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Canadian Association of Radiologists Central Nervous System Diagnostic Imaging Referral Guideline

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Abstract

The Canadian Association of Radiologists (CAR) Central Nervous System Expert Panel is made up of physicians from the disciplines of radiology, emergency medicine, neurosurgery, and neurology, a patient advisor, and an epidemiologist/guideline methodologist. After developing a list of 24 clinical/diagnostic scenarios, a rapid scoping review was undertaken to identify systematically produced referral guidelines that provide recommendations for one or more of these clinical/diagnostic scenarios. Recommendations from 55 guidelines and contextualization criteria in the Grading of Recommendations, Assessment, Development, and Evaluations (GRADE) for guidelines framework were used to develop 51 recommendation statements across the 24 scenarios. This guideline presents the methods of development and the referral recommendations for congenital disorders of the brain, cerebrovascular disease, multiple sclerosis and demyelinating disease, headache, concussion, pituitary and juxtasellar lesions, cranial neuropathy, brain stem symptoms, altered intracranial pressure (hypertension, hypotension, hydrocephalus suspected shunt malfunction, normal pressure hydrocephalus), vestibular and cochlear symptoms (hearing loss, vertigo), mental status change (acute, dementia/memory loss), visual loss, epilepsy and seizure, CNS infection, intracranial space-occupying lesions, suspected cerebral venous sinus thrombosis, vasculitis, movement disorders/Parkinsonism, metabolic and toxic encephalopathies, and aneurysm screening.

Résumé

Le groupe d'experts du système nerveux central de l'Association canadienne des radiologistes (CAR) regroupe des médecins spécialisés en radiologie, urgentologie, neurochirurgie et neurologie, ainsi qu'une représentante des patients et une épidémiologiste spécialisée en méthodologie de l'élaboration de lignes directrices. Après avoir élaboré une liste de 24 scénarios cliniques/diagnostiques, le groupe d'experts a entrepris une revue rapide des publications en vue de repérer les lignes directrices relatives aux demandes d'examen élaborées de façon systématique qui fournissent des recommandations pour un ou plusieurs de ces scénarios. Les recommandations de 55 lignes directrices et critères de contextualisation du cadre GRADE (notation des recommandations, analyses, développements et évaluations) concernant la structure des lignes directrices ont été utilisées pour rédiger 51 énoncés de recommandations couvrant les 24 scénarios. Ces lignes directrices présentent les étapes à suivre et les recommandations d'orientation dans les cas d'anomalie congénitale du cerveau,

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de maladie cérébro-vasculaire, de sclérose en plaques et de neuropathie démyélinisante, de céphalée, de commotion cérébrale, de lésion de l'hypophyse et de la région sellaire, de neuropathie crânienne, de symptômes liés au tronc cérébral, de variation de la pression intracrânienne (hypertension, hypotension, hydrocéphalie causée par le dysfonctionnement présumé d'un shunt, hydrocéphalie accompagnée d'une pression normale), de symptômes vestibulaires ou cochléaires (hypoacousie, vertige), d'altération aiguë de l'état mental (démence/perte de mémoire), de perte de vision, d'épilepsie et de crise, d'infection du SNC, de lésion occupant l'espace intracrânien, de thrombose des veines et des sinus intracrâniens, de vasculite, de troubles du mouvement/parkinsoniens, d'encéphalopathie métabolique et toxique, et dans le cadre du dépistage de l'anévrysme.

Keywords
central nervous system, diagnostic imaging, referrals, guideline, recommendations

Introduction

Beginning in January 2024, an Expert Panel (EP) made up of physicians from the disciplines of radiology, emergency medicine, neurosurgery, neurology, and physiatry, a patient advisor, and an epidemiologist/guideline methodologist met to develop a new set of recommendations specific to referral pathways for central nervous system (CNS) conditions. Through discussion (via a virtual meeting) followed by offline communication, the EP developed a list of 24 clinical/diagnostic scenarios to be covered by this guideline. These recommendations are intended primarily for referring clinicians (eg, family physicians, specialty physicians, nurse practitioners); however, they may also be used by radiologists, individuals/patients, and patient representatives.

