning.

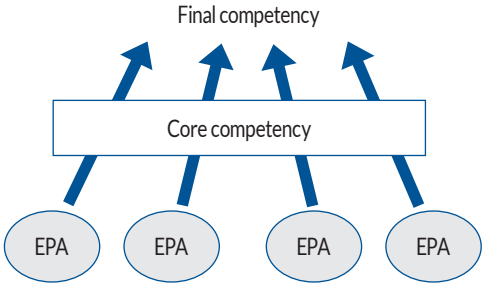

Fig. 1. Schematic diagram for understanding entrustable professional activity (EPA), core competency, and final competency.

To encourage these final competencies, individual programs must define the required neurosurgical knowledge, procedures, techniques, patient management, attitude, and personality of the residents and provide educational experiences called core competencies. 1) Neurosurgical knowledge, 2) neurosurgical procedures and techniques, 3) patient management, and 4) attitude and personality

However, supervising medical specialists who educate residents do not adequately assess these competencies. This is because the definition of competency presented is comprehensive, and it is challenging to explicitly reflect the clinical results. To overcome this problem, the EPAs were introduced to define competency goals and delegate different levels of activity to residents. ten Cate[4] set out the following criteria for these activities : it is an essential professional task that only qualified personnel can perform; it specifies the knowledge, skills, and attitudes that can be acquired through training; it leads to recognized output as professional labor; and it can be executed independently within a certain period. It is also observable and measurable, and conclusions can be drawn for evaluation. What is important is that the set of competencies throughout these activities is not only comprehensive but also measurable. During the training period, we developed the following EPA to stimulate intellectual curiosity, evaluate it, provide feedback, and present the competency.

We identified 10 EPAs for residents specializing as neurosurgeons; the EPAs contain 12 procedures. EPA 1 : medical history taking and neurosurgical physical examinations are available; EPA 2 : based on the test results, physicians can interpret findings, establish diagnoses, and implement evidence-based medical treatments; EPA 3 : medical records and prescriptions can be made; EPA 4 : neurosurgical procedures are available : 1) emergency cerebral angiography; 2) ventriculoperitoneal shunt; 3) burr hole trephination for chronic subdural hematoma; 4) aspiration for spontaneous intracranial hemorrhage; 5) ventricular drainage; 6) decompressive craniotomy; 7) navigation-guided stereotactic functional surgery; 8) intraoperative

nervous system monitoring; 9) decompressed laminoplasty; 10) peripheral nerve decompression; 11) nerve block; and 12) neurointensive care with intracranial pressure monitoring; EPA 5 : emergency response and safety management can be performed; EPA 6 : communication with patients and caregivers; EPA 7 : collaboration with other medical staff and occupations; EPA 8 : medical development and research can be conducted; EPA 9 : residents can understand social and healthcare systems; and EPA 10 : residents can cultivate professional expertise and global leadership skills.

ANNUAL TRAINING PROGRAM TO REACH CORE COMPETENCIES

According to the characteristics of neurosurgery training, the following annual training courses were prepared. This is the list and goal of the minimum competency performance to be performed each year for the final competency. To this end, it was divided into knowledge, skill, and management for each year, and evaluated in connection with the EPA. To assist with the training courses, the KNS provides workshops for new residents in the first year, hands-on workshops in the second and third years, and informative training education in the fourth year. The annual training program emphasizes achieving the minimum competencies required to become a neurosurgeon. As a result, the content and timing of each program may vary based on the specific circumstances of each training hospital.

First year neurosurgical resident

Knowledge

(1) Understand neurological examinations : consciousness level, cranial and spinal nerve test, motor and sensory function test, reflex, cerebellar function test, peripheral nerve test, and musculoskeletal system test. (2) Understand neuroanatomical findings relevant to clinical presentations, including the skull structure, cerebral surface anatomy, cerebrovascular anatomy, cerebrospinal fluid circulation, spinal cord surface anatomy, spinal vascular anatomy, spine surgical anatomy, dermatomes, peripheral nerve anatomy and function, and associated musculoskeletal systems. (3) Understand basic radiological findings : simple radiography, computed tomography, magnetic resonance imaging and angiography. (4) Understand the assessment and treatment of neurological emergency patients. (5) Understanding and managing intracranial pressure (drug therapy and surgery). And (6) residents must pass at least one interim evaluation during their 2nd through 4th years of training.

