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Saudi Commission for Health Specialties

Saudi Board of Neurosurgery Curriculum

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SECTION 1: INTRODUCTION

Preamble

Definition

Neurosurgery is a surgical specialty addressing a spectrum of disorders of the nervous system and meninges in adults and children that necessitate a neurosurgeon's attention, intervention, or opinion. It mostly addresses highly critical conditions and demanding procedures.

Vision

To provide the community with well-trained graduates who will be potential leaders in the field of neurosurgery, as reflected in our motto, "Bettering program outcomes to better patient outcomes."

Mission

To institute a progressive neurosurgical training program that is comparable to the world's best such programs.

Educational goals and objectives

- Offer the highest quality of modern training and ensure that residents completing the training have developed the required skills and competencies.
- Focus on training outcomes. The graduates must demonstrate their competencies in essential neurosurgical domains so that they may readily transfer them into independent practice.
- Accelerate learning and skill attainment through focused up-to-date teaching methods and frequent exposure to cases with balanced supervision and independence.
- Involve the trainees in specialty-related community health projects and scholarly projects that will help shape their future practice.

History

The recognized paucity of Saudi neurosurgeons and the rapid growth of the Saudi population have necessitated the establishment of a high-quality national program for training neurosurgeons. The first training program was a 1987 collaborative endeavor between King Faisal University in Dammam and the King Faisal Specialist Hospital and Research Center in Riyadh. This program was gradually replaced by the Saudi Neurosurgery Residency Training Program (SNRTP) that was established in 1995 under the authority of the Saudi Commission For Health Specialties (SCFHS). This program attracted an increasing number of trainees from Saudi Arabia and neighboring countries. This encouraged the establishment of an increasing number of high-quality training centers in Gulf countries. These centers are mainly located in major cities where several large hospitals can complement each other to fulfill training requirements.

Scope of neurosurgical practice

Neurosurgeons treat diseases and conditions related to the nervous system at cranial, spinal, and peripheral nerve locations. As in other specialties, these diseases and conditions include several categories:

- Congenital and developmental disorders
- Degenerative disorders
- Trauma
- Neoplasm
- Vascular disorders
- Infection and inflammation
- Functional disorders

Principal neurosurgical disciplines

- Nervous system trauma and critical care:
  Includes treatment and comprehensive management of head, spine, and peripheral nerve injuries. Head and spine injuries are a major cause of death and disability in children and young adults.

- Pediatric neurosurgery:
  Treats disorders of the developing nervous system, including hydrocephaly, brain malformations, cranial and spinal dysraphism, craniofacial anomalies, and intracranial masses.

- Neuro-oncology:
  Manages neoplasms of the brain, spinal cord, and meninges.

- Skull-base surgery:
  Surgically accesses and manages neurosurgical diseases at or near the skull-base.

- Vascular neurosurgery:
  Manages intracranial, spinal, and cervical vascular diseases with intravascular methods. The main conditions in this category are aneurysms, vascular malformations, carotid artery diseases, and cerebral ischemia.

- Functional and epilepsy surgery
  Manages epilepsy disorders, movement disorders, pain, and spasticity.

- Peripheral nerve surgery:
  Manages trauma, entrapment syndromes, tumors, and other disorders of the peripheral nervous system.

- Spinal surgery:
  Treats traumatic, degenerative, and neoplastic conditions of the entire spine. This includes minimally invasive spinal procedures.

Above is a loose classification of existing neurosurgical subspecialties and not a complete list. Neurosurgery is an ever-expanding field with emerging new technologies and advancement.

Curriculum updates

The SCFHS neurosurgery training program (SNRTP) is adopting a competency-centered training model within the confines of time-based training. Emphasizing competencies will improve training quality and outcomes, patient wellbeing, and the healthcare system in general. A structured, competency-based neurosurgical curriculum will better prepare residents for independent practice and protect patients from avoidable complications.

The curriculum details the required basic neuroscientific and clinical neurosurgical knowledge and the methods of achieving objectives at different training levels. It will guide program directors and training staff in their efforts to provide residents with the necessary academic, clinical, technical, and professional training. A structured curriculum enables close monitoring of competency milestones to ensure that those promoted to higher training levels have attained the prerequisite competencies.

Under the curriculum, the trainee bears gradually increasing responsibilities. The trainee is supervised by a staff neurosurgeon who grants him/her a certain degree of autonomy in preparation for independent practice after graduation.

Our target neurosurgical competencies are best categorized by the Canadian Medical Education Directions for Specialists (CanMEDS) framework, which is internationally recognized in many training programs because of its comprehensiveness and relevance to specialists' contemporary aspirations. The CanMEDS Framework defines 7 broad roles for physicians that lend themselves to refinement and improvement:

- Medical Expert
- Communicator
- Collaborator
- Leader
- Health Advocate
- Scholar
- Professional

A team of leading neurosurgery educators was assembled to create and examine an SNRTP curriculum centered on these seven CanMEDS roles. The team defined competencies relevant to these roles and responsibilities, explored approaches for teaching and learning them, identified assessment mechanisms, and prepared a set of policies and procedures.

Implementing a competency-centered curriculum requires incorporating the CanMEDS competencies into resident teaching, assessments/examinations, and accreditation standards. The curriculum should be readily available to all health stakeholders. Faculty training, through workshops, seminars, or CanMEDS educators, is essential to incorporating the CanMEDS roles throughout the residency training.

Program Framework

Program structure

The program has a 6-year structure administratively divided into a 3-year junior level (R1-R3) and a 3-year senior level (R4-R6). The junior level primarily focuses on introducing the trainee

to the clinical neurosurgical specialty and informing him/her about general surgical principles and basic neuroscience. During the senior level, the trainee bears progressively increased neurosurgical and administrative responsibilities.

Eighteen months of the 6-year program are spent in surgical and other medical specialties. This period is divided into 6 3-month rotations that are mostly completed during the junior level:

- General surgery
- Critical care
- Neurology
- Neuroradiology
- Neuropathology (can be done at senior level)
- An elective rotation (can be done during any training year except R6)

The elective rotation is offered at any time during the training (except R6) to give the program some structural flexibility and to allow the residents to choose their own subject of interest in their chosen center. The residents will be exposed to new experiences to broaden their knowledge or skill in fields usually outside the core of neurosurgery. Several elective rotations are offered:

- Plastic surgery
- Otorhinolaryngology
- Neurophysiology
- Radiosurgery
- Neuro-ophthalmology
- Neuroanatomy
- Additional neurosurgery exposure
- Neurointervention

The remaining 54 months are devoted to rotations within different neurosurgical disciplines:

- Pediatric neurosurgery (6 months)
- Spinal surgery (6 months)
- Functional surgery (3 months)
- Trauma (6 months)
- Cranial surgery, including neurovascular and neuro-oncological surgery (12 months)
- General neurosurgery including all of the above disciplines and peripheral nerve surgery (21 months)

During the general neurosurgery rotation, the resident has the opportunity to undergo additional training in 1 or more preferred fields.

To facilitate training and the acquisition of skills and knowledge, the curriculum is stratified into 3-year junior and 3-year senior levels. Intense learning is an essential component of training at all levels. In the final year, the resident will acquire the title and status of Chief Resident, and he/she will hone his/her administrative and technical skills in preparation for independent practice after graduation.

Training is conducted at institutions accredited for neurosurgical training by the SCFHS. A list of accredited centers is available from the SCFHS Accreditation Office.

SECTION 2: ACCEPTANCE AND ADMISSION TO THE PROGRAM

Admission to the residency program is highly competitive. The applicants are evaluated against strict criteria to confirm their appropriateness before enrolment.

For details about the admission requirements, **please refer to the general bylaws of training and executive policies of acceptance and registration requirements at the SCFHS website (http://www.scfhs.org.sa/).**

Application requirements:

1. Bachelor's degree in medicine and surgery (MBBS) from a Saudi University or equivalent from recognized universities.
2. The applicant shall be medically fit according to the requirements of the profession applied for.
3. The applicant shall undertake to pay full training, examination, and certification fees.
4. The applicant shall be registered within the Saudi Commission for Health Specialties at the appropriate professional rank.
5. The applicant shall pass the Saudi Licensing examination of the profession, examination held by the Commission, or equivalent.
6. The applicant shall follow the admission procedures in accordance with the implementation rules approved by the Executive Council for Education and Training in a timely manner.

SECTION 3: OUTCOMES AND COMPETENCIES

Introduction to learning outcomes and competency-based education

Training should be guided by well-defined *learning objectives* that are driven by targeted *learning outcomes* of a particular program to serve specific specialty needs. Learning outcomes are supposed to reflect the professional *competencies* that are aimed for trainees to be *entrusted* in upon graduation. This will ensure that graduates will meet the expected demands of the healthcare system in relation to their particular specialty. *Competency-based education* (CBE) is an approach of *adult-learning* that is based on achieving *pre-defined*, *fine-grained*, and *well-paced* learning objectives that are driven by complex professional competencies.

Professional competencies related to healthcare are usually complex and entertain a mixture of multiple learning domains (knowledge, skills, and attitude). CBE is expected to change the traditional way of postgraduate education. For instance, though time of training is a precious resource, it should not be looked to as a proxy for *competence* (e.g. time of rotation in certain hospital areas is not the primary marker of competence). Furthermore, CBE emphasizes the critical role of informed judgment of learners' competency progress, which is based on a staged and formative assessment that is driven by multiple workplace-based observations. Several CBE models have been developed for postgraduate education in healthcare (for example, CanMEDs by the Royal College of Physicians and Surgeons of Canada (RCPSC), the CBME-Competency model by the Accreditation Council for Graduate Medical Education (ACGME), *Tomorrow's Doctors* in the UK, and multiple others). The following are concepts to enhance the implementation of CBE in this curriculum:

- **Competency:** Competency is a cognitive construct assessing the potential to perform efficiently in a given situation based on the standards of the profession. Professional roles (e.g. expert, advocate, communicator, leader, scholar, collaborator, and professional) are used to define competency-role in order to make it identifiable for learning and assessment.
- **Milestones**: Milestones are points along the developmental journey throughout the competency continuum. Trainees throughout their learning journey, from junior and throughout senior levels, will be assisted to transform from being novice/supervised into master/unsupervised practitioners. This should not undermine the role of supervisory/regulatory bodies toward malpractice of independent practitioners. Milestones are expected to enhance the learning process by pacing the training/assessment to match the developmental level of trainees (junior vs. senior).
- **Learning domains:** Whenever possible, efforts should be directed to annotate the learning outcomes with the corresponding domain (K=Knowledge, S=Skills, and A=Attitude). In general, it is advisable to design learning outcomes at the mid-level (i.e. neither too broad nor too specific). For example, "Demonstrate competency in taking a focused pediatrics history and performing a complete and appropriate physical examination (S)." One might have more than one annotation for a given learning outcome.
- **Content-area categorization:** It is advisable to categorize the learning outcomes by the broad content area related to the practice of the profession. For example, in pediatrics some of the content areas are: growth, nutrition, development, adolescent health issues, prevention and healthy lifestyle, diagnosis, and management of childhood diseases.

Mapping of Milestones

The SNRTP curriculum is centered on these seven CanMEDS roles.

- MEDICAL EXPERT
- COMMUNICATOR
- COLLABORATOR
- LEADER
- HEALTH ADVOCATE
- SCHOLAR
- PROFESSIONAL

Medical Expert

- *During the Junior years, the trainee should gain the medical expertise to be able to:*
  1. apply knowledge of the basic and clinical sciences relevant to surgical neurology.
  2. obtain a detailed and accurate medical history
  3. conduct a thorough and accurate general and neurological physical examination
  4. localize the precise anatomical sites of neurological disorders based on clinical findings and investigations
  5. perform a differential diagnosis by evaluating symptoms and signs
  6. outline a medical and surgical management plan
  7. manage common and important perioperative problems
  8. demonstrate the technical skills necessary for neurosurgical procedures (refer to table under Technical skills)
  9. gradually improve clinical decision-making skills so that he/she can function independently at senior level
  10. thoroughly understand the use and interpretation of ancillary diagnostic aids for neurological diseases

- *During the Senior years, the trainee should gain the medical expertise to be able to:*
  1. help junior residents and other health professionals understand the basic science pertinent to particular neurosurgical cases
  2. demonstrate the technical skills necessary for neurosurgical procedures (see table at the end of this section)
  3. write a concise but accurate pre-operative note that includes the following
     Primary diagnosis
     Concurrent diagnoses
     Surgical goals
     Expected course and risks
     Perioperative monitoring
     Management plans
  4. demonstrate the technical skills necessary for neurosurgical procedures (refer to table under Technical skills)
  5. correctly choose and use surgical instruments
  6. properly position patients for surgery
  7. achieve optimal surgical exposure with minimal healthy tissue disruption, blood loss, cosmetic damage, and risk of bacterial contamination
  8. efficiently complete surgeries
  9. properly close surgical wounds with minimal blood loss and infection risk and with optimal chances for wound healing and functional recovery

Communicator

Junior years

- Demonstrates proficient verbal and written communication with patients and their relatives:
  1. Can explain neurological diseases
  2. Can guide patients and their families to sources of reliable information about neurosurgical conditions and coping methods
  3. Can seek and understand feedback from patients and their families regarding care given by oneself and one's team
  4. Can track outcomes of cases in which one has had significant involvement

- Demonstrates proficiency in dictating and charting the following:
  1. Histories
  2. Physical examinations
  3. Consultations
  4. Progress notes
  5. Discharge summaries
  5. Preoperative notes
  7. Operative notes

Senior years

- Demonstrates proficiency in presenting clinical and investigative information at teaching rounds and scientific conferences and can interactively engage the audience and accurately evaluate learning results
- Can list management options and present information needed for informed consent for surgery while confirming that the patient or substitute decision-maker has adequate recall and understanding of that information
- Accurately informs and advises family or other significant associates of procedure completion, expected outcomes and risks, and plans for the early postoperative phase

Collaborator

Junior years

- Can effectively participate in interdisciplinary meetings and demonstrate:
  1. Professional behavior
  2. Respect for healthcare team members' opinions
  3. Comprehension of others' in-depth expertise
  4. Contribution to decision-making

- Demonstrates awareness of his/her limitations and those of other healthcare team members by:
  1. Not anticipating and declining performance of surgery if he/she is unfamiliar with the patient and/or the procedure

- Can interact with physicians and surgeons from other specialties
  1. Understands collective and individual responsibilities in multi-specialty surgeries
  2. Recognizes and respects boundaries between specialties

Senior years

- Can perform surgical procedures accurately and efficiently and demonstrate the following:
  1. Organizes tasks so that the surgical team can perform them efficiently and safely
  2. Anticipates next steps and communicates with team members to avoid unnecessary confusion, stress, and delay
  3. Uses proper technical lexicon in communicating with surgical nurses
- Can help others and himself/herself to become fully aware of each other's strengths and weaknesses in a timely and professional manner

Leader

Junior years

- Can properly use appropriate laboratory aids to document and substantiate the clinical diagnosis
- Demonstrates practical administrative skills such as:
  1. arranging meetings
  2. delegating tasks
  3. chairing meetings
  4. setting schedules
  5. resolving problems with self-control and fairness

Senior years

- Appropriately delegates clinical and scholarly tasks to residents and clerks and evaluates their results
- Obtains informed consent, appropriately discusses the planned surgical intervention with a patient's relevant associates, and demonstrates the ability to prepare for the surgical procedure by
  1. scheduling the procedure based on its urgency and duration
  2. requisitioning the appropriate equipment
  3. assembling a team capable of the procedure
  4. accurately noting potential teaching and learning opportunities and planning for their utilization

Health Advocate

Junior years

- In appropriate circumstances, acts as a health advocate for the patient to facilitate optimal outcomes
- Demonstrates awareness of efficacious prophylactic measures for various at-risk patient groups (e.g., educational interventions)

Senior years

- To be proactive when needed to overcome systemic problems such as access to healthcare resources for diagnosis and treatment
- Understands the determinants of health as they apply to neurosurgical patients and seeks to provide appropriate resources and opportunities for patient health and autonomy

Scholar

Junior years

- Clinical issues: identifies clinical issues that he/she does not fully understand and does the following:
  1. Formulates a clinical question
  2. Identifies his/her own knowledge and its limitations
  3. Develops a plan for appropriate research
  4. Assimilates and analyzes the material available
  5. Consults other physicians and allied health care personnel as needed
  6. Proposes a solution to the clinical question
  7. Implements the solution
  8. Evaluates the solution's efficacy
  9. Formulates relevant new clinical questions

- Research issues: demonstrates ability to
  1. generate a research question
  2. review relevant literature
  3. assimilate the literature
  4. identify and collaborate with appropriate personnel
  5. write a research proposal
  6. conduct the research
  7. disseminate the results by presenting at conferences, writing a paper for publication, and identifying future research possibilities

- Educational issues: demonstrates ability to
  1. understand the principles of self-directed learning
  2. teach clinical clerks and undergraduates the various clinical and surgical aspects of neurosurgery
  3. impart appropriate clinical information to allied health personnel
  4. review textbooks, papers, and other publications prior to surgery and be comfortable with the surgical approach prior to the operation
  5. prepare for neuroscience rounds and neurosurgical seminars despite busy schedule
  6. study and use hardcopy and electronic sources to gather information relating to observations in the emergency room, clinics, and neurosurgical wards

Senior years

- Accurately, consistently, and conspicuously incorporates evidence-based research and guidelines into treatment decisions and discussions, particularly noting points of controversy and progress
- Supports, attends, and often organizes educational sessions for the neurosurgical team

Professional

Junior years

- Professionally interacts with patients, relatives, his/her peers, and other healthcare personnel
- Respects the opinions of others
- Provides care in an honorable and ethical manner
- Can evaluate his/her knowledge and abilities and their limitations

- Addresses his/her limitations by asking for help from colleagues when he/she is uncomfortable with a clinical situation
- Demonstrates a keen sense of responsibility and compassion

Senior years
- Demonstrates appropriate continuing patient care by completing and documenting frequent postoperative visits to ensure that patients' needs for comfort, safety, information, and optimal outcomes are met
- Helps guide junior residents in all aspects of their learning and training
- Evaluates himself/herself and fellow health professionals in an accurate, effective, professional, and timely manner

Continuum of Learning

This includes learning that should take place in each key stage of progression within the specialty. Trainees are reminded of life-long Continuous Professional Development (CPD). Trainees should keep in mind the necessity of CPD for every healthcare provider in order to meet the demands of their vital profession. The following table states how the role is progressively expected to develop throughout junior, senior, and consultant levels of practice.