Our methods describing the guideline development process, including the rapid scoping review to identify the evidence base, has been published in *CMAJ Open*[1] and an editorial to this series of guideline publications is available in *CARJ*.[2] The application of well-established scoping review and rapid review guidance (JBI,[3] Cochrane Handbook,[4] Cochrane Rapid Review Methods Group[5]) and guideline methodology (ie, Grading of Recommendations Assessment, Development, and Evaluation or GRADE[6,7]) were used to identify the evidence-base and to guide the Expert Panel in determining the strength and direction of the recommendations for each clinical scenario (Table 1). The quality of conduct and reporting of the included guidelines identified in the scoping review were evaluated with the AGREE-II checklist,[8] using a modified scoring system. In instances where guidelines were lacking, expert consensus was used to develop the recommendation. Contextualization to the Canadian health care system was considered for each recommendation, with discussion around the factors found in the Evidence to Decision framework in GRADE for guidelines (eg, balance of desirable and undesirable outcomes, values and preferences, resources implications).[7]

A systematic search for guidelines (with an a priori defined inclusion criteria) was run in Medline and Embase on February 27, 2024. The search was limited to publications from 2019 onward (Supplemental Appendix 1). Supplemental searching included the following national radiology and/or guideline groups: the American College of Radiology, the National Institute for Health and Care Excellence, and the Royal College of Radiologists 8th Edition (2017). Recommendations for each clinical scenario were formulated over 2 virtual meetings on October 18 and 23, 2024. External review and feedback were obtained from radiologists, an emergency physician, and family physicians. The full guideline can be found on the CAR website (www.car.ca).

Results

Systematic Scoping Review

A total of 6737 records were identified through the electronic database and 17 additional records were added from the supplemental search. Fifty-five guidelines, plus 4 companion papers, were included (Figure 1). Potentially relevant guidelines published in languages other than English can be found in Supplemental Appendix 2. A list of excluded records with justifications for exclusion is available upon request. Most guidelines were rated as moderate or high quality, using the modified AGREE-II checklist[8] (Supplemental Appendix 3). The number of guidelines included per clinical/diagnostic scenario ranged from 0 to 16, with a median of 3 guidelines per clinical scenario.

Recommendations

Additional details of the included guidelines, including which imaging modalities (eg, computed tomography [CT], magnetic resonance imaging [MRI], radiograph [XR], ultrasound [US]) that were discussed can be found in Supplemental Appendix 4.

A guideline is intended to guide and not be an absolute rule. Medical care is complex and should be based on evidence, a clinician's expert judgment, the patient's circumstances, values, preferences, and resource availability. Not all imaging modalities are available in all clinical environments, particularly in rural or remote areas of Canada. Decisions about patient transfer, use of alternative imaging or serial clinical examination and observation can be complex and difficult. Therefore, the expected benefits of recommended imaging, risks of travel, patient preference, and other factors must be considered. The

Table 1. Recommendation Text, Symbol, and Interpretation.

Recommendation	AGAINST	FOR
STRONG	**Strong, against** "we recommend against" (↓↓) • All or almost all informed people would not recommend/choose the course of action and only a small proportion would.	**Strong, for** "we recommend" (↑↑) • All or almost all informed people would recommend/choose the course of action and only a small proportion would not. • Request discussion if the intervention is not offered.
CONDITIONAL	**Conditional, against** "we suggest against" (↓) • Most informed people would not recommend/choose the course of action, but a substantial number would. • This may be conditional upon patient values and preferences, the resources available or the setting in which the intervention will be implemented.	**Conditional, for** "we suggest" (↑) • Most informed people would recommend/choose the course of action, but a substantial number would not. • This may be conditional upon patient values and preferences, the resources available or the setting in which the intervention will be implemented.