Skill

(1) Understand the following neurosurgical techniques (treatment, procedure, and surgery) and perform them over the first and second years. (A) Endotracheal intubation, central venous line insertion, hematoma irrigation, lumbar puncture, tracheostomy, scalp suturing, ventricular drainage, and burr hole trephination can be performed (a total of more than 20 times); (B) understand cerebrovascular angiography and endovascular procedures (observe or participate more than five times); (C) must demonstrate competency in using brain navigation systems and stereotactic frames (minimum of five cases); (D) participate in the treatment of neurogenic pain; (E) spine fixation and traction devices may be used; and (F) understand the following special evaluation methods : neurophysiological examination (electroencephalography, electromyography, nerve conduction study, evoked potential, and intraoperative nerve monitoring), neurosurgical ultrasonography (musculoskeletal system, carotid artery, and Doppler), myelography, and discography. And (2) participate in hands-on workshops for residents (it is mandatory to participate in and complete the program at least once during the training period).

All participation records must be documented on the KNS's e-portfolio homepage for residents and managed under the supervision and responsibility of faculty members at each training institution.

Management

(1) Taking and record the medical history of inpatients and emergency patients and became familiar with neurological examinations. (2) Request for various laboratory tests and develop the ability to interpret test results. (3) Understand and explain various neurosurgical procedures and complications. And (4) be able to manage patients appropriately before and after surgery.

Second year neurosurgical resident

Knowledge

(1) Understand the clinical symptoms, diagnosis, and treatment of neurosurgical diseases such as cerebrovascular disease,

 https://doi.org/10.3340/jkns.2024.0056

brain tumor disease, spinal and spinal cord disease, peripheral nerve disease, trauma, nervous system infections, congenital malformations, and hydrocephalus. (2) Acquire competency in managing and treating critically ill neurosurgical patients. (3) Understand neuropathological findings on neurosurgical diseases. (4) Understand neuroimaging findings : magnetic resonance imaging/computed tomography, nuclear medicine, myelography, neuroultrasonography, and electrophysiological examination. (5) Be able to use intracranial pressure monitoring device and assess intracranial pressure. And (6) residents must pass at least one interim evaluation during their 2nd through 4th years of training.

Skill

(1) Be able to understand the following neurosurgical techniques (treatment, procedure, and surgery) and perform them over the first and second years. (A) Endotracheal intubation, central venous line insertion, hematoma irrigation, lumbar puncture, tracheostomy, scalp suturing, ventricular drainage, and burr hole trephination can be performed (a total of more than 20 times); (B) understand cerebrovascular angiography and endovascular procedures (observe or participate more than five times); (C) must demonstrate competency in using brain navigation systems and stereotactic frames (minimum of five cases); (D) participate in the treatment of neurogenic pain; (E) spine fixation and traction devices may be used; and (F) understand the following special evaluation methods : neurophysiological examination (electroencephalography, electromyography, nerve conduction study, evoked potential, and intraoperative nerve monitoring), neurosurgical ultrasonography (musculoskeletal system, carotid artery, and Doppler), myelography, and discography. And (2) participate in hands-on workshops (it is mandatory to participate in and complete workshops at least once during the resident's training period).

All participation records must be documented on the KNS's e-portfolio homepage for residents and managed under the supervision and responsibility of faculty members at each training institution.

Management

(1) Be able to understand and implement the management and treatment of the neuro-intensive care unit. And (2) be able to manage neurosurgical emergency patients and multiple trauma patients.

Third year neurosurgical resident

Knowledge

(1) Residents must pass at least one interim evaluation during their 2nd through 4th years of training. And (2) learn basic knowledge of the skills below and understand the complications and management caused by these skills.

Skill

(1) Understand and perform the following neurosurgical techniques (treatment, procedures, and surgery) (surgery participation accumulated more than 150 times in the third and fourth years). (A) The ability to perform cranial surgery depends on the type and location of the brain lesion, head trauma surgery, emergency brain decompression, cranioplasty, laminoplasty, spinal intervertebral disc removal, spinal fixation, pain surgery, and procedure; and (B) participate in the following skills : surgical resection for brain tumors, cerebrovascular disease surgery, endovascular surgery, stereotactic and functional neurosurgery (deep brain stimulation, microvascular decompression), radiosurgery, spinal tumor surgery, corpectomy, peripheral nerve surgery, and congenital malformation surgery. (2) Participate in hands-on workshops for residents (it is mandatory to participate in and complete workshops at least once during the resident's training period). And (3) take an in-training exam (interim evaluation). Must take and finally pass at least once in years 2–4 during the residency training period to be eligible for a specialist examination.