Undergraduate	Postgraduate		Continuous Professional Development
	R 1-3 (Junior Level)	R 4-6 (Senior Level)	
Non-practicing	Dependent/supervised practice	Dependent/supervised practice	Independent practice/provide supervision
Pre-entrustable	Approaching entrustable	Approaching entrustable	entrustable
Obtain basic health science and foundational level to core discipline knowledge	Obtain fundamental knowledge related to core clinical problems of the specialty	Apply knowledge to provide appropriate clinical care related to core clinical problems of the specialty	Acquire advanced and up-to-date knowledge related to core clinical problems of the specialty
Internship to the practice of discipline	Apply clinical skills such as physical examination and practical procedures related to the core presenting problems and procedures of the specialty	Analyze and interpret the findings from clinical skills to develop appropriate differential diagnoses and management plan for the patient	Compare and evaluate challenging, contradictory findings and develop expanded differential diagnoses and management plan

SECTION 4: TEACHING AND LEARNING

Learning is achieved through the following formats:

1. Self-directed learning: This is the principal form of learning in which the trainee, independently or with assistance, takes initiative and responsibility for identifying his/her learning needs, formulating learning goals, choosing and implementing appropriate learning strategies, and evaluating learning outcomes.
2. Core Education Program: A formal education and training program that includes
   a. universal topics
   b. core specialty topics (e.g., city-wide 3 hours per week of academic activity)
   c. self-selected topics
   d. courses, workshops, and simulations
   e. professional development topics
   f. research skills: the trainee is encouraged to participate in research projects anytime during their training
3. Practice-based learning that includes
   a. clinical case-based learning
   b. morning reports and discussion
   c. case presentations and grand rounds
   d. morbidity and mortality reviews
   e. journal clubs and evidence-based neurosurgery
   f. neuroradiology and neuropathology sessions
   g. multidisciplinary case discussions (e.g., tumor board)

The weekly academic activities vary between training sites. Each week features 6-12 hours of education including 3 hours of formal teaching.

4. Technical skills and procedural milestones

Self-directed Learning

Part of the trainee education should be performed inside and outside the formal channel. By the end of the training period the following topics should covered. The three self-directed learning domains are Basic science, General Knowledge, and Neurosurgical Knowledge (for listing of topics refer to Appendix 6).

Core Education Program

Universal Topics

These are high-value, interdisciplinary topics of utmost importance to the trainee. They are centrally delivered by the SCFHS through an e-learning portal. The duration of each topic is 1.5 hours, and it is followed by an online formative assessment. After completion of all topics, there is a combined summative multiple-choice test for further details about each module objectives and content (refer to e-learning portal).

All 16 topics should be completed within the 3-year junior level of training. These topics are:

R1 topics
1. Hospital-acquired infections *(module 1)*
2. Sepsis, systemic inflammatory response syndrome, and disseminated intravascular coagulation *(module 1)*
3. Blood transfusion *(module 1)*
4. Side effects of chemotherapy and radiation therapy *(module 2)*
5. Managing hypotension and hypertension *(module 4)*
6. Fluids management for inpatients *(module 5)*
7. Managing electrolytes imbalances *(module 5)*

R2 topics
1. Preoperative assessment *(module 5)*
2. Postoperative assessment *(module 5)*
3. Managing acute pain *(module 5)*
4. Managing chronic pain *(module 5)*

R3 topics
1. Occupational hazards for healthcare workers *(module 7)*
2. Patient advocacy *(module 7)*
3. Ethical issues: transplantation/organ harvesting and withdrawal of care *(module 7)*
4. Ethical issues: treatment refusal and patient autonomy *(module 7)*
5. Role of doctors in death and dying *(module 7)*

Core Specialty Topics

Knowledge
Each week involves a city-wide 3-hour formal interactive supervised teaching activity covering topics including neurosurgical anatomy, pathophysiology, clinical neurosurgery, and common neurosurgical techniques. They are distributed over the following subjects to cover the main neurosurgical subspecialties:
1. Spinal surgery
2. Functional surgery
3. Neurovascular surgery
4. Neuro-oncology
5. Pediatric neurosurgery
6. General neurosurgery

The trainee is relieved of clinical duties for the 3 hours of the weekly session.

The trainees take the lead in preparing and presenting these sessions, though staff neurosurgeons provide supervision and contribute ideas. The sessions consist of trainees giving short didactic lectures and case presentations to each other under the moderation of staff neurosurgeons.

Each subject is reviewed for 3 months. Three subject reviews occur in a year, and all 6 form a cycle that is repeated every 2 years. The first year covers spinal, functional, and neurovascular surgery while the second-year covers neuro-oncology, pediatrics, and general neurosurgery. This 2-year cycle is important for the end of year promotion exam (please refer to the corresponding appropriate section blueprint).

Reviewed subject	Learning outcomes
Spinal surgery	▪ Understand and review the anatomy of different spinal regions with an emphasis on junctional zones ▪ Recognize the basic biomechanics of different spinal regions and how they relate to spinal anatomy ▪ Review the pathogeneses of different spinal pathologies and how they impact treatment ▪ Understand basic spinal cord anatomy and its blood supply, pathological conditions, and related clinical presentations ▪ Understand the pathology, assessment, and modern treatment of spinal cord injuries ▪ Recognize critical signs and know how to respond to various spinal emergencies ▪ Discuss various spinal pathology cases and demonstrate the ability to choose appropriate treatment options ▪ Understand the scientific literature and the latest seminal articles
Functional surgery	▪ Understand the principles of stereotactic surgery and the basic science of basal ganglia and motor circuits ▪ Understand surgeries for movement disorders ▪ Understand surgeries for epilepsy ▪ Understand neurosurgeries for pain ▪ Understand other current applications of functional neurosurgery
Neurovascular surgery	▪ Understand the neurovascular anatomy of the brain and spinal cord ▪ Understand the pathophysiology of various neurovascular problems affecting the brain and spinal cord ▪ Can diagnose and manage all neurovascular lesions ▪ Understand various surgical approaches and techniques for vascular lesions ▪ Selects appropriate techniques for managing these lesions, including neuro intervention procedures and radiosurgery
Neuro-oncology	▪ Understand the basic pathological descriptions of intracranial tumors affecting the brain, skull base, spinal cord, and peripheral nerves ▪ Understand the latest molecular genetics research into brain neoplasms ▪ Understand the clinical presentations of patients with brain tumors and understand different assessment and treatment options ▪ Be able to plan and execute standard and complex surgical approaches ▪ Clearly understand intracranial brain cysts, non-neoplastic lesions, and other benign pathologies

Pediatric neurosurgery	▪ Understand the importance of minimal blood loss and proper technique to avoid excessive blood loss ▪ Understand the basic pathological descriptions of common congenital anomalies in spinal dysraphysim, hydrocephalus, and encephalocele ▪ Understand the principle mechanics, genetic basis, and management of craniosynostosis and syndromic craniosynostosis ▪ Understand the genetics of infantile and pediatric brain tumor ▪ Understand the clinical presentation of phakomatosis or neurocutaneous tumor genetics and management of different types
General neurosurgery	▪ Understand the perioperative management of neurosurgical patients and how to avoid complications ▪ Understand positions and approaches for neurosurgical procedures ▪ Is familiar with the neurosurgical armamentarium ▪ Understand the pathophysiology, types, critical care, and timely surgical management of head trauma ▪ Understand the indications and outcomes for brain injury rehabilitation ▪ Understand the pathophysiology, diagnosis, and management of peripheral nerve entrapments, injuries, and neoplasms ▪ Can recognize, diagnose, and manage various nervous system pathogens, with emphasis on immunocompromised cases and common infections

Practice-based learning

Practice-based learning essentially involves orienting the resident to decision-making regarding fact collection on actual medical problems. In other words, residents confront contextualized, counter-intuitive problems and strive to find meaningful solutions.

Activity	**Objectives** *Trainees will learn to do the following:*
Clinical case-based learning	▪ Generate explanatory hypotheses for patients' problems that refer to anatomical locations, pathophysiological processes, and etiological mechanisms ▪ Conduct a focused inquiry to obtain the information necessary to confirm or reject a hypothesis ▪ Analyze clinical data based on hypotheses concerning the basic mechanisms responsible for symptoms, signs, and laboratory findings ▪ Synthesize acquired data into an organized, developing picture of the patient's problem ▪ Design an appropriate intervention and management plan
Morning reports and discussion	▪ Educate all attending residents, monitor patient care, and review management decisions and their outcomes ▪ Develop competence through short scientific and informative presentations on all admitted patients ▪ Develop confidence in systematically presenting complex cases ▪ Learn to appropriately perform differential diagnoses and develop proper management plans

Case presentations and grand rounds	▪ Present a comprehensive history and physical examination with details pertinent to the patient's problem ▪ Formulate a list of all problems identified in the history and physical examination ▪ Develop a proper differential diagnosis for each problem ▪ Formulate a diagnosis and treatment plan for each case ▪ Present a follow-up patient's case in a focused, problem-based manner that includes pertinent new findings and diagnostic and treatment plans ▪ Demonstrate a commitment to improving case presentation skills by regularly seeking feedback
Morbidity and mortality reviews	▪ Learn from complications and errors ▪ Modify behavior and judgment based on previous experiences ▪ Avoid repetition of errors leading to complications ▪ Identify areas for improvement for clinicians involved in case management
Journal clubs and evidence-based neurosurgery meetings	▪ Systematically appraise and assimilate scientific evidence from journal articles ▪ Apply knowledge of study designs and statistical methods to appraise clinical studies and other sources of information on diagnostic and therapeutic effectiveness ▪ Cite specific articles in future grand rounds or morning rounds presentations or in charts of patients with relevant conditions ▪ Facilitate the education of other residents ▪ Synthesize information from articles with knowledge of relevant clinical and basic sciences to achieve an analytical and investigative approach to patient care ▪ Encourage all group members to participate, especially those who have difficulty doing so
Neuroradiology and neuropathology sessions	▪ Discuss cases of interest, describe radiological findings, and elaborate on the differential diagnosis ▪ Review pathological slides and discuss the findings with neuropathologists
Multidisciplinary case discussion (e.g., tumor board)	▪ Participate in multidisciplinary discussions of new diagnoses and review cases of cancer within an appropriate timeframe to facilitate effective treatment planning ▪ Use all available information and evidence to determine the most appropriate treatment plan for each patient ▪ Participate in educational opportunities for team members and trainees

Skills

Common neurosurgical procedures

A full list of neurosurgical procedures would be too extensive to present here, but a list of major groupings can be presented:

- Procedures related to head trauma (e.g., burr holes, craniotomies, and craniectomies)
- Cerebrospinal fluid (CSF) diversions
- Closure and repair of spina bifida disorders
- Craniotomies for intracranial masses
- Craniotomies and craniectomies for vascular disorders
- Transsphenoidal and skull base approaches
- Endoscopic procedures
- Discectomies and decompressive laminectomies
- Spinal instrumentations and fusions for degenerative diseases and trauma
- Epilepsy procedures
- Movement disorder procedures
- Peripheral nerve procedures

Technical skills

	Independent component (without step-by-step supervision)	**Assisting/supervised component (step-by-step supervision)**

R1	• Sterile technique
	• Professional behavior in operating team
	• Postoperative patient transfer
	• Urinary catheter insertion
	• Wound dressing
	  ○ Cranial wounds
	  ○ Spinal wounds
	  ○ Limb wounds
		General
		• Lumbar puncture
		• Ventriculostomy and lumbar drain
		• Preoperative skin preparation and draping
		• Preoperative patient registration in the neuronavigation system
		• Understanding of surgical equipment
		  ○ Microscope
		  ○ Ultrasonic aspirator
		  ○ Craniotome/high-speed drill
		• Craniotomy closure (bone to skin)

R2	• All R1 supervised activities • Accurately listing goals and risks of surgical procedures • Accurately naming surgical instruments • Preoperative patient registration into the neuronavigation system	**General** • Operating hemostatic tools • Surgical exposure (skin to dura) • Decompressive craniectomy **Trauma** • Elevation of depressed skull fractures • Surgical management of extra-axial hematomas **Tumor** • Positioning for supratentorial craniotomies • Positioning for transsphenoidal surgery **Pediatrics** • Ommaya reservoir placement • Ventricular tap

		Spinal • Positioning for surgery • Posterior approach exposure (skin to bone) **PNS** • Nerve/muscle biopsy
R3	• All R2 supervised activities • Accurately estimating procedure duration and expected blood loss	**General** • Bone flap re-implantation/cranioplasty • Opening dura **Trauma** • Surgical management of complex skull fractures • Surgical management of intra-axial hematomas **Tumor** • Intracranial tumor resection **Pediatrics** • Ventriculoperitoneal shunts **Functional and epilepsy** • Stereotactic brain lesion biopsy **Spinal** • Skeletal traction application • Closure of spinal dura • Posterior approach exposure (skin to dura) **PNS** • Carpal tunnel syndrome
R4	• All R3 supervised activities	**Tumor** • Craniectomy for posterior fossa tumors • Transsphenoidal resection of pituitary adenoma **Pediatrics** • Simple craniosynostosis **Functional and epilepsy** • Stereotactic calculation of target coordinates • Vagus nerve stimulation • Frontal lobectomy **Spinal** • Chiari malformation decompression • Anterior approach exposure (skin to bone) • Applying lumbar pedicle screws **PNS** • Surgical management of entrapment neuropathy • Primary nerve anastomosis

R5	• All R4 supervised activities	**Tumor** • Craniotomy for complex tumors **Pediatrics** • Complex craniosynostosis repair • Repair of myelomeningoceles **Functional and epilepsy** • Stereotactic electrode placement • Anterior temporal lobectomy **Vascular** • Surgical clipping of simple aneurysms **Spinal** • Anterior cervical discectomy • Spinal tumor removal • Applying thoracic and subaxial cervical screws
R6	• All R5 supervised activities	**Tumor** • Craniotomies for complex skull base tumors **Pediatrics** • Neuro endoscopy in the cranial cavity **Functional and epilepsy** • Lesionectomy • Corpus callosotomy • Awake craniotomy **Vascular** • Surgical management of complex aneurysms • Resection of supratentorial vascular malformations **Spinal** • Applying axial cervical screws • Advanced spine instrumentation **PNS** • Brachial plexus surgery • Resection of peripheral nerve tumors

To reach the milestones discussed below, the trainee is expected to perform different procedures at various training levels, though the expectations are subject to personalized assessments and evaluations of the residents' abilities. Please refer to the table in Appendix 1. As indicated in this table, the minimum number of cases expected per year is as follows (these numbers may vary by +/-10% due to the different rotations performed by trainees each year):
R1 Level: 100 cases/year
R2 Level: 110 cases/year
R3 Level: 120 cases/year
R4 Level: 140 cases/year
R5 Level: 150 cases/year
R6 Level: 100 cases/year

Attitude

The residents will be monitored during his/her daily activities for attitude and behavior skills. A multisource feedback will be used to assess the progression and to correct the areas for improvement. The behavior skills that are most required in neurosurgery residents before graduation are mainly good interpersonal and communication skills. The residents are expected to act and participate in the patients' care according to the expected level of responsibility and to communicate appropriately with the medical personnel and the patients and their families. The residents are expected to be responsible for their patient and demonstrate their responsibility in preoperative, intraoperative, and postoperative management periods with a high level of confidentiality.

Courses and workshops

This is a list of example courses and workshops that are currently running, and residents are recommended to take them. It is far from exhaustive. New courses, workshops, and simulation centers are expected to emerge in the near future.