Note. Down arrows are red and Up arrows are green when available in colour.
Created using the guidance provided in Andrews et al.[6]

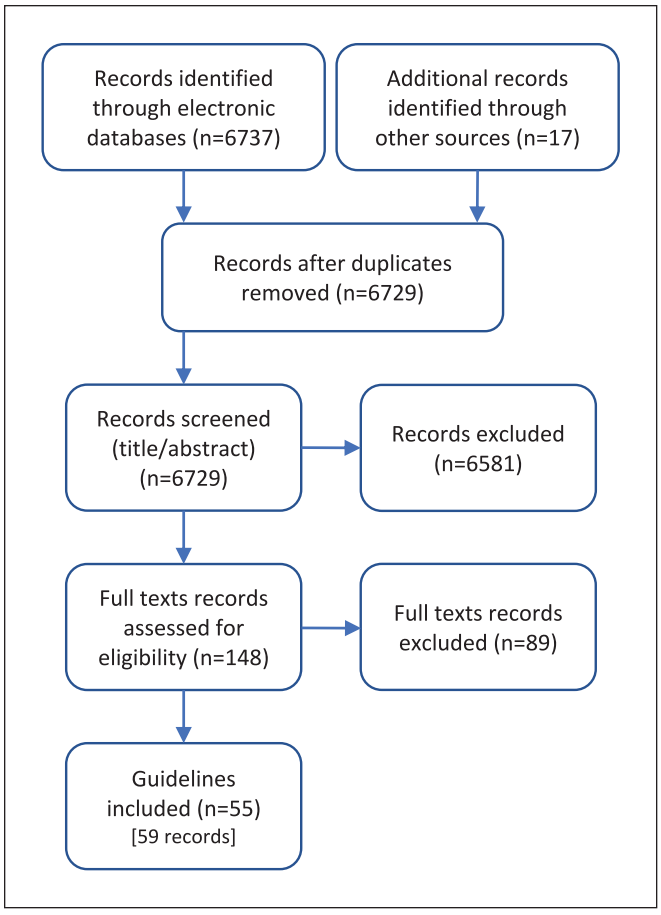

Figure 1. PRISMA flow diagram.

guideline recommendations are designed to assist the choice of imaging modality in situations where it is deemed clinically necessary to obtain imaging.

Unless the panel agreed a specific protocol is required to optimize patient care/diagnosis, the recommendations do not specify when contrast should or should not be used, as this decision may vary based on clinical presentation, regional practice preferences, preference of the referring clinician, radiologist and/or the patient, and resource availability.

We reviewed relevant recommendations related to the 24 clinical/diagnostic scenarios previously published by radiology and specialty societies, including: the Canadian Association of Radiologists,[9] the American Association of Neurological Surgeons and the Congress of Neurological Surgeons,[10] the American College of Radiology,[11-20] the American Headache Society,[21] the American Heart Association/American Stroke Association,[22,23] British Society of Rheumatology,[24,25] the British Society for Haematology,[26] the Canadian Consensus Conference guideline,[27] the Canadian Parkinson's Disease guideline,[28] the Canadian Stroke Consortium,[29] the Canadian Stroke Best Practice,[30] the Chinese Hepatic Encephalopathy guideline,[31] the Chinese Neurosurgical Society of the Chinese Medical Association/Society of Hematological Malignancies of the Chinese Anti-Cancer Association,[32] the Chinese Stroke Association,[33-35] the European Academy of Neurology,[36,37] the European Academy of Neurology/Peripheral Nerve Society,[38,39] the European Alliance of Associations for Rheumatology,[40] the European Association of Neuro-Oncology,[41-43] the European Association of Neuro-Oncology and the European Society for Medical Oncology,[44] European Association for the Study of the Liver,[45] the European Society of Clinical Microbiology and Infectious Diseases,[46] the European Stroke Organization,[47,48] the Italian Society of Neurosurgery, Italian Association of Neuro-Oncology, and Italian Association of Neurology,[49] the Japanese Society of Normal Pressure Hydrocephalus,[50] the Japan Stroke Society,[51] the Japanese National Research

Table 2. Central Nervous System Recommendations.