The above participation should be recorded on the e-portfolio homepage for Korean neurosurgical residents, and it should be managed under the supervision and responsibility of professors at each training institution.

Management

(1) Complete various surgical procedures in neurosurgery. (2) Be able to respond to consults from other departments. (3) Be able to lead a lower year resident. And (4) have counseling capabilities with patients and guardian or family member.

Fourth year neurosurgical resident (the chief resident)

Knowledge

(1) Residents must pass at least one interim evaluation during

their second through fourth years of training. And (2) learn basic knowledge of the skills below and understand the complications and management caused by these skills.

Skill

(1) Understand and perform the following neurosurgical techniques (treatment, procedures, and surgery) (surgery participation accumulated more than 150 times in the third and fourth years). (A) Acquire skulls to perform cranial surgery depending on the type and location of the brain lesion, head trauma surgery, emergency brain decompression, cranioplasty, laminoplasty, spinal intervertebral disc removal, spinal fixation, pain surgery, and procedure and (B) participate in the following skills : surgical resection for brain tumors, cerebrovascular disease surgery, endovascular surgery, stereotactic and functional neurosurgery (deep brain stimulation, microvascular decompression), radiosurgery, spinal tumor surgery, corpectomy, peripheral nerve surgery, and congenital malformation surgery. (2) Participate in hands-on workshops (it is mandatory to participate in and complete workshops at least once during the resident's training period). And (3) take an in-training exam (interim evaluation). Must take and pass at least once in years 2–4 during the residency training period to be eligible for a specialist examination.

The above participation should be recorded on the e-portfolio homepage for Korean neurosurgical residents, and it should be managed under the supervision and responsibility of professors at each training institution.

Management

(1) Educate and supervise first-, second-, and third-year residents, and foster leadership as chief residents and (2) acquire competence capable of neurosurgical treatment independently. (A) Decide whether patients should be hospitalized or operated on; (B) able manage outpatient clinic; and (C) provide holistic management of inpatients.

EPA ESTIMATION

Who : program director

Program directors manage supervising medical specialists to educate residents of neurosurgery training institutions to acquire knowledge and skills related to medical care. They also promote teaching communication, attitude, personality, and improvements in the medical system. They serve as mentors to develop knowledge so that doctors can learn about lifelong learning, improve the medical system environment, and contribute to society, even after obtaining specialist qualifications. The program directors are responsible for the residents and directly guides residents' training goals according to the training program of the training institution. They also educate and evaluate residents to become neurosurgical specialists through the EPAs and strive to have the competency of neurosurgery experts through feedback, if necessary.

How : milestone evaluation method

The program director shall notify residents of the core competencies to be completed during training, the timing of the evaluation, the evaluation method, the evaluation results, and the feedback. The evaluation method will be a step-by-step evaluation using milestones that considers the overall competence of residency training. According to the EPA, the evaluation method is classified as non-delegation (1–3), supervisory delegation (4–6), or full delegation (7–9). If a resident is not eligible for evaluation due to their birth year or other valid reasons, it shall be marked as 'unable to evaluate' and postponed until the appropriate time. Table 1 presents an example of an EPA assessment based on the milestone evaluation tool. For more information, please refer to Supplementary Material 1.

When : annually

The program director shall notify residents of the core competencies to be completed during the training, the timing of the evaluation, the evaluation method, the evaluation results, and the feedback and evaluate the EPA development process based on each resident's core competency performance annually.