Course name	Principles	SCFHS resident training level
Neurosurgery Boot Camp	Intensive 2-day course for the upcoming neurosurgical trainees to expose them to the basic knowledge and skills to facilitate the beginning of their residency.	Junior level
Basics of Drilling	High-speed drilling is a basic neurosurgical skill. This hands-on course teaches basic skills and techniques for high-speed drilling at the skull and skull base. It starts with simple "dry" exercises to familiarize trainees with different burr types for different indications.	Junior level
Basic Neurosurgical Approaches	This course covers basic neurosurgical techniques and clinical knowledge necessary for residents to advance in neurosurgery. A key feature is the practical skills training on cadaveric material. It provides instruction in: • Frontotemporal craniotomies • Bifrontal craniotomies • Parasagittal craniotomies • Posterior fossa craniotomies	Junior level
Basic Operative Surgical Skills (BOSS)	This course introduces trainees to safe surgical practice within a controlled workshop environment. It aims to teach, assess, and certify the ability to use safe, sound surgical techniques that are common to all forms of surgery. The course covers: • Safe operating practices, gowning, and gloving • Handling of surgical instruments • Suturing techniques • Safe surgical knots • Tissue handing and wound management	Junior level

Advanced Trauma Life Support (ATLS)	ATLS trains medical providers in acute trauma management, with an emphasis on treating the greatest threat to life first. It stresses that the lack of a definitive diagnosis and detailed history should not delay the application of indicated treatments for life-threatening injuries, with the most time-critical interventions performed first.	Junior level
Neurolife (Neurocritical Care Course)	The neurocritical course program focuses on the latest evidence-based management of all aspects of neurocritical care. This 1-day course includes a combination of didactic, case-based, and evidence-based guideline review, as well as interactive case discussion workshops and multimodal monitoring case review. It is usually held in collaboration among the Saudi Association of Neurological Surgery Society (SANS) and the Neurocritical Care Chapter of the Saudi Critical Care Society (SCCS).	Junior and Senior levels
Microsurgery Course	This course covers the use of operating microscopes, micro instruments, and micro sutures. Participants are trained in vessel dissection, various microsurgical techniques, arterial and venous end-to-end and end-to-side anastomosis, and vascular graft preparation and placement.	Junior level
Skull Base Approaches (Open Advance and Endoscopic Advanced)	This workshop provides neurosurgeons, fellows, and residents the opportunity to enhance their own skills in a variety of surgical and endoscopic skull base approaches. The participants: • review and perform surgical approaches to the anterior, lateral, and posterior skull base on cadaveric specimens, under the direction of world-class faculty • perform endoscopic approaches to the anterior skull base • discuss the surgical techniques and complexity of the various surgical skull base approaches, view surgical videos, and interact with world-renowned experts in the field • discuss complication avoidance	Senior level

Spine Update	This course covers degenerative spinal diseases, spinal trauma, spinal cord injuries, and spinal tumors. The latest technologies, including motion preservation, and minimally invasive spinal surgery are addressed in full reviews and scientific debates throughout the conference. It includes a 1-day hands-on cadaveric workshop that covers common surgical approaches to the cervical, thoracolumbar, and lumbar spine including lumbar discectomy. The workshop uses Thiel-embalmed human cadavers to provide a realistic operating room experience. Presentations are kept to a minimum so that most of the day is spent practicing operative skills.	Junior and Senior levels
Arab Spine Course Diploma	This course aims to establish Arab education standards, both for spine specialists in training and as part of continuous medical education that utilizes research and advocacy to promote the highest quality of treatment and prevention-based spinal care.	Senior level
Peripheral Nerve Course	This course focuses on peripheral nerve surgical anatomy. The lectures provide an overview of recent advances in nerve injury, healing, repair, and rehabilitation. Throughout the workshop, participants can refine their surgical skills in nerve repair and nerve grafting/transfers.	Junior and Senior levels
Virtual Reality (VR) Neurosurgical Skill Training Course	The use of currently available neurosurgical skill training VR simulation technologies is expected to help trainees exercise some basic and intermediate skills on the VR platform in a safe environment. The equipment is available to trainees during courses or independently in 2 institutions at this point. King Fahad Medical City and King Abdelaziz University Hospital (NeuroVR® and ImmersiveTouch®).	Junior and Senior levels
Chicago Review Course Chicago, USA	An intensified 1-week course with 10-hour daily lectures in all aspects of neurosurgery neuroanatomy, neurophysiology, and pathology, usually attended by neurosurgery residents before the final exam in North America. This is a intensive review course more than an education.	Senior level

SECTION 5: ASSESSMENT

Formative Assessment

General Principles

Trainees, as adult learners, should strive for feedback throughout their journey of competency from "novice" to "mastery" levels. *Formative assessment* (also referred to as continuous assessment) is the component of assessment that is distributed throughout the academic year, aiming primarily to provide trainees with effective feedback. Input from the overall formative assessment tools will be utilized at the end of the year to make the decision of promoting each individual trainee from current to subsequent training level. Formative assessment will be defined based on the scientific council recommendations (usually updated and announced for each individual program at the start of the academic year). According to the executive policy on continuous assessment (available online: www.scfhs.org), formative assessment will have the following features:

a. Multisource: minimum four tools.
b. Comprehensive: covering all learning domains (knowledge, skills, and attitude).
c. Relevant: focusing on workplace-based observations.
d. Competency-milestone oriented: reflecting trainees' expected competencies that match their developmental level.

Trainees should play an active role in seeking feedback during their training. Also, trainers are expected to provide timely and formative assessment. SCFHS will provide an e-portfolio system to enhance communication and analysis of data arising from formative assessment.

Tools for Formative Assessment

Formative assessment complies with the updated general policy of SCFHS that includes promotion criteria and selection of tools and is divided into knowledge, skills, and attitudes. Trainees and trainers are advised to follow any adjustments by the scientific council. The following table summarizes the assessment tool that was approved at the time of this curriculum approval:

Level of training (year)	Knowledge	Skills	Attitude
1-5	1- Percentage of attendance of the weekly half-day academic activities. 2- End of year promotion examination 3- SOE	Logbook and DOPS	In-Training End of Rotation reports (ITERs)
6	1- SOE	Logbook and DOPS	1- In-Training End of Rotation reports (ITERs) 2- MiniCEX

Academic Activities Attendance (AAA) (Knowledge Parameter)

Attendance of the obligatory weekly academic activities organized by SCFHS is counted each session. The percentage of attendance will indicate the AAA mark. The activities are held and broadcasted every Tuesday from 1:00-4:00pm across all programs throughout the Gulf. The activities are organized by the regional program directors. Attendance of 70% or more of this weekly activity is required to pass this parameter.

Two exemptions:

1- Sixth year residents are exempt from this activity but allowed to attend if they want and freed from clinical obligations only if they are attending. Sixth year residents will be given 100% in this parameter.
2- Fifth year residents should attend 50% or more to get a borderline pass.

End of Year Promotion examination (Knowledge Parameter)

This annual examination is prepared by the training committee, with 80% of the examination covering the topics given during the weekly academic activities in that year (please refer to the core specialty topics section above). The blueprint below alternates according to the academic year cycle.

Blueprint Outlines

The content of the following table is for demonstration only; please refer to the most updated version published on the SCFHS website.

End-of-year written neurosurgery examination (Cycle 1: Spine, functional, and neurovascular) blueprint

TOPICS	%
Clinical and operative neurosurgery	
Neuro-oncology	3
Pediatric neurosurgery	3
Spinal surgery	15
Cranial trauma	4
Neurovascular surgery	15
Infections	3
Functional neurosurgery	15
Peripheral nerve surgery	3
General neurosurgical principles, approaches, and adjuvant therapies	15
Basic neurosciences and practice-related topics	
Neurosurgical anatomy	10
Neuropathology, molecular biology, neuroradiology, and diagnostic approaches	5
Pathophysiology, neurophysiology, and neurology	3
Neurocritical and general care, pharmacology, and neuroanesthesia	3
CanMEDS roles and research skills	3
Total	100%

Note: Blueprint distributions of the examination may differ up to +/-3% in each category.

Blueprint Outlines

The content of the following table is for demonstration only, please refer to the most updated version published on the SCFHS website.

End-of-year written neurosurgery examination (Cycle 2: Neuro-oncology, pediatrics, and general neurosurgery) blueprint

TOPICS	%
Clinical and operative neurosurgery	
Neuro-oncology	15
Pediatric neurosurgery	15
Spinal surgery	3
Cranial trauma	10
Neurovascular surgery	3
Infections	7
Functional neurosurgery	3
Peripheral nerve surgery	10
General neurosurgical principles, approaches, and adjuvant therapies	10
Basic neurosciences and practice-related topics	
Neurosurgical anatomy	10
Neuropathology, molecular biology, neuroradiology, and diagnostic approaches	5
Pathophysiology, neurophysiology, and neurology	3
Neurocritical and general care, pharmacology, and neuroanesthesia	3
CanMEDS roles and research skills	3
Other	
Total	100%

Note: Blueprint distributions of the examination may differ up to +/-3% in each category.

In-Training End of Rotation reports (ITERs) (Attitude Parameter)

Formerly this was referred to as the end of rotation evaluation. Typically, this evaluation is done 4 times per year concluding each 3-month rotation. In case of shorter rotations, the ITERs would be given for that period and averaged with the rest of the ITERs of the same 3-month period according to its weight. It is crucial that marking per each item in the ITERs and the overall marking truly reflects the resident's performance.

According to this:

1. a resident who clearly performs at level appropriate to their year of training should "Clearly Pass" the rotation if they score 70% or above.
2. a borderline pass resident should be assigned a mark between 60 to 69.4%.
3. a borderline fail resident should be assigned a mark between 50 to 59.4%.
4. a clear failure is a mark below 50%.
5. Please refer to the guidelines outlined in the SCFHS executive policy of continuous assessment.

Structured Oral Exam (SOE)

This SOE is conducted once every year. It is prepared and conducted by the training committees.

Surgical Logbook and DOPS (Skills Parameter)

Submission of the logbook for surgical rotation for 1st and 2nd year residents is sufficient to obtain a "clear pass," with "borderline fail" for submission of incomplete logbook and "clear fail" for not submitting a logbook. Any resident beyond their 2nd year should at least submit 4 DOPS per year and a surgical logbook appropriate to their level of training (please refer to Appendix, Table 1). This is an ongoing assessment; the final mark will be given to the trainee at the end of each rotation during the end of rotation face-to-face evaluation.

By the end of the academic year, the trainee should have 4 independent DOPS evaluations (one every three months) The average calculated yields 50% in addition to 50% for the logbook.

Forms

- Trainees and evaluators should use the One45 system and the SCFHS approved forms to document DOPS and Logbook. Please refer to Appendix 3, 4, and 5.
- We encourage all trainees to keep a summary of their annual surgical procedures using the table attached in Appendix 2.
- The marks for all parameters will be graded according to the SCFHS guidelines:
- The marking of each continuous assessment tool is based on the guidelines outlined in the SCFHS executive policy of continuous assessment. A graded scoring system will be applied for each assessment tool (clear pass, borderline pass, clear fail, borderline fail). Trainees should satisfactorily pass each tool. Comprehensive assessment can be applied for borderline failure: refer to the policy on the SCFHS website.

Continuous holistic appraisals and assessments

Mid-rotation assessments and feedback

Before completing the first half of any rotation, the trainer/mentor should meet one-to-one at least once with his/her trainee especially if there are any concerns that may yield an undesirable ITER or DOPS. This would be a form of a non-creditable formative evaluation that serves as a constructive feedback for the trainee, the minutes of such meetings should be documented confidentially. Tools such as MiniCEX and others may be used.

Resident portfolio

This contains everything the resident has done over his/her period of training, including and not limited to courses, workshops, community work, elective rotations attended, publications, research work, recommendation letters by key figures, and so on.

Summative Assessment

These examinations are a responsibility of the Examination committee of the Saudi Commission for Health Specialties. This committee is independent of the Scientific Council of Neurosurgery training program.

The Saudi Board has 2 examinations:
A. Part 1 neurosurgical principles examination
B. Final neurosurgery examination:
    1. Final written examination
    2. Final Objective Structured Clinical Examination (OSCE)

A. Part 1 Examination

The Part 1 Examination of the Saudi Board shall cover applied basic health sciences related to the specialty. This examination is not applicable to other postgraduate training programs such as diplomas and fellowships.

Requirements to take the examination are as follows:

1. Completion of at least 9 months' training in any of the Saudi Board certificate programs.
2. Valid registration in any of the Commission postgraduate programs.
3. Any other conditions approved by the Council of Education and Training.
4. Completion of the examination registration process within the specified period.

General Provisions

1. The trainee may not be promoted from junior to senior level (as determined by the relevant Scientific Council) unless he/she passes the Part 1 Examination of the Saudi Board.
2. Exemption from the examination due to the completion of any other previous postgraduate studies/examinations has to be approved by the Central Training Committee.
3. The Part 1 Saudi Board examination will be held once each year on a date published on the Commission website.
4. Candidates are allowed a limited number of attempts to pass the Part 1 Saudi Board examination, before being dismissed from the program (refer to SCFHS assessment executive policy).
5. For further and updated details regarding exam policy and regulations please refer to general bylaw and executive policy of assessment (available on SCFHS website).

Examination Format

1. The Part 1 examination of the Saudi Board certificate shall consist of one paper with 120-150 multiple-choice questions (single best answer out of 4 options). Ten unscored items can be added for pretesting purposes.
2. If any other assessment format is used, the Central Assessment Committee must agree to its implementation and changes will be announced.

Suggested References

1. *Schwartz's Principles of Surgery* textbook (Basic Principles of Surgery section)
2. Schwartz's principles of surgery: ABSITE and board review
3. *Rush University Medical Center Review of Surgery*
4. *Handbook of Neurosurgery* 8th Edition by Mark S. Greenberg. Anatomy, Physiology, and General Neurosurgery sections
5. *Youmans Neurological Surgery* textbook (Basic Science and General Neurosurgery sections)
6. *Comprehensive Neurosurgery Board Review* by Jonathan Citow (Anatomy, Physiology, and Critical Care sections)

Note:
This list is intended for use as a study aid only. SCFHS does not intend the list to imply endorsement of these specific references, nor are the exam questions necessarily taken solely from these sources.

Blueprint Outlines

The content of the following table is for demonstration only, please refer to the most updated version published on SCFHS website.

Sections	%	Domains				
		Diagnosis and Basic Knowledge	Investigation	Treatment	Health Care Promotion and professionalism	Total
Principles of Surgery	50%					50%
Fluids, Electrolytes, and Acid-Base Balance	(10%)	4%	3%	3%	-	
Shock and Haemostasis	(10%)	4%	2%	4%	-	
Surgical Infections and Antibiotics	(10%)	4%	2%	4%	-	
Perioperative Management and Surgical Critical Care	(10%)	3%	3%	4%	-	
Wounds and Wound Healing	(10%)	6%	1%	3%	-	
Basic Principles of Neuroscience	20%					20%
Neuro-anatomy	(5%)	4%	1%	-	-	
Neurophysiology	(5%)	3%	2%	-	-	

Neurological examination skills	(5%)	5%	-	-	-	
Neurochemistry and pharmacology	(5%)	2%	1%	2%	-	
Basic Principles of Neurosurgery	20%					**20%**
Raised ICP, Cerebral Edema, and Brain Herniation	(10%)	4%	2%	4%	-	
Hydrocephalus and Basic Neurosurgical approaches	(5%)	3%	1%	1%	-	
Neuotrauma	(5%)	3%	1%	1%	-	
Research and Ethics	**10%**	**-**	**-**	**-**	10%	**10%**
Total	**100%**					**100%**

Note: Blueprint distributions of the examination may differ up to +/-3% in each category.

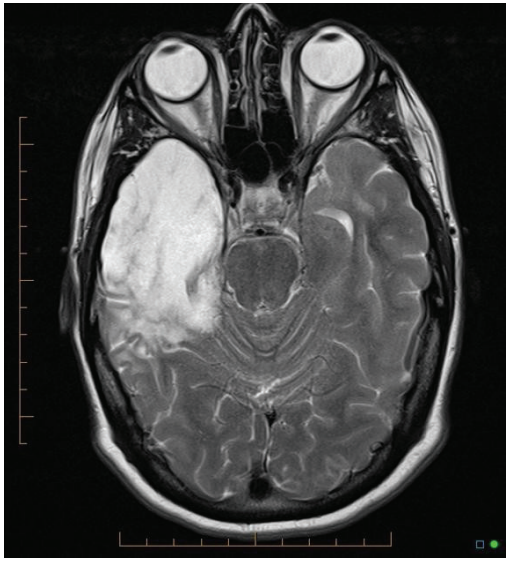
Example Questions for K2

Question 1

An otherwise healthy 31-year-old male is involved in a motor vehicle accident. When he presents to ER, a dilated right pupil was identified. He was obeying commands and moving all limbs with a Glasgow Coma Scale score of 15 points. CT brain scan revealed a fracture at the right frontal base extending to the orbital apex.