Clinical/diagnostic scenario and recommendations

CN01. CONGENITAL DISORDERS OF THE BRAIN[9]

1. In adults with suspected congenital disorder of the brain, we recommend **MRI** as the initial imaging modality (↑↑).

CN02. CEREBROVASCULAR DISEASE[9,12,13,22,23,29,30,34,35,37,48,51,58,59,64,67]

Acute stroke

1. In adults with symptoms of acute stroke who may be eligible for intervention, we recommend a stroke protocol that includes at minimum a **non-contrast CT head and multi-phase CTA** as the initial imaging modalities (↑↑).
If CT perfusion is available, it may be included.

Transient ischaemic attack

1. In adults with a high-risk✧transient ischaemic attack, we recommend **CT/CTA as soon as possible** as the initial imaging modality (↑↑).
2. In adults with a non-high-risk transient ischaemic attack, we recommend **CT/CTA** as the initial imaging modality (↑↑).
↳ **2.1** If CTA is unavailable, we suggest **carotid Doppler US** as a suitable interim modality until CTA is available (↑).

✧Individuals presenting within 48 h of symptoms consistent with a new acute stroke or TIA event (especially transient focal motor or speech symptoms, or persistent stroke symptoms).[29]

Extracranial carotid stenosis

1. In adults with symptomatic✦ carotid stenosis, we recommend **MRA or CTA** as the initial imaging modality (↑↑).
↳ **1.1** If MRA or CTA are unavailable, we suggest **carotid Doppler US** as an alternative for screening (↑).
↳ **1.2** If revascularization procedures are being considered, we recommend **MRA or CTA** (↑↑).
2. In adults with asymptomatic carotid stenosis who are being considered for revascularization procedures, we recommend **MRA or CTA** (↑↑).

✦Ipsilateral carotid-territory cerebral or retinal ischaemic event (ischaemic stroke, transient ischaemic attack, transient monocular blindness, or retinal artery occlusion) within the preceding 6 mo.[29]

Arterial dissection/injury

For traumatic vascular injury, refer to the CAR Trauma guideline,[68] *scenario T07. Suspected head and neck vascular injury, including penetrating injury.*

CN03. MULTIPLE SCLEROSIS AND DEMYELINATING DISEASE[9,14,38,39,60]

1. In adults with suspected multiple sclerosis or demyelinating disease, we recommend **MRI** as the initial imaging modality (↑↑).

CN04. HEADACHE[9,13,15,21,35,51,57,59]

1. In adults with acute or chronic headache clinically suspected to be a benign primary headache disorder (eg, migraine, tension headache), we recommend **no routine imaging** (↓↓).
2. In adults with acute headache with red flags✧, we recommend **CT** as the initial imaging modality (↑↑).
↳ **2.1** If a vascular cause is suspected, we suggest **CTA/CTV** as an additional imaging modality (↑).
↳ **2.2** If a non-vascular cause is suspected, we suggest **MRI** as an additional imaging modality (↑).
3. In adults with chronic headache with concerning features✦, we recommend **MRI** as the initial imaging modality (↑↑).
↳ **3.1** If MRI is unavailable or contraindicated, we recommend **CT** as an alternative imaging modality (↑↑).

✧Such as, severe, sudden onset (“thunderclap”), features of intracranial hypertension or hypotension, new onset or pattern during pregnancy or peripartum period, increasing frequency or severity, fever or neurologic deficit, history of cancer or immunocompromise, older age (>50 y) of onset, or posttraumatic onset.[15]

✦Such as, recent onset and rapidly increasing frequency and severity of headache, headache causing the patient to wake from sleep, associated dizziness, lack of coordination, tingling or numbness, new neurologic deficit, new onset of a headache in a patient with a history of cancer or immunodeficiency.[9]

For traumatic vascular injury, refer to the CAR Trauma guideline,[68] *scenario T07. Suspected head and neck vascular injury, including penetrating injury.*

CN05. CONCUSSION

1. In adults with suspected acute concussion, refer to the CAR Trauma guideline,[68] scenario T01. Acute head trauma in adults.
2. In adults with post-concussion syndrome, we recommend **no routine imaging** (EPc).