What : quantitative evaluation

A quantitative evaluation is conducted to determine whether the entire procedure is performed. As mentioned previously, we defined 12 procedures and developed a quantitative evaluation tool. The procedures for residents presented in this manner must be evaluated occasionally and pass at least once. They can be evaluated by direct bed-side observations and must perform at least 60% of the assessment items correctly. Table 2 presents examples of such evaluation tools. For more information, please refer to Supplementary Material 1.

 https://doi.org/10.3340/jkns.2024.0056

Table 1. The example of entrustable professional activity (EPA) assessment

EPA 1. Medical history taking and neurosurgery physical examinations are available				
Core competency – Medical knowledge				
Level 1	Level 2	Level 3	Level 4	Level 5
I understand the elements of medical history taking. The level of consciousness can be assessed. I can understand the function of each cranial nerve. Tools necessary for physical examination are available. I can understand basic physical examinations.	I understand the medical history taking related to neurosurgery diseases. It is possible to determine the presence or absence of abnormalities in each cranial nerve. The presence or absence of abnormalities in motor, sensory, and autonomic nerves can be assessed step by step. Tools necessary for physical examination are available. Basic physical examinations can be performed. Demonstrate ability to recognize emergency conditions through clinical assessment.	Able to make diagnosis through neurologic examinations. Be able to determine appropriate next steps in diagnostic testing.	Able to make diagnosis through neurologic examination. It is possible to point out errors in the examination records of the other residents.	Able to educate neurosurgery physical examinations.
Many of the assessment items performed require improvement.	Some of the assessment items performed require improvement.	A few of the assessment items performed require improvement.	Few of the assessment items performed require improvement.	Has expert level understanding of assessment items.
☐	☐ ☐	☐ ☐	☐ ☐	☐ ☐
Comments:				
				Not Yet Completed Level 1 ☐ Unable to evaluate ☐

FEEDBACK AND REEDUCATION

For the systematic education and evaluation of neurosurgical residents, it is necessary to develop guidelines for core competencies to evaluate and supplement the results of education for learners with appropriate education plans. To this end, basic knowledge and core competency evaluations for essential skill acquisition and self-evaluation are conducted separately so that new knowledge and skills can be systematically learned by helping complete competency development through appropriate feedback. To this end, the core competency evaluation is divided into supervised and self-directed learning evaluations, and the degree of learning of the core competency is evaluated. All evaluations are linked to an e-portfolio to effectively evaluate insufficient competencies and compensate for them with appropriate feedback. EPA milestones self-evaluated by the resident are checked and evaluated by the relevant supervisor; if the skill is deemed insufficient, retraining is conducted. Lack of education is addressed through video education and e-learning quizzes linked to e-portfolios, which the supervisor checks and re-evaluates.

E-portfolio (https://www.neurosurgery.or.kr/new_record/)

The e-portfolio is meant to establish an online training record through an integrated management system for neurosurgical residents, to evaluate the residents' training environment, and for the residents to evaluate their own training process so that they can become neurosurgeons who meet their core competencies (Fig. 2). E-learning is implemented to standardize education across residency training institutions. E-learning is an online lecture platform designed to create and watch video lectures on 12 procedures. We created an e-test to evaluate this hypothesis. The e-test is an evaluation tool that solves 10 quiz questions and is retaken if the score does not exceed 60 points. In the case of failure of more than twice the e-test, the training hospital supervisor should conduct face-to-face retraining.