Which of the following is the most appropriate explanation for his dilated pupil?
A. Anterior transtentorial herniation
B. Right optic nerve injury
C. Horner syndrome
D. Large right temporal extradural hematoma

Question 2



A 21-year-old male came to the clinic with a visual field chart showing left upper quadrantanopia after neurosurgical intervention to treat epilepsy. MRI of brain is shown.

Which of the following is the pathomechanism of his visual field defect?
A. Meyer's loop injury
B. Lateral geniculate body injury
C. Optic tract injury
D. Optic nerve injury

Example Questions for K1

Question 3

A 24-year-old male presents with right/left dissociation, impaired calculation function, finger agnosia, and agraphia. He has right-sided hemiparesis, however, he failed to appreciate his weakness.

Which of the following describes his neurological dysfunction?

A. Ideational apraxia
B. Dejerine-Roussy syndrome
C. Akinetic mutism
D. Gerstmann's syndrome

Question 4

A 24-year-old man sustains a head trauma and is found to have an ecchymosis behind the ear that is indicative of which of the following?
A. Frontal bone fracture
B. Parietal bone fracture
C. Skull base fracture
D. Orbital bone fracture

B. Final neurosurgery examination

Objectives

1. Determine whether the trainee has sufficient competency related to the required specialty.
2. Determine the eligibility for entering the final clinical examination.

General Provisions

1. Trainees will be required to pass the final written exam in order to be eligible to sit for the final OSCE exam.
2. The final written examination for Saudi Board certificates will be held once each year.
3. The final written examination may not be repeated.
4. Examination dates shall be provided by the Specialty Examination Committee in accordance with the approved annual schedule submitted by the Executive Assessment Administration.
5. The candidate remains eligible for the final written examination for a period not longer than 3 years after completion of training provided that he/she presents evidence of continuing clinical practice.
6. For further and updated details regarding exam policy and regulations (e.g. eligibility to sit for exam, number of attempts, etc.) please refer to general bylaw and executive policy of assessment (available on the SCFHS website).

Examination Format

A Saudi Board final specialty written examination shall consist of 2 papers each with 100 SBA MCQs. Ten unscored items can be added for pretesting purposes.

Passing Score

As these regulations are subject to change, updated details regarding exam policy, regulations, and passing score are available in the general bylaw and executive policy of assessment (available on the SCFHS website).

Suggested References

1. *Youman's Neurological Surgery latest edition*
2. *Schmidek and Sweet: Operative Neurosurgical Techniques*
3. *Handbook of Neurosurgery* by Mark Greenberg
4. *Neuropathology: A Reference Text of CNS Pathology* by David Ellison et al.

5. *The Human Nervous System* by John Kiernan
6. *WHO Classification of Tumours of the Central Nervous System* from The International Agency for Research on Cancer
7. *Rhoton's Cranial Anatomy and Surgical Approaches* by Albert Rhoton

Note:
This list is intended for use as a study aid only. SCFHS does not intend the list to imply endorsement of these specific references, nor are the exam questions necessarily taken solely from these sources.

Blueprint Outlines

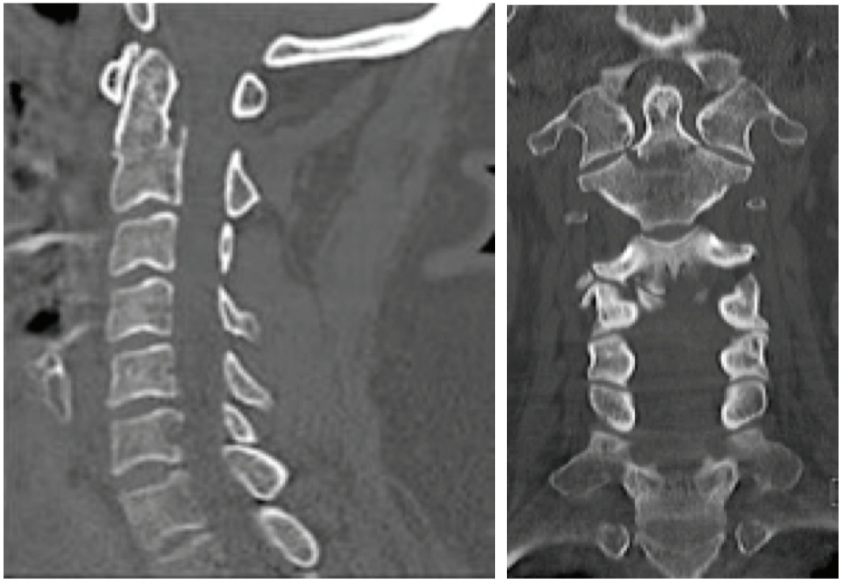
The content of the following table is for demonstration only; please refer to the most up-to-date version published on the SCFHS website.

Section	%
Clinical and Operative Neurosurgery	
Neurovascular	10%
Neuro-oncology	10%
Cranial Trauma	5%
Pediatric Neurosurgery	10%
Spine	10%
Infection	5%
Functional Neurosurgery	5%
Peripheral Nerve	5%
General Neurosurgical Principles/Neurosurgical Approaches/Adjuvant Therapies	5%
Basic Neurosciences and Practice-related topics	
Neuro-Anatomy/Neurosurgical Anatomy	10%
Neuropathology and Molecular Biology/Neuroradiology and Diagnostic Approaches	10%
Pathophysiology/Neurophysiology/Neurology	5%
Neurocritical and General Care/Pharmacology/Neuro-Anesthesia	5%
Research, Ethics, and Professionalism and Patient Safety	5%
Total	**100%**

Note: Blueprint distributions of the examination may differ up to +/-3% in each category.

Example Questions

Examples of K2 Questions



A 21-year-old man sustained a cervical spine injury after a fall. His Glasgow Coma Score is 15 (see report).

Blood pressure	100/55 mmhg
Heart Rate	86 beats per minute

CT of spine:
Showed a transverse fracture line that extends through the body to C2 below the base of the odontoid process. CT of cervical spine is shown (see images).

Which of the following represent the classification of this fracture?
A. Type I, Odontoid fracture
B. Type II, Odontoid fracture
C. Type III, Odontoid fracture
D. Type II, Hangman's fracture

Examples of K1 Questions
An 18-year-old male is brought into the emergency department after a motor vehicle accident. On examination, he opens his eyes to painful stimulation, makes incomprehensible sounds, and withdraws his extremities to painful stimulation.

What is the patient's Glasgow Coma Scale score?
A. 5
B. 6
C. 7
D. 8

Final Objective Structured Clinical Examination (OSCE)

Exam Format

1- The neurosurgery final clinical examination shall consist of 12 graded stations each with 15-minute encounters.
2- The 12 stations consist of 6 Objective Structured Clinical Exam (OSCE) stations with 1 examiner each and 6 Structured Oral Exam (SOE) stations with 2 examiners each.
3- All stations shall be designed to assess integrated clinical encounters.
4- SOE stations are designed with preset questions and ideal answers.
5- Each OSCE station is assessed with a predetermined performance checklist. A scoring rubric for post encounter questions is also set in advance.
6- As these regulations are subject to change, updated details regarding exam policy and regulations are available in the general bylaw and executive policy of examination (available on the SCFHS website).

Final Clinical Exam Blueprint Outlines

The content of the following table is for demonstration only, please refer to the most updated version published on SCFHS website.

		DIMENSIONS OF CARE				
	STATIONS	Clinical Assessment	Diagnosis and Investigations	Treatment	Surgical Treatment	Overall Management
STATIONS FOR INTEGRATED CLINICAL ENCOUNTER	Neuro-oncology Two stations	2	3	1	3	1
	Neurovascular Two stations	2	3	1	3	1
	Spine Two stations	2	3	1	3	1
	Pediatric Two stations	2	3	1	3	1
	Functional/Peripheral Nerves Two stations	2	3	1	3	1
	Trauma & Infection Two stations	2	3	1	3	1

Numbers represent the distribution of clinical assessment scores out of 10 for each station.
Cases can differ up to +/-2
Each station includes either OSCE or SOE cases. A single case or multiple cases will be used for each station.

Definitions

Dimensions of care	Focus of care for the patient, family, community, and/or population
Clinical assessment	The process of initial clinical evaluations that include relevant focused history taking and clinical examination.
Diagnosis and investigations	Appropriate use of different diagnostic methods and investigations. This dimension includes but is not limited to urgent, emergent, and life-threatening conditions, new conditions, and exacerbation of underlying conditions.
Treatment	The process of medical and surgical treatment of acute and chronic neurosurgical conditions.
Surgical treatment	Neurosurgical interventions that include but are not limited to surgical approaches, techniques, technology, and interventional procedures.
Overall management	Perioperative patient management in acute and chronic conditions and postoperative care that includes is but not limited to post-surgical complications management, disease prevention, ethics, professionalism, and research.

SECTION 6: CERTIFICATION OF TRAINING COMPLETION

In order to be eligible to sit for final specialty examinations, each trainee is required to obtain a "Certification of Training-Completion." Based on the training bylaws and executive policy (please refer to www.scfhs.org) trainees will be granted "Certification of Training-Completion" once the following criteria are fulfilled:

a. Successful completion of all training rotations
b. Completion of training requirements as outlined by the scientific council of specialty
c. Clearance from SCFHS training affairs that ensures compliance with tuitions payment and completion of universal topics

A "Certification of Training-Completion" will be issued and approved by the local supervisory committee or its equivalent according to SCFHS policies. As these regulations are subject to change, updated details regarding exam policy and regulations are available in the general bylaw and executive policy (available on the SCFHS website).

Appendix

Appendix 1. Procedures List

According to this table the minimum number of cases expected per year is as follows (these numbers may vary by +/-10% due to the different rotations performed by the trainee each year):
R1 Level: 100 cases/year
R2 Level: 110 cases/year
R3 Level: 120 cases/year
R4 Level: 140 cases/year
R5 Level: 150 cases/year
R6 Level: 100 cases/year

Key

O:	Observation
AS:	Assist only
PS:	Perform under supervision
PI:	Perform independently (not step-by-step supervised)

An empty slot means PI.

A number in parentheses is the minimum number to be performed per year of training (these numbers may vary by +/-10% due to the different rotations performed by the trainee each year).

CSF pressure release and diversion procedures	RI	R2	R3	R4	R5	R6
Lumbar puncture	PS (3)	PI (3)				
Ventricular drain and intracranial monitor insertion	PS (4)	PS (4)	PI (4)			
Ventriculoperitoneal shunt insertion	AS (2)	AS (2)	PS (2)	PS (4)	PI (4)	
Ventriculoperitoneal shunt correction	AS (2)	AS (2)	PS (2)	PS (4)	PI (4)	
Ommaya reservoir insertion	O (1)	O (1)	AS (1)	PS (2)	PI (2)	
Endoscopic third ventriculostomy	O (1)	O (1)	O (1)	AS (2)	PS (2)	PI (2)
Endoscopic fenestration of loculated hydrocephalus	O (0)	O (1)	O (1)	AS (1)	PS (1)	PI (2)
CSF leak repair	O (2)	O (2)	AS (2)	AS (2)	PS (2)	PI (2)
Head trauma						
Burr holes for chronic subdural evacuation	AS (2)	PS (2)	PI (2)	PI (4)	PI (4)	
Hemicraniectomy and bilateral craniotomy for intracranial pressure	O (2)	AS (2)	PS (2)	PI (4)	PI (4)	
Evacuation of acute epidural and subdural hematomas	O (2)	AS (2)	PS (2)	PI (4)	PI (4)	
Elevation of Depressed skull fractures with or without dural tear	O (2)	AS (2)	PS (2)	PI (4)	PI (4)	
Cranioplasty	O (2)	AS (2)	PS (2)	PI (4)	PI (4)	
Evacuation of intra-parenchymal hemorrhage	O (2)	AS (2)	AS (2)	PS (4)	PI (4)	PI (2)
Spinal surgery						
Laminectomy for cauda equina decompression	O (1)	AS (1)	AS (1)	PS (1)	PI (2)	PI (2)
Anterior cervical discectomy and fusion	O (1)	AS (1)	AS (1)	AS (1)	PS (2)	PI (2)
Application of spine traction	O (1)	AS (2)	AS (2)	AS (2)	PS (2)	PI (2)
Thoracic disc interventions	O (1)	AS (1)	AS (1)	AS (1)	PS (2)	PS (2)
Lumbar and lumbosacral microdiscectomy	O (2)	AS (3)	AS (4)	PS (4)	PS (4)	PI (4)
Lumbosacral instrumentation	O (2)	AS (3)	AS (4)	PS (4)	PI (4)	PI (4)
Laminectomy for stenosis of any vertebrae	AS (2)	AS (2)	PS (2)	PS (2)	PI (2)	PI (2)
C1-C2 surgery	O (0)	AS (1)	AS (1)	PS (1)	PS (1)	PS (2)
Neuro-oncology						
Operation of neuronavigation systems	AS (2)	AS (4)	PS (4)	PI (4)	PI (4)	
Resection of cortical metastasis	O (2)	AS (2)	AS (2)	PS (2)	PS (2)	PI (2)

Resection of convexity meningiomas	O (2)	AS (2)	AS (2)	PS (2)	PS (2)	PI (2)
Resection of parasagittal meningiomas	O (2)	AS (2)	AS (2)	PS (2)	PS (2)	PI (2)
Resection of skull base meningiomas	O (2)	AS (2)	AS (2)	AS (2)	PS (2)	PS (2)
Resection of low-grade gliomas (non-eloquent cortex)	O (2)	AS (2)	AS (2)	PS (2)	PS (2)	PI (2)
Resection of low-grade gliomas (eloquent cortex)	O (2)	AS (2)	AS (2)	AS (2)	PS (2)	PS (2)
Resection of high-grade gliomas (non-eloquent cortex)	O (2)	AS (2)	AS (2)	PS (2)	PS (2)	PI (2)
Resection of high-grade gliomas (eloquent cortex)	O (2)	AS (2)	AS (2)	AS (2)	PS (2)	PS (2)
Stereotactic brain lesion biopsy (with neuronavigation or a stereotactic frame)	O (2)	AS (2)	AS (2)	PS (2)	PI (2)	PI (2)
Craniopharyngioma (open)	O (1)	AS (1)	AS (1)	AS (1)	PS (2)	PS (2)
Craniotomy for sellar or suprasellar tumors	O (1)	AS (1)	AS (1)	AS (1)	PS (2)	PS (2)
Transsphenoidal surgery for simple adenoma	O (2)	AS (2)	AS (2)	PS (2)	PS (2)	PI (2)
Suboccipital craniotomy for tumors	O (3)	AS (3)	AS (3)	PS (3)	PS (3)	PI (3)
Other complex skull base tumors	O (1)	AS (1)	AS (1)	AS (1)	AS (1)	PS (1)
Placement of stereotactic frames for radiosurgery and other indications	O (1)	AS (1)	AS (1)	AS (1)	AS (1)	PS (1)
Extended endoscopic skull base approach	O (1)	AS (1)	AS (1)	PS (1)	PS (2)	PS (2)
Pediatric and congenital condition surgery						
Closure of myelomeningoceles	O (2)	AS (2)	AS (2)	PS (3)	PS (3)	PI (3)
Closure of encephaloceles	O (1)	AS (1)	AS (1)	PS (2)	PS (2)	PI (2)
Closure of spinal lipomas	O (1)	AS (1)	AS (1)	PS (1)	PS (1)	PI (2)
Spinal cord untethering	O (2)	AS (2)	AS (2)	PS (3)	PS (3)	PI (3)
Correction of diastematomyelia	O (1)	AS (1)	AS (1)	PS (1)	PS (1)	PI (1)
Removing pediatric infratentorial brain tumors	O (2)	AS (2)	AS (2)	PS (3)	PS (3)	PI (3)
Removing pediatric supratentorial brain tumors	O (2)	AS (2)	AS (2)	PS (3)	PS (3)	PI (3)

Functional neurosurgery and procedures for epilepsy and pain						
Temporal lobectomy for epilepsy	O (1)	AS (1)	AS (1)	PS (1)	PS (2)	PI (2)
Selective amygdalohippocampectomy	O (1)	O (1)	O (1)	PS (1)	PS (1)	PS (1)
Other epilepsy procedures such as callosotomy and/or hemispherectomy	O (1)	O (1)	O (1)	PS (1)	PS (1)	PS (1)
Brain mapping	O (1)	O (1)	O (1)	PS (1)	PS (1)	PS (1)
Deep brain stimulation for Parkinson's disease	O (1)	O (1)	O (1)	PS (1)	PS (1)	PS (1)
Deep brain stimulation for other functional indications	O (1)	O (1)	O (1)	PS (1)	PS (1)	PS (1)
Vagus nerve stimulator insertion	O (1)	AS (1)	AS (1)	PS (1)	PS (2)	PI (2)
Baclofen and morphine pump insertion and revision	O (1)	AS (1)	AS (1)	PS (1)	PS (2)	PI (2)
Spinal cord stimulator insertion	O (1)	AS (1)	AS (1)	PS (1)	PS (2)	PS (2)
Microvascular decompression for trigeminal neuralgia and hemi-facial spasm	O (1)	AS (1)	AS (1)	PS (2)	PS (2)	PI (2)
Chiari decompression with or without C1 or C2 laminectomy, duroplasty, or tonsillar herniation	AS (1)	AS (1)	AS (2)	PS (2)	PS (2)	PI (2)
Peripheral nerve surgery						
Entrapment neuropathies	AS (2)	AS (2)	AS (2)	PS (2)	PI (2)	PI (2)
Resection of peripheral nerve tumors	O (1)	O (1)	O (1)	PS (1)	PS (1)	PS (1)
Nerve suture	O (1)	O (1)	O (1)	PS (1)	PS (1)	PS (1)
Sural nerve harvesting	O (2)	AS (2)	AS (2)	PS (2)	PI (2)	PI (2)
Neurovascular surgery						
Craniotomy for Sp. Mart. grade I, II arteriovenous malformations	O (1)	AS (1)	AS (1)	PS (1)	PS (2)	PI (2)
Craniotomy for complex arteriovenous malformations	O (1)	O (1)	O (1)	AS (1)	AS (1)	PS (1)
Sylvian fissure dissection	O (1)	AS (1)	AS (1)	PS (2)	PS (2)	PI (2)
Pterional craniotomy approach	O (3)	AS (3)	AS (3)	PS (3)	PI (4)	PI (4)
Extended Pterional craniotomy	O (3)	AS (3)	AS (3)	AS (3)	Ps (4)	PS (4)
Resection of surface cavernomas	O (1)	AS (1)	AS (1)	PS (2)	PI (2)	PI (2)
Clipping of simple aneurysm	O (1)	AS (2)	AS (3)	PS (4)	PS (4)	PI (2)
Clipping of complex aneurysm	O (0)	O (1)	AS (1)	AS (1)	PS (2)	PS (2)

Appendix 2. Annual Summary of Procedures Form

Name: SCFHS Number:
Period: (/ /) to (/ /)
Institution(s)

Institution	From	To	Instructors	Number of cases
1. 2. 3. 4.				

