



# Test Definition: PNEFC

## Neuroimmunology Antibody Follow-up, Spinal Fluid

### Overview

### Useful For

Monitoring patients who have previously tested positive for 1 or more antibodies within the past 5 years in a Mayo Clinic Neuroimmunology Laboratory spinal fluid evaluation

### Reflex Tests

| Test Id | Reporting Name                       | Available Separately | Always Performed |
|---------|--------------------------------------|----------------------|------------------|
| AMPCC   | AMPA-R Ab CBA, CSF                   | No                   | No               |
| AMPHC   | Amphiphysin Ab, CSF                  | No                   | No               |
| AGN1C   | Anti-Glial Nuclear Ab, Type 1        | No                   | No               |
| ANN1C   | Anti-Neuronal Nuclear Ab, Type 1     | No                   | No               |
| ANN2C   | Anti-Neuronal Nuclear Ab, Type 2     | No                   | No               |
| ANN3C   | Anti-Neuronal Nuclear Ab, Type 3     | No                   | No               |
| CS2CC   | CASPR2-IgG CBA, CSF                  | No                   | No               |
| CRMWC   | CRMP-5-IgG Western Blot, CSF         | No                   | No               |
| CRMC    | CRMP-5-IgG, CSF                      | No                   | No               |
| GABCC   | GABA-B-R Ab CBA, CSF                 | No                   | No               |
| LG1CC   | LGI1-IgG CBA, CSF                    | No                   | No               |
| NMDCC   | NMDA-R Ab CBA, CSF                   | No                   | No               |
| PCTRC   | Purkinje Cell Cytoplasmic Ab Type Tr | No                   | No               |
| PCA1C   | Purkinje Cell Cytoplasmic Ab Type 1  | No                   | No               |
| PCA2C   | Purkinje Cell Cytoplasmic Ab Type 2  | No                   | No               |
| DPPCC   | DPPX Ab CBA, CSF                     | No                   | No               |
| DPPIC   | DPPX Ab IFA, CSF                     | No                   | No               |
| GL1CC   | mGluR1 Ab CBA, CSF                   | No                   | No               |
| GL1IC   | mGluR1 Ab IFA, CSF                   | No                   | No               |
| AGNBC   | AGNA-1 Immunoblot, CSF               | No                   | No               |
| AINCC   | Alpha Internexin CBA, CSF            | No                   | No               |
| AMIBC   | Amphiphysin Immunoblot, CSF          | No                   | No               |
| AN1BC   | ANNA-1 Immunoblot, CSF               | No                   | No               |

|       |                          |    |    |
|-------|--------------------------|----|----|
| AN2BC | ANNA-2 Immunoblot, CSF   | No | No |
| APBCC | AP3B2 CBA, CSF           | No | No |
| APBIC | AP3B2 IFA, CSF           | No | No |
| GFACC | GFAP CBA, CSF            | No | No |
| GFAIC | GFAP IFA, CSF            | No | No |
| GRFCC | GRAF1 CBA, CSF           | No | No |
| GRFIC | GRAF1 IFA, CSF           | No | No |
| IG5CC | IgLON5 CBA, CSF          | No | No |
| IG5IC | IgLON5 IFA, CSF          | No | No |
| ITPCC | ITPR1 CBA, CSF           | No | No |
| ITPIC | ITPR1 IFA, CSF           | No | No |
| NCDIC | Neurochondrin IFA, CSF   | No | No |
| NCDCC | Neurochondrin CBA, CSF   | No | No |
| NFHCC | NIF Heavy Chain CBA, CSF | No | No |
| NIFIC | NIF IFA, CSF             | No | No |
| NFLCC | NIF Light Chain CBA, CSF | No | No |
| PC1BC | PCA-1 Immunoblot, CSF    | No | No |
| PCTBC | PCA-Tr Immunoblot, CSF   | No | No |
| SP5CC | Septin-5 CBA, CSF        | No | No |
| SP5IC | Septin-5 IFA, CSF        | No | No |
| SP7CC | Septin-7 CBA, CSF        | No | No |
| SP7IC | Septin-7 IFA, CSF        | No | No |
| PDEIC | PDE10A Ab IFA, CSF       | No | No |
| T46CC | TRIM46 Ab CBA, CSF       | No | No |
| T46IC | TRIM46 Ab IFA, CSF       | No | No |

**Method Name**

AMPHC, AGN1C, ANN1C, ANN2C, ANN3C, PCTRC, PCA1C, PCA2C, DPPTC, GL1IC, GFAIC, IG5IC, ITPIC, GRFIC, NIFIC, APBIC, SP5IC, SP7IC, CRMC, NCDIC, DPPIC, PDEIC, T46IC: Indirect Immunofluorescence Assay (IFA)