CN06. PITUITARY AND JUXTASELLAR LESIONS[9]

1. In adults with pituitary and/or juxtasellar lesions, we recommend **MRI** as the initial imaging modality (↑↑).

CN07. CRANIAL NEUROPATHY, BRAIN STEM SYMPTOMS[9,16,36]

1. In adults with cranial neuropathy and/or brain stem symptoms, we recommend **MRI** as the initial imaging modality (↑↑).
↳ **1.1** If MRI is unavailable or contraindicated, we recommend **CT** as an alternate imaging modality (↑↑).

(continued)

Table 2. (continued)

Clinical/diagnostic scenario and recommendations

CN08. ALTERED INTRACRANIAL PRESSURE

CN08A. Idiopathic intracranial hypotension[15]

1. In adults with suspected or known idiopathic intracranial hypertension, we recommend **MRI/MRV or CT/CTV** as the initial imaging modality (↑↑).
Panel consensus is a preference for MRI/MRV.

CN08B. Spontaneous intracranial hypotension[9,15,17,55]

1. In adults with spontaneous intracranial hypotension, we recommend **head MRI with contrast** as the initial imaging modality (↑↑).
↳ **1.1** If MRI is unavailable or contraindicated, we recommend **CT** as an alternative imaging modality (↑↑).
↳ **1.2** If head MRI is positive, we recommend **whole spine MRI** as the next imaging modality (↑↑).

CN08C. Hydrocephalus, suspected shunt malfunction[9]

1. In adults with hydrocephalus, suspected shunt malfunction, we recommend **head CT and shunt series XR** as the initial imaging modalities (↑↑).

CN08D. Normal pressure hydrocephalus[18,50]

1. In adults with suspected normal pressure hydrocephalus✧, we recommend **MRI or CT** (↑↑).
✧Clinical triad for normal pressure hydrocephalus: mental/cognitive impairment, gait disturbance, and incontinence[18]

CN09. VESTIBULAR AND COCHLEAR SYMPTOMS

CN09A. Hearing loss[9,19,53,54,61,65,66]

1. In adults with unexplained conductive hearing loss, we recommend **CT temporal bone** as the initial imaging modality (↑↑).
2. In adults with sensorineural hearing loss, we recommend **MRI** as the initial imaging modality (↑↑).

CN09B. Vertigo[9,19,53,54]

1. In adults with brief episodic vertigo, we recommend **no routine imaging** (↓↓).
2. In adults with persistent peripheral vertigo, we suggest **MRI or temporal bone CT** as the initial imaging modality (↑).
3. In adults with persistent central vertigo, we recommend **MRI/MRA or CT/CTA** as the initial imaging modality (↑↑).

CN10. MENTAL STATUS CHANGE

CN10A. Acute (eg, delirium, first-onset episode)[9,20]

1. In adults with unexplained acute mental status changes, we recommend **CT** as the initial imaging modality (↑↑).
↳ **1.1** If CT is negative and occult pathology is suspected, we recommend **MRI** as the next imaging modality (↑↑).
CT and MRI have a low yield in those with new onset psychosis and no neurologic deficit

CN10B. Dementia/memory loss[9,14,18,27]

1. In adults with suspected dementia (including rapidly progressive dementia), we recommend **MRI** as the initial imaging modality (↑↑).
↳ **1.1** If MRI is unavailable, we suggest **CT** as a suitable interim modality until MRI is available (↑).