Procedure type	Number
Minor Procedures	
Major Procedures	
Total Procedures	

Specialty	Number of cases
Trauma and General	
Cranial Oncology	
Spine	
Cranial Vascular	
Pediatric Neurosurgery	
Functional Neurosurgery – movement disorders	
Functional Neurosurgery – epilepsy surgery	
Functional Neurosurgery – pain	
Skull base – Open	
Skull base – Neuro-endoscopic	
Peripheral Nerve Surgery	
Minor Procedures (external ventricular drains, ICP monitors, bedside shunt externalization, etc.)	
Sub-specialty ( )	
Other	
Total	

Candidate attended a sufficient amount of cases during rotation to fulfill his/her training needs for that level: Yes ( ) No ( )
If not, why?
Personal log-book was submitted and discussed at the end of rotation: Yes ( ) No ( )
Total grade for log-book (please check one):

Clear fail (<50%)	Border line fail (50-59.4%)	Border line pass (60-69.4)	Clear pass (≥70%)

Comments: ……

Signature of faculty:

Date:

Signature of trainee:

Date:

Appendix 3. In-Training Evaluation Report (ITER)

Saudi Commission for Health Specialties
M.R.NeuroSx-MOE.KKUH-Riyadh

Evaluated By : evaluator's name
Evaluating : person (role) or moment's name (if applicable)
Dates : start date to end date

* indicates a mandatory response

	N/A (0)	Clear Fail (1)	Borderline (2)	Clear Pass (3)	Exceed Expectations (4)
***A. MEDICAL EXPERT:** **History & Physical Examination:** **1. Comprehensive, accurate & concise with all relevant details**	○	○	○	○	○
***Diagnostic Tests:** **2. Used in a cost-effective manner & understands limitations & predictive value.**	○	○	○	○	○
***Clinical Decision:** **3. Able to formulate appropriate differential diagnosis.**	○	○	○	○	○
***4. Able to analyze, integrate, and formulate effective management strategies.**	○	○	○	○	○
***Medical Knowledge:** **5. Broad Clinical & Basic knowledge of a wide variet of medical problems and develops a plan of secondary prevention.**	○	○	○	○	○
***Emergency Management:** **6. Able to identify and respond appropriately to urgent cases**	○	○	○	○	○
***Evidence-based Practice/Critical Appraisal Skills:** **7. Aware of the role of evidence in clinical decision-making.**	○	○	○	○	○
***8. Able to apply relevant information in problem-solving.**	○	○	○	○	○
***9. Demonstrates knowledge of medications used, mechanisms of action, clinically relevant pharmacokinetics, indications, contraindications, and adverse effects.**	○	○	○	○	○
***Procedural Skills:** **10.. Perform diagnostic & therapeutic procedures, undestands indications, limitations & complications.**	○	○	○	○	○
***B. COMMUNICATOR** **11. Communicates effectively with patients, their families, and HCPs.**	○	○	○	○	○
***12. Able to maintain clear, accurate & appropriate records.**	○	○	○	○	○
***13. Written orders and progress notes are well organized & legible.**	○	○	○	○	○
***14. Discharge summaries are concise & completed promptly.**	○	○	○	○	○
***C. COLLABORATOR:** **15. Works effectively in a team environment with attending, juniors & nursing staff.**	○	○	○	○	○
***D. MANAGER :** **16. Serves in administration and leadership roles as appropriate.**	○	○	○	○	○
***17. Appropriate & efficient use of health care resources.**	○	○	○	○	○

	N/A (0)	Clear Fail (1)	Borderline (2)	Clear Pass (3)	Exceed Expectations (4)
***E. SCHOLAR :** **18. Attends and contributes to rounds, seminars, and other learning events.**	○	○	○	○	○
***19. Accepts and acts on constructive feedback.**	○	○	○	○	○
***20. Contributes to the education of patients, junior residents, house staff, and students.**	○	○	○	○	○
***21. Contributes in scientific research.**	○	○	○	○	○
***F. HEALTH ADVOCATE :** **22. Able to identify the psychosocial, economic, environmental & biological factors which influence the health of patients and society.**	○	○	○	○	○
***23. Offers advocacy on behalf of patients at practice and general population levels.**	○	○	○	○	○
***G. PROFESSIONAL :** **24. Delivers the highest quality of care with integrity & compassion. Recognizes limitations and seeks advice and consultations when necessary.**	○	○	○	○	○
***25. Reflects the highest standards of excellence in clinical care and ethical conduct.**	○	○	○	○	○

*Comments (areas of strengths/areas for improvement)

Appendix 4. Direct Observation of Procedural Skills (DOPS Assessment)

Appendix 4. Direct Observation of Procedural Skills (DOPS Assessment)

Saudi Commission for Health Specialties

Evaluated By: evaluator's name
Evaluating: person (role) or moment's name (if applicable)
Dates : start date to end date

* indicates a mandatory response

Direct Observation of Procedural Skills – DOPS Assessment

*Procedure:

	n/a	Below expectations 1	Borderline 2	Meets expectations 3	Above expectations 4
***Domain and Comments: Professional Approach (including to communication, consent and consideration of the patient.)**	○	○	○	○	○
***Handling of normal and abnormal tissue**	○	○	○	○	○
***Economy of movement**	○	○	○	○	○
***Instrument handling**	○	○	○	○	○
***Aseptic Technique**	○	○	○	○	○
***Hemostasis**	○	○	○	○	○
***Overall flow of the procedure**	○	○	○	○	○

***Overall ability to perform Procedure:**

- Competent to perform unsupervised
- May need supervision if complications arise
- Needs more practice

*Complexity of procedure:

- Low
- Average
- High

*Assessor's position:

- Consultant
- Associate Consultant
- Senior Registrar
- Registrar
- Fellow
- Senior Resident
- Nurse
- Others

Others (specify):

Appendix 5. Mini-Clinical Evaluation Exercise (MiniCEX)

Appendix 5. Mini-Clinical Evaluation Exercise (MiniCEX)

Saudi Commission for Health Specialties

Evaluated By: evaluator's name

Evaluating: person (role) or moment's name (if applicable)

Dates: start date to end date

* indicates a mandatory response

Mini-Clinical Evaluation Exercise (MiniCEX)

	n/a	Below expectations (1)	Borderline (2)	Meets expectations (3)	Above expectation (4)
*1) Medical Interview Skills					
*2) Physical Examination Skills					
*3) Counselling and Communications Skills					
*4) Clinical Judgement					
*5) Consideration for Patient/Professionalism					
*6) Organization/Efficiency					
*7) Overall Clinical Competence					

*Brief Summary of Case:

*Comments:					
*Which aspects of the encounter were done well?					
*Suggested areas for improvement/development?					
*Agreed Actions/learning plan:					

*Student's reflections on patient and areas of learning:

*Assessor's position:

Consultant
Associate Consultant
Senior Registrar
Registrar
Fellow

Others (specify):

*Time taken for Observation & Feedback (in minutes):

Appendix 6. List of topics for Self-directed Learning

Part 1: Basic Science

1. **NEUROANATOMY**
   - **1.1. Embryology**
     - 1.1.1. Cranium
       - 1.1.1.1. Cerebrum
       - 1.1.1.2. Cerebellum
       - 1.1.1.3. Brainstem
       - 1.1.1.4. Basal ganglia
       - 1.1.1.5. Thalamus
       - 1.1.1.6. Cranial nerves
       - 1.1.1.7. Ventricles
       - 1.1.1.8. Skull and fontanelles
     - 1.1.2. Spine
       - 1.1.2.1. Spinal cord
       - 1.1.2.2. Conus medullaris
       - 1.1.2.3. Cauda equina
       - 1.1.2.4. Bony spine
     - 1.1.3. Peripheral nervous system (PNS)
     - 1.1.4. Autonomic nervous systems
     - 1.1.5. Fetal cerebral circulation
   - **1.2. Histology**
     - 1.2.1. Neurons
       - 1.2.1.1. Types
       - 1.2.1.2. Microanatomy
         - 1.2.1.2.1. Cell body
         - 1.2.1.2.2. Dendritic process
         - 1.2.1.2.3. Axonal process
     - 1.2.2. Microglial elements
       - 1.2.2.1. Astrocytes
       - 1.2.2.2. Oligodendrocytes
       - 1.2.2.3. Microglia
       - 1.2.2.4. Ependyma
       - 1.2.2.5. Choroid epithelium
   - **1.3. Vascular Anatomy**
     - 1.3.1. Carotid and vertebral arteries
       - 1.3.1.1. Course
       - 1.3.1.2. Branches
       - 1.3.1.3. Target structures
     - 1.3.2. Blood supply to the spinal cord and spine
       - 1.3.2.1. Spinal and radicular arteries
       - 1.3.2.2. Watershed strokes
     - 1.3.3. Venous drainage of
       - 1.3.3.1. Cerebrum
       - 1.3.3.2. Cerebellum
       - 1.3.3.3. Spinal cord
       - 1.3.3.4. Spine

1.4. Osteology
- 1.4.1. Skull
  - 1.4.1.1. Bones
  - 1.4.1.2. Foramina and their contents
- 1.4.2. Scalp
  - 1.4.2.1. Layers
  - 1.4.2.2. Blood supply
  - 1.4.2.3. Innervation
- 1.4.3. Spine
  - 1.4.3.1. Atlas and axis vertebrae
  - 1.4.3.2. Subaxial cervical vertebrae
  - 1.4.3.3. Thoracic vertebrae
  - 1.4.3.4. Lumbar vertebrae
  - 1.4.3.5. Sacrum and coccyx
  - 1.4.3.6. Intervertebral disc complex

1.5. Myology
- 1.5.1. Gross
  - 1.5.1.1. Skull-attacked muscles
  - 1.5.1.2. Spinal muscles
  - 1.5.1.3. Facial muscles
  - 1.5.1.4. Abdominal muscles
- 1.5.2. Microscopic
  - 1.5.2.1. Motor unit
  - 1.5.2.2. Motor end plate
  - 1.5.2.3. Striated and smooth muscles

1.6. Ventricles
- 1.6.1. Compartments
- 1.6.2. Boundaries
- 1.6.3. Fourth ventricle
  - 1.6.3.1. External topography
  - 1.6.3.2. Anatomical landmarks

1.7. Meninges and CSF
- 1.7.1. Dura mater
  - 1.7.1.1. Falx cerebri
  - 1.7.1.2. Tentorium
  - 1.7.1.3. Incisura
  - 1.7.1.4. Blood supply
- 1.7.2. Pia mater
- 1.7.3. Arachnoid mater
  - 1.7.3.1. Major cisterns
- 1.7.4. CSF
  - 1.7.4.1. Chemical content
  - 1.7.4.2. Functions
  - 1.7.4.3. Production
  - 1.7.4.4. Circulation and flow
  - 1.7.4.5. Reabsorption
- 1.7.5. Blood-brain barrier
  - 1.7.5.1. Structure
  - 1.7.5.2. Functions
  - 1.7.5.3. Circumventricular organs

1.8. Central nervous system (CNS)

- 1.8.1. Topographical anatomy
  - 1.8.1.1. Cerebrum
  - 1.8.1.2. Cerebellum
  - 1.8.1.3. Brainstem
  - 1.8.1.4. Spinal cord
- 1.8.2. Cerebral cortex
  - 1.8.2.1. Cortical layers
  - 1.8.2.2. Sensory areas
  - 1.8.2.3. Motor areas
  - 1.8.2.4. Prefrontal cortex
  - 1.8.2.5. Fiber tracts
  - 1.8.2.6. Primary visual cortex
- 1.8.3. Temporal lobe
  - 1.8.3.1. Rhinencephalon
  - 1.8.3.2. Olfactory pathways
  - 1.8.3.3. Anterior commissure
  - 1.8.3.4. Hippocampus
  - 1.8.3.5. Amygdala
  - 1.8.3.6. Limbic system
- 1.8.4. Corpus striatum
  - 1.8.4.1. Striatum
  - 1.8.4.2. Globus pallidus
  - 1.8.4.3. Caudate nucleus
  - 1.8.4.4. Claustrum
  - 1.8.4.5. Subthalamic region
  - 1.8.4.6. Afferent and efferent connections
- 1.8.5. Hypothalamus and pituitary gland
  - 1.8.5.1. Hypothalamic cytoarchitecture
  - 1.8.5.2. Hypothalamic connections
  - 1.8.5.3. Supraoptic nuclei and tracts
  - 1.8.5.4. Hypophysial portal system
  - 1.8.5.5. Pituitary stalk
  - 1.8.5.6. Anterior lobe
  - 1.8.5.7. Posterior lobe
  - 1.8.5.8. Hormonally active cells
- 1.8.6. Diencephalon
  - 1.8.6.1. Midbrain-diencephalon junction
  - 1.8.6.2. Caudal diencephalon
  - 1.8.6.3. Epithalamus
  - 1.8.6.4. Thalamus (including nuclei)
  - 1.8.6.5. Thalamic radiations
  - 1.8.6.6. Internal capsule
  - 1.8.6.7. Visual pathways
- 1.8.7. Cerebellum
  - 1.8.7.1. Cerebellar organization
  - 1.8.7.2. Deep cerebellar nuclei
  - 1.8.7.3. Cerebellar connections
  - 1.8.7.4. Cerebellar peduncles

1.8.8. Mesencephalon
- 1.8.8.1. Tectum
  - 1.8.8.1.1. Superior colliculus
  - 1.8.8.1.2. Inferior colliculus
- 1.8.8.2. Pretectal region
- 1.8.8.3. Posterior commissure
- 1.8.8.4. Mesencephalic nuclei
- 1.8.8.5. Tegmentum
- 1.8.8.6. Midbrain reticular formation
- 1.8.8.7. Substantia nigra
- 1.8.8.8. Crus cerebri
- 1.8.8.9. Ascending and descending tracts

1.8.9. Pons and medulla
- 1.8.9.1. Olivary nucleus
- 1.8.9.2. Medullary reticular formation
- 1.8.9.3. Pontine cranial nerves
- 1.8.9.4. Cranial nerves of the medulla
- 1.8.9.5. Ascending and descending tracts

1.8.10. Cranial nerves
- 1.8.10.1. Nuclei locations and connections
- 1.8.10.2. Courses from nuclei to end organs
- 1.8.10.3. Blood supply
- 1.8.10.4. Posterior fossa
- 1.8.10.5. Gacial, vestibular, and cochlear nerves and the internal auditory canal
- 1.8.10.6. Mass lesions syndromes affecting cranial nerves in:
  - 1.8.10.6.1. Suprasellar cistern
  - 1.8.10.6.2. Jugular foramen
  - 1.8.10.6.3. Internal auditory canal
  - 1.8.10.6.4. Incisura tentorii

1.9. Spinal cord
- 1.9.1. Rexed laminae
- 1.9.2. Somatic and visceral efferent neurons
- 1.9.3. Posterior horn neurons
- 1.9.4. Ascending and descending tracts
- 1.9.5. Upper and lower motoneurons
- 1.9.6. Somatotopic organization
- 1.9.7. Boundaries of the spinal neural foramina