Table 2. Pass/fail quantitative evaluation table

EPA 4-1. Emergency cerebral angiography			
Competency description	Diagnostic cerebral angiography can be performed.		
Method	Simulation models, direct patient examination, oral prescription		
Performance goal	Can be performed independently without supervisor		
Evaluator	Program director		
Number of evaluations	Frequently (must pass at least once)		
Passing criteria	Perform at least 60% of the assessment items correctly.		
		PASS	FAIL
Preparation			
Patient assessment	Check for underlying disease and current medications		
	Confirm that there is no contraindication of angiography through laboratory finding(s) and physical examinations		
	Can select the appropriate diagnostic catheter for the patient based on CT or MR angiography		
Procedure			
Femoral artery access	Predict the location of the femoral artery and specify the puncture site through fluoroscopy in the inguinal area		
Artery puncture	Perform appropriate disinfection and local anesthesia		
	Perform skin incision and subcutaneous tissue dissection using forceps		
	Locate and fix the femoral artery with the left hand, and use a puncture needle with the right hand to puncture at a 45-degree angle toward the patient's opposite shoulder to check for backflow of arterial blood		
	Insert the J-wire through the Hub		
	Check the direction of J-wire movement by fluoroscopy		
	Remove the puncture needle and insert the sheath along the J-wire		
	Aspirate the air of the sheath, perform femoral angiography, and evaluate whether the sheath is located at an appropriate position		
Aortic arch navigation	Under fluoroscopy, the diagnostic catheter is guided into the aortic arch along the guide wire		
	The right brachiocephalic trunk, left common carotid artery, and left subclavian artery are accessed by manipulating the diagnostic catheter		
	If the target artery is not easily accessible, the diagnostic catheter can be replaced with an HN-5, Simmons, or Berenstein catheter		
Carotid artery angiography	Can place a diagnostic catheter in the common carotid artery		
	Can identify internal and external carotid arteries by performing a roadmap on the common carotid artery		
	Can place a diagnostic catheter in the internal carotid artery and external carotid artery under the roadmap		
	Position the catheter parallel to the curvature of the artery, withdraw it appropriately, and check whether the catheter moves according to pulsation within the target artery		
	After removing the wire, aspirate blood through the hub of the catheter to remove air and thrombus, and use contrast to check whether the catheter is properly positioned		
	When performing angiography by hand injection, inject with the barrel standing vertically with the Luer lock facing down to prevent air from entering the catheter		
Vertebral artery angiography	Can place a diagnostic catheter in the subclavian artery		
	Can locate the orifice of the vertebral artery by performing a roadmap on the subclavian artery		
	Can use a non-traumatic maneuver to place a diagnostic catheter in the vertebral artery by manipulating the wire under the roadmap		
	Position the catheter parallel to the curvature of the artery, withdraw it appropriately, and check whether the catheter moves according to pulsation within the target artery		
	After removing the wire, aspirate blood though the hub of the catheter to remove air and thrombus, and use contrast to check whether the catheter is properly positioned		
	When performing angiography by hand injection, inject with the barrel standing vertically with the Luer lock facing down to prevent air from entering the catheter		
Finishing the procedure			
Hemostasis after removal of sheath	Remove the sheath and compress the area 1 cm proximal to the puncture site to stop the bleeding		
	Achieve hemostasis using hemostatic devices such as Femoweal®, Angioseal®, and Perclose®		
	After hemostasis is completed, compression dressing can be applied by placing sand on the puncture site		
	After being transferred to the ward, check the condition of the puncture site and check the dorsalis pedis artery pulse		

CT : computed tomography, MR : magnetic resonance

 https://doi.org/10.3340/jkns.2024.0056

Fig. 2. E-portfolio homepage for Korean neurosurgical residents.

DISCUSSION

To become a specialist, a standardized and tailored training program is necessary. In the United States, this is managed by the Accreditation Council for Graduate Medical Education (ACGME), whereas in Canada, the Royal College of Physicians and Surgeons of Canada utilizes the CanMEDS framework. The ACGME recommends six core competencies for specialists : patient care, medical knowledge, practice-based learning and improvement, interpersonal and communication skills, professionalism, and systems-based practice.

Canada's competency-based residency training program is built on the CanMEDS framework, which emphasizes seven key competencies essential for training specialists : medical expertise, effective communication with patients and colleagues, teamwork, resource management and roles within the healthcare system, health advocacy for patients and communities, continuous learning and teaching, and maintaining ethical responsibility and professionalism.

Key elements of the training program include personalized education based on the resident's goals, regular assessments through multi-faceted evaluations and practical assessments, experiential learning, mentorship from experienced professionals, and continual improvement of the curriculum based on resident feedback.

In South Korea, the general surgery department has been most proactive in adopting competency-based residency training. In 2018, the general surgery residency program was reduced from 4 years to 3, actively integrating competency-based training. To enhance training efficiency, education was divided into general surgery specialists and subspecialists, focusing on maximizing basic surgical skills among residents. In 2021, the Ministry of Health and Welfare led an initiative to systematize the residency training curriculum, encouraging the development of competency-based programs across 26 specialties.

Despite these efforts, there are practical challenges in implementing competency-based residency training programs. Financial support for residency training is essential. Currently, there is no national funding, and the financial burden falls entirely on the training hospitals, making it impractical to implement these programs beneficially. Additionally, unless conditions for training supervisors (program directors) are improved, even the best training programs will be ineffective.