CN11. VISUAL LOSS[9,24,25,40,52,67]

Etiology of visual loss is often identified on ocular exam.[69] If imaging is required, then:
1. In adults with acute visual loss, we recommend **CT/CTA** as the initial imaging modality (↑↑).
2. In adults with progressive/chronic visual loss, we recommend **MRI** as the initial imaging modality (↑↑).

CN12. EPILESPY AND SEIZURE[9,11,44,62,63]

1. In adults with established epilepsy presenting at an emergency department after a typical seizure, we **recommend no routine imaging** (↓↓).
↳ **1.1** If there is concern for an acute intracranial injury or a significant change in the pattern of seizures, we recommend **CT or MRI** as the initial imaging modality (↑↑).
2. In adults with new onset seizure, we recommend **CT or MRI** as the initial imaging modality (↑↑).
If concern for CNS infection, see CN13, for cerebrovascular disease, see CN02.

(continued)

Table 2. (continued)

Clinical/diagnostic scenario and recommendations
CN13. CNS INFECTION
1. In adults with suspected CNS infection✧, we recommend **MRI brain with contrast** as the initial imaging modality (EP consensus). ✧For example, meningitis, ventriculitis, encephalitis
CN14. INTRACRANIAL SPACE-OCCUPYING LESIONS[10,26,32,41-44,46,49,56]
1. In adults with suspected intracranial space-occupying lesions, we recommend **MRI or CT** as the initial imaging modality (↑↑).
CN15. SUSPECTED CEREBRAL VENOUS SINUS THROMBOSIS[12,30,33]
1. In adults with suspected venous sinus thrombosis, we recommend **MRI/MRV or CT/CTV** as the initial imaging modality (↑↑).
CN16. VASCULITIS[13,24,25,40,47,52]
1. In adults with suspected CNS vasculitis, we recommend **CT/CTA ± MRI** as the initial imaging modality (↑↑). **2.** In adults with suspected giant cell/temporal arteritis, where biopsy is not performed, we suggest **MRI or US** as the initial imaging modality (↑).
CN17. MOVEMENT DISORDERS/PARKINSONISM[14,28]
1. In adults with movement disorders/Parkinsonism, we recommend **MRI** as the initial imaging modality (↑↑).
CN18. METABOLIC AND TOXIC ENCEPHALOPATHIES[31,45]
1. In adults with suspected metabolic or toxic encephalopathy, we recommend **against routine imaging** (↓↓). ↳ **1.1** If there remains diagnostic uncertainty or non-response to treatment, we recommend **CT or MRI** as the initial imaging modality (↑↑). ↳ **1.2** If there is clinical suspicion of PRES, we recommend **MRI** as the initial imaging modality (EPc). PRES: Posterior Reversible Encephalopathy Syndrome
CN19. ANEURYSM SCREENING[13]
1. In adults at high risk✧ for cerebral aneurysm, we recommend **MRI/MRA or CT/CTA** (↑↑). ✧Patients with autosomal dominant polycystic kidney disease,[13] patients with ≥2 family members with intracranial aneurysms or subarachnoid haemorrhage. A higher risk of aneurysm occurrence in such families is found in those with a history of hypertension, smoking, and female sex.[70]

Note. Strength of recommendation: ↑↑ = strong for; ↑ = conditional for; ↓↓ = strong against; ↓ = conditional against; EPc = Expert Panel consensus. CT = computed tomography; CTA = computed tomography angiography; CTV = computed tomography venography; MRA = magnetic resonance angiography; MRI = magnetic resonance imaging; MRV = magnetic resonance venography; US = ultrasound; XR = radiography.

Committee,[52] the Meniere's disease guideline,[53,54] the Multidisciplinary Specialists Interest Group,[55] the National Institute for Health and Care Excellence,[56-63] the Society of NeuroInterventional Surgery,[64] the Sudden Hearing Loss guideline,[65,66] and the Swedish Society of Rheumatology.[67]

Recommendations are presented in Table 2.

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Supplemental Material

Supplemental material for this article is available online.

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