1.10. Autonomic nervous system
- 1.10.1. Pre- and postganglionic neurons
- 1.10.2. Visceral afferent fibers
- 1.10.3. Structure of the autonomic ganglia
- 1.10.4. Central autonomic pathways
- 1.10.5. Sympathetic functions
- 1.10.6. Parasympathetic functions

1.11. PNS

1.11.1. Structure
- 1.11.1.1. Nerve roots
- 1.11.1.2. Myelinated nerves
- 1.11.1.3. Unmyelinated nerves
- 1.11.1.4. Schwann cells

1.11.2. Plexi
- 1.11.2.1. Cervical plexus
- 1.11.2.2. Brachial plexus
- 1.11.2.3. Lumbosacral plexus

1.11.3. Upper extremity
- 1.11.3.1. Axillary nerve
- 1.11.3.2. Suprascapular nerve
- 1.11.3.3. Median nerve
- 1.11.3.4. Ulnar nerve
- 1.11.3.5. Radial nerve
- 1.11.3.6. Long thoracic nerve
- 1.11.3.7. Musculocutaneous nerve

1.11.4. Lower extremity
- 1.11.4.1. Lateral femoral nerve
- 1.11.4.2. Femoral nerve
- 1.11.4.3. Obturator nerve
- 1.11.4.4. Sciatic nerve
- 1.11.4.5. Saphenous nerve
- 1.11.4.6. Peroneal nerve
- 1.11.4.7. Tibial nerve

2. NEUROPHYSIOLOGY

2.1. Synaptic transmission
- 2.1.1. Types
- 2.1.2. Neurotransmitter release
- 2.1.3. Neuromuscular transmission
- 2.1.4. Chemical messengers
- 2.1.5. Directly gated receptors
- 2.1.6. Second messenger-linked receptors

2.2. Sensory systems
- 2.2.1. Sensory receptor physiology
- 2.2.2. Coding of modality-specific sensation
- 2.2.3. Pain and analgesia
- 2.2.4. Cortical integration of sensory perception
- 2.2.5. Thalamus
- 2.2.6. Visual system
  - 2.2.6.1. Retinal processing
  - 2.2.6.2. Central visual processing
  - 2.2.6.3. Visual cortex columnar units
  - 2.2.6.4. Geniculate nucleus processing
  - 2.2.6.5. Visual motion and form perception

2.3. Motor system
- 2.3.1. Muscle contraction mechanisms
- 2.3.2. Muscle receptors and spinal reflexes
- 2.3.3. Positional spinal reflexes
- 2.3.4. Brainstem locomotor reflexes
- 2.3.5. Vestibular nucleus control of movement and posture
- 2.3.6. Red nucleus control of movement
- 2.3.7. Cortical control of movement
- 2.3.8. Cerebellar control of movement
  - 2.3.8.1. Cerebellar regional and cellular organization
  - 2.3.8.2. Cerebellar functional divisions
  - 2.3.8.3. Cerebellar role in planning movement
- 2.3.9. Basal ganglia pathways and circuits

2.4. Physiological basis of arousal and emotion
- 2.4.1. Noradrenergic systems
- 2.4.2. Limbic system
- 2.4.3. Memory
- 2.4.4. Sleeping and sleep states
- 2.4.5. Reticular activating system

2.5. Higher cortical functions
- 2.5.1. Anatomy of language
- 2.5.2. Association cortex

3. FLUID and ELECTROLYTES

3.1. Intracellular and extracellular fluids
- 3.1.1. Sodium and water distribution and metabolism
- 3.1.2. Clinical assessment of water and sodium balance
- 3.1.3. Osmolality

3.2. Management of pathologic conditions
- 3.2.1. Diabetes insipidus
- 3.2.2. Syndrome of inappropriate antidiuretic hormone secretion
- 3.2.3. Cerebral salt wasting

3.3. Clinical implications and treatment of excesses and deficiencies
- 3.3.1. Calcium
- 3.3.2. Phosphorous
- 3.3.3. Magnesium

3.4. Neurosurgical diseases and nutritional deficiencies
- 3.4.1. Metabolic and nutritional requirements of trauma patients
- 3.4.2. Swallowing disorders

4. INFECTIONS

4.1. Antimicrobials
- 4.1.1. Classification
- 4.1.2. Indications in CNS infections
- 4.1.3. Potential complications
- 4.1.4. Traversing the blood-brain barrier

4.2. Corticosteroids: advantages and disadvantages in CNS infections
- 4.2.1. The mechanism of function of steroids
- 4.2.2. The blood brain barrier and steroid effect
- 4.2.3. Potential disadvantage of steroids in infection

4.3. Cranial infections
- 4.3.1. Meningitis
- 4.3.2. Tuberculosis
- 4.3.3. Abscess
- 4.3.4. Fungi and parasites
- 4.3.5. Postoperative infections
- 4.3.6. Dural space infections
- 4.3.7. Pituitary abscess
- 4.3.8. Encephalitis
- 4.3.9. Neurosyphilis
- 4.3.10. Human immunodeficiency virus

4.4. Spinal infections
- 4.4.1. Osteomyelitis
- 4.4.2. Pott's disease
- 4.4.3. Spinal epidural abscess
- 4.4.4. Fungi and parasites

4.5. Managing non-CNS infections in neurosurgical patients
- 4.5.1. Respiratory infections
- 4.5.2. Urinary tract infections
- 4.5.3. Wound infections

4.6. Prion diseases
- 4.6.1. Clinical evaluation
- 4.6.2. Prevention

4.7. Fever
- 4.7.1. Workup for a febrile patient
- 4.7.2. Postoperative fever etiologies
- 4.7.3. Diagnosis and management of sepsis
- 4.7.4. Prophylactic antibiotics

Part 2: General Knowledge

5. NEUROPATHOLOGY

5.1. General
- 5.1.1. Surgical specimen examination techniques
  - 5.1.1.1. CNS samples
  - 5.1.1.2. PNS samples
  - 5.1.1.3. Skeletal muscle samples
  - 5.1.1.4. Pineal and pituitary samples
- 5.1.2. Stains
  - 5.1.2.1. Chromatic stains
  - 5.1.2.2. Histochemical stains
  - 5.1.2.3. Immunohistochemical stains
- 5.1.3. CSF morphological examinations

5.2. Congenital and prenatal disorders
- 5.2.1. Encephalocele
- 5.2.2. Myelomeningocele and meningocele
- 5.2.3. Diastematomyelia and diplomyelia
- 5.2.4. Syringomyelia and syringobulbia
- 5.2.5. Chiari malformations
- 5.2.6. Dandy-Walker malformation
- 5.2.7. Arachnoid cysts
- 5.2.8. Porencephaly
- 5.2.9. Aqueductal stenosis
- 5.2.10. Subependymal germinal matrix hemorrhages
- 5.2.11. Posthemorrhagic hydrocephalus
- 5.2.12. Periventricular leukomalacia

5.3. Trauma
- 5.3.1. Skull fractures
- 5.3.2. Gunshot wounds to the skull and brain
- 5.3.3. Epidural hematomas
- 5.3.4. Acute and chronic subdural hematomas
- 5.3.5. Recent and remote cerebral contusions
- 5.3.6. Intracerebral hemorrhages
- 5.3.7. Diffuse axonal injuries
- 5.3.8. Traumatic cranial nerve injuries
- 5.3.9. Spinal cord injuries
- 5.3.10. Cerebral herniation syndromes
- 5.3.11. Fat embolization
- 5.3.12. Trauma in infancy

5.4. Infectious diseases
- 5.4.1. Epidural abscess
- 5.4.2. Subdural abscess
- 5.4.3. Meningitis
- 5.4.4. Brain abscesses
- 5.4.5. Tuberculomas
- 5.4.6. Sarcoidosis
- 5.4.7. Cryptococcosis
- 5.4.8. Mucormycosis
- 5.4.9. Toxoplasmosis
- 5.4.10. Cysticercosis
- 5.4.11. Encephalitis
- 5.4.12. Human immunodeficiency virus
- 5.4.13. Cytomegalovirus

5.5. Vascular pathologies
- 5.5.1. Acute and subacute infarcts
- 5.5.2. Embolic infarcts
- 5.5.3. Vasculitis
  - 5.5.3.1. Temporal arteritis
  - 5.5.3.2. Primary CNS vasculitis
  - 5.5.3.3. Granulomatous angiitis
  - 5.5.3.4. Wegener's granulomatosis

5.5.4. Intracerebral hemorrhage
5.5.4.1. Hypertensive hemorrhage
5.5.4.2. Lobar hemorrhage
5.5.4.3. Amyloid angiopathy
5.5.5. Malformations
5.5.5.1. Arteriovenous malformations
5.5.5.2. Cavernous angiomas
5.5.5.3. Venous angiomas
5.5.5.4. Capillary telangiectasias
5.5.6. Aneurysms
5.5.6.1. Saccular aneurysms
5.5.6.2. Mycotic aneurysms
5.5.6.3. Giant aneurysms
5.5.6.4. Traumatic and dissecting aneurysms
5.5.7. Spinal cord
5.5.7.1. Vascular malformations
5.5.7.2. Spinal cord infarcts

5.6. Neoplasms

5.6.1. Gliomas
5.6.1.1. Astrocytomas
5.6.1.1.1. Diffuse fibrillary astrocytomas
5.6.1.1.2. Gemistocytic astrocytomas
5.6.1.1.3. Anaplastic astrocytomas
5.6.1.1.4. Pilocytic astrocytomas
5.6.1.1.5. Cerebellar astrocytomas
5.6.1.1.6. Diencephalic astrocytomas
5.6.1.1.7. Dorsal exophytic pontine astrocytomas
5.6.1.1.8. Pilocytic astrocytomas
5.6.1.1.9. Subependymal giant cell astrocytomas
5.6.1.1.10. Pleomorphic xanthoastrocytomas
5.6.1.2. Oligodendrogliomas
5.6.1.2.1.1. Pure oligodendrogliomas
5.6.1.2.1.2. Anaplastic oligodendrogliomas
5.6.1.2.1.3. Mixed oligodendrogliomas
5.6.1.3. Glioblastomas
5.6.1.3.1.1. Giant cell glioblastomas
5.6.1.3.1.2. Gliosarcomas
5.6.1.3.1.3. Gliomatosis cerebri
5.6.1.4. Ependymomas
5.6.1.4.1.1. Cellular ependymomas
5.6.1.4.1.2. Papillary ependymomas
5.6.1.4.1.3. Clear cell ependymomas
5.6.1.4.1.4. Tanycytic ependymomas
5.6.1.4.1.5. Myxopapillary ependymomas
5.6.1.4.1.6. Subependymomas
5.6.1.5. Neuronal and mixed gliomas
5.6.1.5.1. Gangliocytomas
5.6.1.5.2. Gangliogliomas
5.6.1.5.3. Dysembryoplastic neuroepithelial tumors
5.6.1.5.4. Central neurocytomas

- 5.6.2. Choroid plexus tumors
  - 5.6.2.1. Papillomas
  - 5.6.2.2. Carcinomas
- 5.6.3. Embryonal tumors
  - 5.6.3.1. Medulloblastomas
  - 5.6.3.2. Atypical teratoid/rhabdoid tumor
  - 5.6.3.3. Primitive neuroectodermal tumor
- 5.6.4. Meningiomas
  - 5.6.4.1. Meningothelial meningiomas
  - 5.6.4.2. Fibrous meningiomas
  - 5.6.4.3. Transitional meningiomas
  - 5.6.4.4. Psammomatous meningiomas
  - 5.6.4.5. Angiomatous meningiomas
  - 5.6.4.6. Papillary meningiomas
  - 5.6.4.7. Atypical meningiomas
  - 5.6.4.8. Anaplastic meningiomas
  - 5.6.4.9. Hemangiopericytomas
- 5.6.5. Pineal and pituitary neoplasms
  - 5.6.5.1. Pineocytomas
  - 5.6.5.2. Pineoblastomas
  - 5.6.5.3. Pituitary adenomas
  - 5.6.5.4. Craniopharyngiomas
  - 5.6.5.5. Rathke pouch cysts
  - 5.6.5.6. Lymphocytic hypophysitis
  - 5.6.5.7. Pituitary apoplexy
  - 5.6.5.8. Empty sella syndrome
- 5.6.6. Germ cell tumors
  - 5.6.6.1. Germinomas
  - 5.6.6.2. Teratomas
  - 5.6.6.3. Embryonal carcinomas
  - 5.6.6.4. Yolk sac tumors
  - 5.6.6.5. Choriocarcinomas
  - 5.6.6.6. Mixed germ cell tumors
- 5.6.7. Other neoplasms
  - 5.6.7.1. Colloid cysts
  - 5.6.7.2. Hemangioblastomas
  - 5.6.7.3. Lipomas
  - 5.6.7.4. Primary CNS lymphomas
  - 5.6.7.5. Metastatic carcinomas
  - 5.6.7.6. Leptomeningeal carcinomatosis
  - 5.6.7.7. Schwannomas
- 5.6.8. Tumor syndromes
  - 5.6.8.1. Neurofibromatosis type 1
  - 5.6.8.2. Neurofibromatosis type 2
  - 5.6.8.3. von Hippel-Lindau syndrome
  - 5.6.8.4. Tuberous sclerosis
  - 5.6.8.5. Cowden syndrome
  - 5.6.8.6. Turcot syndrome

5.7. PNS pathologies
- 5.7.1. Neuropathies
  - 5.7.9.1.1. Traumatic neuropathies
  - 5.7.9.1.2. Compressive neuropathies
  - 5.7.9.1.3. Metabolic neuropathies
- 5.7.2. Leprosy
- 5.7.3. Charcot-Marie-Tooth disease
- 5.7.4. Guillain-Barre syndrome
- 5.7.5. Sympathetic dystrophy
- 5.7.6. Tumors
  - 5.7.9.6.1. Peripheral schwannoma
  - 5.7.9.6.2. Neurofibromas
  - 5.7.9.6.3. Malignant peripheral nerve tumors
  - 5.7.9.6.4. Spinal root and peripheral nerve root cysts

5.8. Skull pathologies
- 5.8.1. Dermoids and epidermoids
- 5.8.2. Hemangiomas
- 5.8.3. Osteomas
- 5.8.4. Skull chordomas
- 5.8.5. Eosinophilic granulomas
- 5.8.6. Paget's disease
- 5.8.7. Osteosarcomas

5.9. Spinal pathologies
- 5.9.1. Herniated intervertebral discs
- 5.9.2. Tumoral calcinosis
- 5.9.3. Hemangiomas
- 5.9.4. Spinal chordomas
- 5.9.5. Metastatic carcinomas
- 5.9.6. Plasmacytomas
- 5.9.7. Primary bone tumors
- 5.9.8. Spinal osteomyelitis

5.10. Eye and orbit pathologies
- 5.10.1. Retinoblastomas
- 5.10.2. Ocular melanomas
- 5.10.3. Optic nerve gliomas
- 5.10.4. Optic nerve meningiomas
- 5.10.5. Orbital lymphomas and pseudotumors
- 5.10.6. Orbital metastases

6. NEURORADIOLOGY

6.1. General neuroradiology
- 6.1.1. Radiological safety
- 6.1.2. Intravenous contrast agents
  - 6.1.2.1. Agent types
  - 6.1.2.2. Potential complications

6.2. Skull X-ray
- 6.2.1. Anatomical structure identification
  - 6.2.1.1. Anteroposterior view
  - 6.2.1.2. Lateral view
  - 6.2.1.3. Towne view

6.2.2. Traumatic injury identification
6.2.2.1. Linear fractures
6.2.2.2. Decompressed fractures
6.2.2.3. Pneumocephalus
6.2.2.4. Foreign bodies

6.3. Computed tomography scan
6.3.1. Anatomical structure identification
6.3.2. Traumatic injury identification
6.3.2.1. (see 6.2.2.1-4.)
6.3.2.2. Intracranial hematomas
6.3.2.2.1. Epidural hematomas
6.3.2.2.2. Acute and chronic subdural hematomas
6.3.2.2.3. Intraparenchymal hematomas
6.3.2.2.4. Intraventricular hematomas
6.3.2.2.5. Cerebral contusions
6.3.2.4. Subarachnoid hemorrhages
6.3.3. Pathologic condition identification
6.3.3.1. Ischemic infarctions
6.3.3.2. Venous infarctions
6.3.3.3. Hydrocephalus
6.3.3.4. Cysts
6.3.3.5. Tumors
6.3.3.6. Cerebral edema
6.3.3.7. Infections
6.3.3.8. Congenital abnormalities

6.4. Magnetic resonance imaging (MRI)
6.4.1. MRI concepts
6.4.2. MRI sequences
6.4.3. Anatomical structure identification
6.4.4. Traumatic injury identification
6.4.4.1. Pneumocephalus
6.4.4.2. Intracranial hematomas
6.4.4.2.1. (see 6.3.2.2.1-5.)
6.4.4.2.2. Diffuse axonal injuries
6.4.5. Pathologic condition identification
6.4.5.1. (see 6.3.3.1-8.)
6.4.5.2. Vascular occlusions