Modern residency training is shifting towards competency-based programs, and societal support is crucial for their successful implementation.

CONCLUSION

In this program, the final, core, and minimum annual competencies were systematized and specified according to the educational mission and vision of the neurosurgical residents. Through the competency-based training program, residents can develop independent clinical skills necessary for their roles as neurosurgeons. This program is expected to address several key issues in traditional residency education. The program shifts focus from simple case numbers to practical clinical competency improvement. While systematic and practical training ensures patient safety, personalized education maximizes each resident's growth and development. Clear competency standards and assessment systems enable the training program to operate efficiently, ultimately leading to improved quality of care and better patient outcomes.

To verify the effectiveness of this program, several evaluation methods have been established. These include tracking residents' competency achievement through the e-portfolio, longitudinal analysis of annual evaluation results, comparison of specialist qualification exam results before and after program implementation, and collection and analysis of feedback from training hospitals, supervisors, and residents. Based on these evaluation results, the program will undergo continuous im-

provement. This includes adjusting and supplementing EPA items, enhancing the validity and reliability of assessment tools, improving the effectiveness of educational content and methods, and reflecting improvements in the training environment.

For these educational programs to be truly effective, a well-established system for the training environment is essential, along with enhanced guidance and oversight from the relevant TEC under the KNS.

AUTHOR'S DECLARATION

Conflicts of interest

Soo Bin Im has been editorial board of JKNS since May 2017. He was not involved in the review process of this original article. No potential conflict of interest relevant to this article was reported.

Informed consent

This type of study does not require informed consent.

Author contributions

Conceptualization : DHK; Data curation : ISB, SHL, JWH; Formal analysis : JUB, SBI, HHC; Funding acquisition : KSL, YJ; Methodology : EKP, SPJ; Project administration : SWC, BJK; Visualization : SDK, MKC; Writing - original draft : KP; Writing - review & editing : KP, SDK

Data sharing

None

Preprint

None

ORCID

Kawngwoo Park	https://orcid.org/0000-0002-6568-1009
Sang-Don Kim	https://orcid.org/0000-0002-2030-8489
Seung-Won Choi	https://orcid.org/0000-0001-8610-887X
Dae-Hyun Kim	https://orcid.org/0000-0003-4716-9551
Eun-Kyung Park	https://orcid.org/0000-0002-8777-3457
In-Suk Bae	https://orcid.org/0000-0002-0738-9253
Jin-Uk Baek	https://orcid.org/0009-0002-8452-1497
Kun Soo Lee	https://orcid.org/0000-0002-3537-3080
Sun-Ho Lee	https://orcid.org/0000-0003-3357-4329
Soo Bin Im	https://orcid.org/0000-0002-1442-0482
Youngjin Jung	https://orcid.org/0000-0002-9659-2607
Sung-Pil Joo	https://orcid.org/0000-0002-4983-0174
Man Kyu Choi	https://orcid.org/0000-0001-6670-7541
Bum-Joon Kim	https://orcid.org/0000-0002-3701-4030
Hyun Ho Choi	https://orcid.org/0000-0003-1170-6829
Junseok W Hur	https://orcid.org/0000-0002-2753-1659

- **Acknowledgements**

This work was supported by the Ministry of Health and Welfare and the Korean Hospital Association as part of the project to systematize the training curriculum for residents.

This manuscript builds upon the concept of a competency-based training program. We are grateful to the project participants, whose discussions helped emphasize the need for a framework to assist academic programs. This work was supported by the Ministry of Health and Welfare and the Korean Hospital Association as part of the project to systematize the training curriculum for residents.

- **Supplementary materials**

The online-only data supplement is available with this article at https://doi.org/10.3340/jkns.2024.0056.

References

1. Ahn JS, Cho S, Park WJ : Changes in the health indicators of hospital medical residents during the four-year training period in Korea. **J Korean Med Sci 37 :** e202, 2022
2. Han ER, Chung EK : The perception of medical residents and faculty members on resident duty hour regulation. **Korean J Med Educ 32 :** 67-72, 1992
3. ten Cate O : Entrustability of professional activities and competency-based training. **Med Educ 39 :** 1176-1177, 2005
4. ten Cate O : Trust, competence, and the supervisor's role in postgraduate training. **BMJ 333 :** 748-751, 2006