6.5. Spinal radiology
6.5.1. Anatomical structure identification
6.5.2. Radiographic diagnoses
6.5.2.1. Platybasia
6.5.2.2. Cranial settling
6.5.3. Traumatic injury identification
6.5.3.1. Craniovertebral junction
6.5.3.2. Occipital condyle fractures
6.5.3.3. Atlanto-occipital dislocations
6.5.3.4. Jefferson fractures
6.5.3.5. Posterior atlas fractures
6.5.3.6. Dens fractures

6.5.3.7. Axis body fractures
6.5.3.8. Hangman's fractures
6.5.3.9. Atlas and axis facet fractures
6.5.3.10. Atlantoaxial rotatory dislocations

7. NEUROLOGY

7.1. Neurophysiology
7.1.1. Normal and abnormal electroencephalogram waveforms
7.1.2. Sensory evoked potential testing
7.1.3. Visual evoked potential testing
7.1.4. Motor evoked potential testing
7.1.5. Nerve conduction velocity testing
7.1.6. Electromyographic testing

7.2. Altered consciousness levels
7.2.1. Delirium
7.2.2. Dementia
7.2.3. Coma
7.2.4. Syncope

7.3. Cerebrovascular neurology
7.3.1. Transient ischemic attacks
7.3.2. Cerebral infarctions
7.3.3. Venous infarctions
7.3.4. Pediatric strokes
7.3.5. Cerebral vasculitis
7.3.6. Brainstem ischemic syndromes
7.3.7. Telangiectasia

7.4. Headaches
7.4.1. Migraines
7.4.2. Non-migrainous headaches

7.5. Epilepsy
7.5.1. Pathophysiology
7.5.2. Clinical presentation
7.5.3. Diagnosis
7.5.4. Treatment
7.5.5. Status epilepticus and its treatment

7.6. Pediatric neurology
7.6.1. Agenesis of the corpus callosum
7.6.2. Anencephaly
7.6.3. Microencephaly
7.6.4. Megalencephaly
7.6.5. Major neurocutaneous disorders

7.7. Neuropathies
7.7.1. Major inherited neuropathies
7.7.2. Guillain-Barre syndrome (GBS)
7.7.3. Non-GBS neuropathies

7.8. Ataxias
- 7.8.1. Major hereditary ataxias
  - 7.8.1.1. Friedreich ataxias
  - 7.8.1.2. Levy-Roussy syndrome
  - 7.8.1.3. Hereditary cerebellar ataxias
- 7.8.2. Major non-inherited ataxias
  - 7.8.2.1. Acute cerebellar ataxias in children
  - 7.8.2.2. Ataxia-telangiectasia
  - 7.8.2.3. Marinesco-Sjögren syndrome
  - 7.8.2.4. Ramsay-Hunt syndrome
  - 7.8.2.5. Joseph's disease

7.9. Degenerative disorders
- 7.9.1. Alzheimer's disease
- 7.9.2. Pick's disease
- 7.9.3. Diffuse Lewy body disease
- 7.9.4. Paraneoplastic degenerative diseases
- 7.9.5. Amyotrophic lateral sclerosis

7.10. Movement disorders
- 7.10.1. Chorea
  - 7.10.1.1. Huntington's disease
  - 7.10.1.2. Syndenham chorea
  - 7.10.1.3. Senile chorea
- 7.10.2. Hemiballismus
- 7.10.3. Major and focal dystonias
- 7.10.4. Parkinson's disease
- 7.10.5. Tourette's syndrome
- 7.10.6. Benign essential tremors
- 7.10.7. Progressive supranuclear palsy
- 7.10.8. Tardive dyskinesia

7.11. Spinal cord disorders
- 7.11.1. Spinal muscular atrophies
  - 7.11.1.1. Wernig-Hoffmann disease
  - 7.11.1.2. Kugelberg-Welander syndrome
  - 7.11.1.3. Benign focal amyotrophy
- 7.11.2. Poliomyelitis
- 7.11.3. Neuromuscular junction disorders
  - 7.11.3.1. Myasthenia gravis
  - 7.11.3.2. Lambert-Eaton syndrome
- 7.11.4. Botulism
- 7.11.5. Muscular dystrophies
  - 7.11.5.1. Duchenne muscular dystrophy
  - 7.11.5.2. Myotonic dystrophy
  - 7.11.5.3. Congenital dystrophy
- 7.11.6. Periodic paralysis syndromes
  - 7.11.6.1. Familial periodic paralysis
  - 7.11.6.2. Hypokalemic periodic paralysis
  - 7.11.6.3. Hyperkalemic periodic paralysis

7.12. Demyelinating disease
- 7.12.1. Multiple sclerosis
- 7.12.2. Devic's disease

7.12.3. Inflammatory demyelinating disease
7.12.4. Leukodystrophies
7.12.4.1. Central pontine myelinolysis
7.12.4.2. Tabes dorsalis
7.12.4.3. Subacute combined degeneration

7.13. Miscellaneous disorders
7.13.1. Pseudotumor cerebri
7.13.2. Normal pressure hydrocephalus
7.13.3. Disorders with neurological manifestations
7.13.3.1. Altitude sickness
7.13.3.2. Decompression sickness
7.13.3.3. Malignant hyperthermia
7.13.4. Neurological aspects of pregnancy

8. CRITICAL CARE MEDICINE

8.1. Indications for critical care admission
8.1.1. Adult indications
8.1.2. Pediatric indications

8.2. Managing general medical issues in neurosurgical patients
8.2.1. Universal precautions
8.2.2. Preventing gastrointestinal hemorrhage
8.2.3. Preventing venous thrombosis and pulmonary embolism
8.2.4. Physical therapy to maintain strength and joint range
8.2.5. Skin and eye care
8.2.6. Workup and treatment of sepsis

8.3. Common critical care medications
8.3.1. Vasoactive drugs
8.3.2. Inotropic drugs
8.3.3. Bronchodilators
8.3.4. Diuretics
8.3.5. Antiarrhythmics
8.3.6. Antihypertensives
8.3.7. Antimicrobials
8.3.8. Anticonvulsants

8.4. Drugs that affect neurologic examinations
8.4.1. Sedatives
8.4.2. Paralytics
8.4.3. Analgesics

8.5. Pulmonary care
8.5.1. Indications for intubation
8.5.1.1. Loss of patent airway
8.5.1.2. Respiratory insufficiency
8.5.2. Inability to protect airway
8.5.3. Measured pulmonary functions
8.5.3.1. Rate
8.5.3.2. Minute ventilation
8.5.3.3. Spontaneous tidal volume
8.5.3.4. Forced vital capacity
8.5.3.5. Functional residual capacity
8.5.3.6. Maximum ventilatory volume

8.5.4. Ventilator modes and settings
8.5.4.1. Pressure vs. volume ventilation
8.5.4.2. Continuous positive airway pressure
8.5.4.3. Intermittent positive airway pressure
8.5.4.4. Pressure support
8.5.4.5. Intermittent mandatory ventilation
8.5.4.6. Positive end expiratory pressure
8.5.4.7. Tidal volume
8.5.5. Indications for tapering ventilatory support

8.6. Indications for monitoring devices
8.6.1. Arterial catheters
8.6.2. Central venous catheters
8.6.3. Swan-Ganz catheters
8.6.4. Pulse oximeters
8.6.5. Electrocardiographic monitoring
8.6.6. End-tidal CO_2 monitors

8.7. Endocrine disorders
8.7.1. Hypo/hyperthyroidism
8.7.2. Hypo/hyperparathyroidism
8.7.3. Adrenal cortical excess and deficiency
8.7.4. Diabetes mellitus
8.7.5. Diabetes insipidus

8.8. Acid-base balance
8.8.1. Metabolic acidosis and alkalosis
8.8.2. Respiratory acidosis and alkalosis

8.9. Medical and legal definitions of brain death

8.10. Moral and ethical issues pertaining to neurosurgical critical care
8.10.1. Patient or family requests to withhold or withdraw treatment
8.10.2. Organ donation

8.11. Critical care procedures
8.11.1. Endotracheal intubation
8.11.2. Nasogastric intubation
8.11.3. Bladder catheterization
8.11.4. Arterial line insertion
8.11.5. Central venous catheterization

8.12. Neurocritical care
8.12.1. Nutritional management
8.12.2. Critical management of spinal cord injuries
8.12.3. Pathophysiology and critical treatment of cerebral vasospasms
8.12.4. Diagnosis and treatment of cerebral ischemias
8.12.5. Care of birth-related intracranial hemorrhage and injuries to spinal cord and brachial plexus

9. GENERAL SURGERY

- **9.1. Perioperative care**
- **9.2. Sterile techniques**
- **9.3. Wound healing and management**
- **9.4. Foundational surgical skills**
  - 9.4.1. Applications of bipolar and unipolar cauterization
  - 9.4.2. Basic surgical instruments
    - 9.4.2.1. Scalpels
    - 9.4.2.2. Retractors
    - 9.4.2.3. Suction devices
    - 9.4.2.4. Drills
    - 9.4.2.5. Scissors
    - 9.4.2.6. Drains
  - 9.4.3. Suture materials and stitching techniques

Part 3: Neurosurgical Knowledge

10. CEREBROVASCULAR SURGERY

- **10.1. Vessel occlusion syndromes**
  - 10.1.1. Internal carotid artery
  - 10.1.2. Middle cerebral artery
  - 10.1.3. Anterior cerebral artery
  - 10.1.4. Recurrent artery of Heubner
  - 10.1.5. Anterior choroidal artery
  - 10.1.6. Vertebral artery
  - 10.1.7. Posterior inferior cerebellar artery
  - 10.1.8. Lower and upper basilar trunk
- **10.2. Cerebrovascular physiology**
  - 10.2.1. Cerebral blood flow
  - 10.2.2. Cerebral autoregulation
  - 10.2.3. Ischemic thresholds
  - 10.2.4. Intracranial pressure
  - 10.2.5. Cerebral perfusion pressure
- **10.3. Hemorrhages**
  - 10.3.1. Aneurysmal diseases
  - 10.3.2. Vascular malformations
  - 10.3.3. Hypertension
  - 10.3.4. Vasculopathies
  - 10.3.5. Degenerative diseases
  - 10.3.6. Arterial infarctions
  - 10.3.7. Venous infarctions
  - 10.3.8. Moyamoya disease
- **10.4. Vascular imaging**
  - 10.4.1. Ultrasound
  - 10.4.2. Magnetic resonance angiography
  - 10.4.3. Computed tomography angiography
  - 10.4.4. Digital subtraction angiography
- **10.5. Extracranial carotid artery diseases**
  - 10.5.1. Clinical features and pathophysiology
  - 10.5.2. Diagnostic modalities

10.5.3. Surgical and non-surgical management
10.5.4. Surgical anatomy
10.5.5. Exposing cervical carotid arteries

10.6. Operations

10.6.1. Surgery for aneurysms at various locations
10.6.2. Surgery for arteriovenous malformations
10.6.3. Routine and complex twist drill or burr-hole procedures for draining the ventricular system or intracranial hematomas
10.6.4. Microsurgical techniques in the laboratory setting
10.6.5. Pterional craniotomy for intracranial vascular pathologies
10.6.6. Vascular disease surgeries
10.6.6.1. Intra-operative anesthesia
10.6.6.2. Proximal and distal control
10.6.6.3. Temporary arterial occlusion
10.6.6.4. Brain protective strategies
10.6.7. Exposure and treatment of intraspinal vascular lesions

11. NEUROSURGICAL ONCOLOGY

11.1. General considerations

11.1.1. Brain tumor epidemiology
11.1.2. Radiologic features of CNS tumors
11.1.3. Basic principles of cranial surgery for brain tumors
11.1.4. Basic principles of skull base surgery
11.1.5. Avoiding complications from brain tumor surgeries
11.1.6. Navigating brain tumors
11.1.7. Endoscopic approaches for brain tumors
11.1.8. Intraoperative MRI

11.2. Gliomas

11.2.1. Proliferation markers
11.2.2. Glial tumor growth factors
11.2.4. Low-grade gliomas
11.2.5. Malignant gliomas
11.2.3. Invasive malignant glioma
11.2.6. Primitive neuroectodermal tumors
11.2.7. Pineal tumors
11.2.8. Medulloblastomas
11.2.9. Ependymomas
11.2.10. Hemangioblastomas

11.3. Extra-axial tumors

11.3.1. Meningiomas
11.3.2. Hemangiopericytomas
11.3.3. Vestibular schwannomas
11.3.4. Ventricular tumors

11.4. Skull base tumors

11.4.1. Pituitary tumors
11.4.2. Craniopharyngiomas
11.4.3. Epidermoid, dermoid, and neurenteric cysts
11.4.4. Chordomas and chondrosarcomas
11.4.5. Glomus tumors
11.4.6. Trigeminal schwannomas

11.5. Other tumors
- 11.5.1. Osseous tumors
- 11.5.2. Orbital tumors
- 11.5.3. Skull and scalp tumors
- 11.5.4. Metastatic tumors
- 11.5.5. Primary CNS lymphomas

11.6. Operations
- 11.6.1. Patient positions for craniotomies
- 11.6.2. Opening and closing craniotomies
- 11.6.3. Assessing the need for pre-, intra-, and postoperative monitoring
- 11.6.4. Neoplasm resection
  - 11.6.4.1. Intra-axial neoplasms
    - 11.6.4.1.1 Supratentorial neoplasms
    - 11.6.4.1.2. Infratentorial neoplasms
  - 11.6.4.1. Extra-axial neoplasms
- 11.6.5. Pituitary lesion resection
- 11.6.6. Performing or assisting skull base procedures
- 11.6.7. Managing postoperative complications
  - 11.6.7.1. Brain edema
  - 11.6.7.2. Meningitis
  - 11.6.7.3. Cranial flap infections
  - 11.6.7.4. Postoperative seizures
  - 11.6.7.4. Other complications

11.7. Chemotherapy
- 11.7.1. Classes of chemotherapy related to neuro-oncology
- 11.7.2. Mechanism of action of chemotherapy agents
- 11.7.3. Common therapeutic régimes
- 11.7.4. Common complications

11.8. Radiation therapy
- 11.8.1. Linear accelerator radiosurgery
- 11.8.2. Gamma knife radiosurgery
- 11.8.3. Image-guided robotic radiosurgery: the CyberKnife
- 11.8.4. Radiosurgery for intracranial vascular malformations
- 11.8.5. Radiosurgery for functional disorders

12. TRAUMA

12.1. Polytraumas
- 12.1.1. Obtaining Advanced Trauma Life Support certificates
- 12.1.2. Assessment
- 12.1.3. Resuscitation
- 12.1.4. Management

12.2. Cranial hemorrhages
- 12.2.1. Pathophysiology
- 12.2.2. Types
  - 12.2.2.1. Epidural hemorrhages
  - 12.2.2.2. Subdural hemorrhages
  - 12.2.2.3. Intracerebral hemorrhages
  - 12.2.2.4. Intraventricular hemorrhages
- 12.2.3. Clinical features
- 12.2.4. Management

12.3. Skull fractures
- 12.3.1. Types
  - 12.3.1.1. Linear fractures
  - 12.3.1.2. Depressed fractures
  - 12.3.1.3. Compound fractures
  - 12.3.1.4. Basal fractures
- 12.3.2. Management
- 12.3.3. Traumatic skull base fractures with CSF leakage

12.4. Intracranial hypertension
- 12.4.1. Pathophysiology
- 12.4.2. Monro-Kellie doctrine
- 12.4.3. Management
- 12.4.4. Inserting intracranial pressure monitoring devices

12.5. Managing infections associated with open CNS injuries

12.6. Operations
- 12.6.1. Twist-drill or burr-hole drainage for subdural fluid collection
- 12.6.2. Patient surgical positions and initial emergency procedures
- 12.6.3. Surgical procedures in uncomplicated cases
  - 12.6.3.1. Craniotomies for subdural and/or epidural hematomas
  - 12.6.3.2. Craniotomies for penetrating head injuries
  - 12.6.3.3. Craniotomies for intracerebral hematomas or contusions
  - 12.6.3.4. Craniotomies for depressed skull fractures
  - 12.6.3.5. Decompressive craniectomies
  - 12.6.3.6. Repairs/canalizations of frontal sinus fractures
  - 12.6.3.7. Craniotomies/craniectomies for posterior fossa epidural, subdural, or intracerebral hematomas
  - 12.6.3.8. Simple cranioplasties
  - 12.6.3.9. Reconstructing complex cranial defects, with assistance from other specialties as indicated
  - 12.6.3.10. Reconstructing traumatic skull base defects, with assistance from other specialties as indicated.
  - 12.6.3.11. Assisting explorations and repairs for peripheral nerve injuries

13. PEDIATRIC NEUROSURGERY

13.1. Congenital/developmental embryonic defects
- 13.1.1. Incidence, epidemiology, and inheritance patterns
- 13.1.2. Myelomeningoceles and meningoceles
- 13.1.3. Encephaloceles
- 13.1.4. Chiari malformations
- 13.1.5. Dandy-Walker syndrome
- 13.1.6. Achondroplasia and other dwarfisms
- 13.1.7. Occult spinal dysraphism
- 13.1.8. Split cord anomalies
- 13.1.9. Tethered spinal cord
  - 13.1.9.1. Fatty filum terminales
  - 13.1.9.2. Meningocele manqué
- 13.1.10. Craniofacial syndromes
- 13.1.11. Arachnoid cysts
- 13.1.12. Phakomatoses

13.2. Hydrocephalus
- 13.2.1. Etiologies and relative incidences
- 13.2.2. Infantile posthemorrhagic hydrocephalus
- 13.2.3. Low-pressure and high-pressure hydrocephalus
- 13.2.4. Treatment and management options
- 13.2.5. Shunt types and their pros and cons
- 13.2.6. Treatment complications
- 13.2.7. Nonsurgical diseases mistaken for hydrocephalus

13.3. Shunt infections
- 13.3.1. Presentations
- 13.3.2. Common pathogens
- 13.3.3. Risk factors
- 13.3.4. Treatment plans

13.4. Neoplasias
- 13.4.1. Common pediatric tumors and their locations
- 13.4.2. Typical presentations and appropriate evaluations
- 13.4.3. Tumor malignancy classifications
- 13.4.4. Surgical vs. nonsurgical therapies and their outcomes
- 13.4.5. Type-specific tumor complications
- 13.4.6. Preoperative tumor management

13.5. Cerebrovascular surgeries
- 13.5.1. Causes of atraumatic intracerebral and subarachnoid hemorrhages
- 13.5.2. Causes of cerebral infarctions/ischemias
- 13.5.3. Embryology of pediatric cerebral and spinal vascular anomalies
- 13.5.4. Common pediatric aneurysm types and their locations
- 13.5.5. Diagnosing and managing vein of Galen aneurysms
- 13.5.6. Pathophysiology, treatment, and outcomes of intraventricular neonatal hemorrhages

13.6. Trauma
- 13.6.1. Glasgow Coma Scale
- 13.6.2. Diagnosing non-accidental trauma
- 13.6.3. Common injuries from birth trauma
- 13.6.4. Growing skull fractures

13.7. Miscellaneous pediatrics
- 13.7.1. Diagnosing and managing cerebral palsy
- 13.7.2. Pediatric spasticity and movement disorders
- 13.7.3. Craniosynostosis
  - 13.7.3.1. Acquired craniosynostosis
  - 13.7.3.2. Syndromic craniosynostosis
  - 13.7.3.3. Open vs. endoscopic treatments
  - 13.7.3.4. Plagiocephaly

14. SPINE SURGERY

14.1. Biomechanics
- 14.1.1. Craniocervical junction biomechanics
- 14.1.2. Cervical biomechanics
- 14.1.3. Thoracolumbar biomechanics
- 14.1.4. Lumbar biomechanics
- 14.1.5. Internal spinal fixator biomechanics

14.2. Spinal pain
- 14.2.1. Differential diagnosis by location
  - 14.2.1.1. Cervical pain
  - 14.2.1.2. Thoracic pain
  - 14.2.1.3. Lumbar pain
- 14.2.2. Differential diagnosis by cause
  - 14.2.2.1. Degenerative origin
  - 14.2.2.2. Traumatic origin
  - 14.2.2.3. Metabolic origin
- 14.2.3. Evaluation
  - 14.2.3.1. History and physical exam
  - 14.2.3.2. Investigations
    - 14.2.3.2.1. Laboratory tests
    - 14.2.3.2.2. Radiological tests
- 14.2.4. Management
  - 14.2.4.1. Non-surgical management
  - 14.2.4.2. Surgical management

14.3. Degenerative disorders
- 14.3.1. Clinical disorders
  - 14.3.1.1. Radiculopathy
  - 14.3.1.2. Myelopathy
  - 14.3.1.3. Neurogenic claudication
- 14.3.2. Indications for cervical and lumbar discectomy
- 14.3.3. Surgeries for thoracic herniated discs
- 14.3.4. Cervical rheumatoid arthritis
- 14.3.5. Cervical spondylotic myelopathy
- 14.3.6. Posterior longitudinal ligament ossification

14.4. Tumors
- 14.4.1. Spinal cord tumors
  - 14.4.1.1. Intradural tumors
    - 14.4.1.1.1. Intramedullary tumors
    - 14.4.1.1.2. Extramedullary tumors
  - 14.4.1.3. Extradural tumors
- 14.4.2. Boney spine tumors
  - 14.4.2.1. Primary tumors
  - 14.4.2.2. Secondary tumors

14.5. Spine infections
- 14.5.1. Spontaneous infections
- 14.5.2. Postoperative infections
- 14.5.3. Tuberculosis
- 14.5.4. Fungal infections

14.6. Spinal cord trauma
- 14.6.1. Pathophysiology of spinal cord injury
- 14.6.2. Grading schemes for spinal cord injury and myelopathy
- 14.6.3. Initial management of spine and spinal cord injuries
  - 14.6.3.1. Immobilization
  - 14.6.3.2. Traction
    - 14.6.3.2.1. Gardner-Wells tongs
    - 14.6.3.2.2. Halo vest
  - 14.6.3.3. Reduction

14.6.4. Spinal cord injury syndromes
- 14.6.4.1. Complete transverse injuries
- 14.6.4.2. Anterior cord injuries
- 14.6.4.3. Brown-Sequard injuries
- 14.6.4.4. Central cord injuries
- 14.6.4.5. Cruciate paralysis
- 14.6.4.6. Syringomyelia
- 14.6.4.7. Conus syndrome
- 14.6.4.8. Sacral sparing

14.6.5. Non-surgical spinal cord syndromes
- 14.6.5.1. Radiographic identification
- 14.6.5.2. Medical management

14.6.6. Fractures
- 14.6.6.1. Injury mechanisms
- 14.6.6.2. Location categories
  - 14.6.6.2.1. Cervical fracture
  - 14.6.6.2.2. Throacolumbar fractures
  - 14.6.6.2.3. Sacral fractures
  - 14.6.6.2.4. Coccygeal fractures
- 14.6.6.3. Other fractures
  - 14.6.6.3.1. Pathological fractures
  - 14.6.6.3.2. Osteopathic fractures

14.6.7. Other injuries
- 14.6.7.1. Subluxations
- 14.6.7.2. Ligamentous injuries
- 14.6.7.3. Spinal gunshots and penetrating wounds

14.7. Instability

14.7.1. Punjabi and White definition of spinal instability

14.7.2. Radiographic signs of instability
- 14.7.2.1. Degenerative instability
- 14.7.2.2. Neoplastic instability
- 14.7.2.3. Traumatic instability
- 14.7.2.4. Congenital instability

14.8. Spinal orthoses

14.8.1. Indications

14.8.2. Relative effectiveness

14.8.3. Degree of segmental and regional immobilization

14.9. Intraoperative spinal cord monitoring

14.9.1. Indications

14.9.2. Physiology

14.9.3. Technical aspects

14.10. Miscellaneous

14.10.1. Cauda equina syndrome

14.10.2. Treating adult tethered cord syndrome and syringomyelia

14.10.3. Management of intra and postoperative CSF leaks

14.10.4. Indications for angiography and endovascular management of spinal disorders

14.10.5. Bone healing and bone grafting in spinal surgery

14.11. Operations

14.11.1. Cervical operations
- 14.11.1.1. Anterior and posterior cervical spine approaches
  - 14.11.1.1.1. Herniated cervical discs
  - 14.11.1.1.2. Spondylosis
  - 14.11.1.1.3. Instability
- 14.11.1.2. Indications for posterior cervical spinal internal fixators
- 14.11.1.3. Indications and techniques for anterior and posterior cervical spinal internal fixators
- 14.11.1.4. Operations for fractures and dislocations affecting the atlas and axis
- 14.11.1.5. Anterior and posterior approaches for fractures and dislocations of the subaxial cervical spine

14.11.2. Thoracolumbar operations
- 14.11.2.1. Anterior and posterior spinal fixators
  - 14.11.2.1.1. Tumors
  - 14.11.2.1.2. Trauma
  - 14.11.2.1.3. Infection
- 14.11.2.2. Lumbar fusion indications
  - 14.11.2.2.1. Congenital disorders
  - 14.11.2.2.2. Iatrogenic disorders
  - 14.11.2.2.3. Degenerative disorders
- 14.11.2.3. Anterior or posterior lumbar interbody fusion and intertransverse fusion for lumbar diseases
- 14.11.2.4. Internal fixation options for posterior lumbar interbody and intertransverse fusion

15. FUNCTIONAL NEUROSURGERY

15.1. Movement disorders

15.1.1. Anatomy and synaptic connectivity of the basal ganglia
15.1.2. Clinical overview of movement disorders
15.1.3. Pros and cons of ablative procedures
15.1.4. Deep brain stimulation (DBS)
- 15.1.4.1. Mechanisms
- 15.1.4.2. Patient selection criteria

15.1.5. Functional imaging of movement disorders
15.1.6. Surgical tremor management
15.1.7. Parkinson's disease
- 15.1.7.1. Pallidal interventions
- 15.1.7.2. DBS for Parkinson's disease
  - 15.1.7.2.1. Subthalamic DBS
  - 15.1.7.2.2. Subthalamotomy DBS

15.1.8. DBS for dystonia
15.1.9. Psychosurgery
- 15.1.9.1. Tourette's syndrome
- 15.1.9.2. Obsessive-compulsive disorder
- 15.1.9.3. Major depression

15.1.10. Stereotactic biopsy
- 15.1.10.1. Frame-based vs frameless biopsies
- 15.1.10.2. Benefits and limitations of frame-based biopsies

15.1.10.3. Minimizing the risk of intracranial hemorrhage
15.1.10.4. Minimizing the risk of a non-diagnostic stereotactic biopsy
15.1.10.5. Appropriate biopsy trajectories
15.1.10.5.1. Pineal lesions
15.1.10.5.2. Midbrain lesions
15.1.10.5.3. Pontine lesions
15.1.10.5.4. Medullary lesions

15.2. Epilepsy
15.2.1. Cortical malformations
15.2.2. Diagnosis and classification of seizures and epilepsy
15.2.3. Antiepileptic drugs
15.2.4. Neuroradiologic tests for epilepsy surgery
15.2.5. Evaluating patients for epilepsy surgery
15.2.6. Motor, sensory, and language mapping
15.2.7. Surgeries for extratemporal lobe epilepsy
15.2.8. Standard temporal lobectomies
15.2.9. Selective amygdalohippocampectomies
15.2.10. Hemispheric disconnection procedures
15.2.11. Vagus nerve stimulation for intractable epilepsy
15.2.12. Radiosurgery for epilepsy
15.2.13. DBS for epilepsy
15.2.14. Outcomes and complications of epilepsy surgery

15.3. Radiosurgery
15.3.1. Stereotactic radiosurgery
15.3.2. Radiosurgery vs. radiation therapy
15.3.3. Indications
15.3.4. Complications
15.3.5. Advantages and disadvantages of radiosurgery and surgical resection
15.3.5.1. Tumors
15.3.5.2. Vascular malformations

16. PAIN MANAGEMENT

16.1. Anatomy and physiology of pain
16.2. Pharmacologic treatment of pain
16.3. Anesthesia for pain
16.4. Trigeminal neuralgia
16.4.1. Diagnosis and non-surgical treatments
16.4.2. Percutaneous procedures
16.4.3. Stereotactic radiosurgery
16.4.4. Microvascular decompression

16.5. Neurostimulation for pain
16.5.1. Peripheral nerve stimulation
16.5.2. Spinal cord stimulation
16.5.3. Motor cortex stimulation

16.6. Destructive procedures
16.6.1. Diagnosing and managing painful neuromas
16.6.2. Dorsal root entry zone lesions
16.6.3. Percutaneous cordotomy and trigeminal tractotomy-nucleotomy

17. PERIPHERAL NERVE SURGERY

17.1. Anatomy

- 17.1.1. Major peripheral nerve structural elements
  - 17.1.1.1. Epineurium
  - 17.1.1.2. Perineurium
  - 17.1.1.3. Endoneurium
  - 17.1.1.4. Axon
  - 17.1.1.5. Fascicle
  - 17.1.1.6. Schwann cell
  - 17.1.1.7. Connective tissue
  - 17.1.1.8. Motor end plate
  - 17.1.1.9. Sensory receptor
- 17.1.2. Blood supply to peripheral nerves
- 17.1.3. Blood-nerve barrier
- 17.1.4. Major peripheral nerves
  - 17.1.4.1. Motor innervation
  - 17.1.4.2. Sensory innervation

17.2. Physiology

- 17.2.1. Fast and slow axonal transport
- 17.2.2. Action potentials and ion flows
- 17.2.3. Action potential propagation
- 17.2.4. Nerve fiber sizes
- 17.2.5. Functional significance of fiber size

17.3. Peripheral nerve examinations, evaluations, and biopsies

- 17.3.1. Motor power rating scales
- 17.3.2. Sensory modalities and their examinations
- 17.3.3. Tinel's sign
- 17.3.4. Symptoms and signs of upper vs. lower motoneuron injuries
  - 17.3.4.1. Anatomical definition
  - 17.3.4.2. Degree of atrophy
  - 17.3.4.3. Distribution of weakness
  - 17.3.4.4. Reflex changes
  - 17.3.4.5. Recovery probabilities
- 17.3.5. Wallerian degeneration
- 17.3.6. Nerve regeneration
  - 17.3.6.1. Sprouting
  - 17.3.6.2. Nerve growth factors
  - 17.3.6.3. Growth rates
  - 17.3.6.4. Remyelination
- 17.3.7. Neuromas
  - 17.3.7.1. Axonal tangle
  - 17.3.7.2. Mechanosensitivity
  - 17.3.7.3. Neuromas-in-continuity

17.4. Electrodiagnostic evaluations

- 17.4.1. Electromyography
- 17.4.2. Nerve conduction studies

17.5. Neuropathies

- 17.5.1. Metabolic neuropathies
- 17.5.2. Inherited neuropathies

17.6. Horner's syndrome
- 17.6.1. Clinical features
- 17.6.2. Causes
- 17.6.3. Management

17.7. Entrapments
- 17.7.1. Distal entrapments
  - 17.7.1.1. Carpal tunnel syndrome
  - 17.7.1.2. Cubital tunnel syndrome
  - 17.7.1.3. Peroneal nerve entrapment
  - 17.7.1.4. Tarsal tunnel syndrome
- 17.7.2. Pelvic entrapments
  - 17.7.2.1. Piriformis syndrome
  - 17.7.2.2. Obturator internus syndrome
  - 17.7.2.3. Pudendal nerve entrapment
- 17.7.3. Uncommon entrapments
  - 17.7.3.1. Guyon's canal syndrome
  - 17.7.3.2. Suprascapular nerve entrapment
  - 17.7.3.3. Posterior interosseous nerve syndrome
  - 17.7.3.4. Anterior interosseous nerve syndrome
- 17.7.4. Thoracic outlet syndrome

17.8. Injuries
- 17.8.1. Burn and electrical injury effects on nerves
- 17.8.2. Management of acute peripheral nerve injuries
- 17.8.3. Brachial plexus injuries
  - 17.8.3.1. Congenital brachial plexus injuries
  - 17.8.3.2. Early management of brachial plexus injuries
  - 17.8.3.3. Secondary procedures for brachial plexus injuries
- 17.8.4. Meralgia paresthetica
- 17.8.5. Timing of peripheral nerve surgery
  - 17.8.5.1. Laceration injuries
  - 17.8.5.2. Blunt injuries
  - 17.8.5.3. Missile injuries
  - 17.8.5.4. Non-surgical iatrogenic injuries
  - 17.8.5.5. Surgical injuries
  - 17.8.5.6. Injection injuries
- 17.8.6. Adjuvant therapies for nerve injuries
  - 17.8.6.1. Muscle and tendon transfers
  - 17.8.6.2. Prosthesis
  - 17.8.6.3. Joint fusion

17.9. Tumors
- 17.9.1. Benign peripheral nerve tumors
- 17.9.2. Surgery for malignant peripheral nerve sheath tumors

17.10. Operative considerations
- 17.10.1. Nerve repair site tension
- 17.10.2. Nerve repair techniques
  - 17.10.2.1. Direct coaptation
  - 17.10.2.2. Nerve grafts
    - 17.10.2.2.1. Graft donor nerves
  - 17.10.2.3. Nerve transfers

17.10.2.5. Epineurial repairs
17.10.2.6. Fascicular repairs
17.10.3. Intra-operative nerve evaluations
17.10.3.1. Visual evaluations
17.10.3.2. Palpation
17.10.3.3. Internal neurolysis
17.10.3.4. Nerve conduction studies
17.10.3.5. Biopsies
17.10.4. Carpal tunnel decompression
17.10.4.1. Open decompression
17.10.4.2. Endoscopic decompression
17.10.5. Ulnar nerve decompression
17.10.5.1. In situ decompression
17.10.5.2. Transposition
17.10.5.2.1. Subcutaneous transposition
17.10.5.2.2. Intramuscular transposition
17.10.5.2.3. Submuscular transposition
17.10.5.3. Medial epicondylectomy
17.10.6. Sural nerve biopsy