AMPCC, CS2CC, GABCC, LG1CC, NMDCC, DPPCC, GL1CC, GFACC, IG5CC, ITPCC, GRFCC, NFLCC, NFHCC, AINCC, APBCC, NCDCC, SP5CC, SP7CC, T46CC: Cell Binding Assay (CBA)

CRMWC: Western Blot (WB)

AN1BC, AN2BC, AMIBC, PC1BC, PCTBC, AGNBC: Immunoblot (IB)

**NY State Available**

Yes

**Specimen**
**Specimen Type**

CSF

## Ordering Guidance

This test is only appropriate for follow-up in patients who have previously tested positive in a spinal fluid test. If patients have not previously been positive in a spinal fluid test, order one of the following:

- DMC2 / Dementia, Autoimmune/Paraneoplastic Evaluation, Spinal Fluid
- ENC2 / Encephalopathy, Autoimmune/Paraneoplastic Evaluation, Spinal Fluid
- EPC2 / Epilepsy, Autoimmune/Paraneoplastic Evaluation, Serum
- MAC1 / Myelopathy, Autoimmune/Paraneoplastic Evaluation, Spinal Fluid
- MDC2 / Movement Disorder, Autoimmune/Paraneoplastic Evaluation, Spinal Fluid
- PCDEC / Pediatric Autoimmune Encephalopathy/CNS Disorder Evaluation, Spinal Fluid
- SPPC / Stiff-Person Spectrum Disorders/PERM Evaluation, Spinal Fluid

This test should not be requested in patients who have recently received radioisotopes, therapeutically or diagnostically, because of potential assay interference. The specific waiting period before specimen collection will depend on the isotope administered, the dose given, and the clearance rate in the individual patient. Specimens will be screened for radioactivity prior to analysis. Radioactive specimens received in the laboratory will be held 1 week and assayed if sufficiently decayed or canceled if radioactivity remains.

## Specimen Required

**Container/Tube:** Sterile vial

**Preferred:** Vial number 1

**Acceptable:** Any vial

**Specimen Volume:** 4 mL

## Forms

If not ordering electronically, complete, print, and send a [Neurology Specialty Testing Client Test Request \(T732\)](#) with the specimen.

## Specimen Minimum Volume

2 mL

## Reject Due To

|                 |        |
|-----------------|--------|
| Gross hemolysis | Reject |
| Gross lipemia   | Reject |
| Gross icterus   | Reject |

## Specimen Stability Information

| Specimen Type | Temperature              | Time     | Special Container |
|---------------|--------------------------|----------|-------------------|
| CSF           | Refrigerated (preferred) | 28 days  |                   |
|               | Ambient                  | 72 hours |                   |
|               | Frozen                   | 28 days  |                   |

## Clinical & Interpretive

### Clinical Information

Paraneoplastic autoimmune neurological disorders reflect a patient's humoral and cellular immune responses to cancer. The cancer may be new or recurrent, is usually limited in metastatic volume, and is often occult by standard imaging procedures. Autoantibodies specific for onconeural proteins found in the plasma membrane, cytoplasm, and nucleus of neurons or muscle are generated in this immune response and serve as serological markers of paraneoplastic autoimmunity. The most recognized cancers in this context are small-cell lung carcinoma, thymoma, ovarian (or related mullerian) carcinoma, breast carcinoma, and Hodgkin lymphoma. Pertinent childhood neoplasms recognized thus far include neuroblastoma, thymoma, Hodgkin lymphoma, and chondroblastoma. An individual patient's autoantibody profile can predict a specific neoplasm with 90% certainty but not the neurological syndrome.

Three classes of autoantibodies are recognized in the spinal fluid analysis:

- Neuronal nuclear (antineuronal nuclear antibody-type 1 [ANNA-1], ANNA-2, ANNA-3)
- Neuronal and muscle cytoplasmic (Purkinje cell cytoplasmic antibody, type 1 [PCA-1]; PCA-2; PCA-Tr, collapsin response-mediator protein-5 [CRMP-5], and amphiphysin)
- Glial nuclear (antiglial nuclear antibody: AGNA)

Patients who are seropositive usually present with subacute neurological signs and symptoms. The patient may present with encephalopathy, cerebellar ataxia, myelopathy, radiculopathy, plexopathy, sensory, sensorimotor, or autonomic neuropathy, with or without coexisting evidence of a neuromuscular transmission disorder: Lambert-Eaton syndrome, myasthenia gravis, or neuromuscular hyperexcitability. Initial signs may be subtle, but a subacute multifocal and progressive syndrome usually evolves. Sensorimotor neuropathy and cerebellar ataxia are common presentations, but the clinical picture in some patients is dominated by striking gastrointestinal dysmotility, limbic encephalopathy, basal ganglionitis, or cranial neuropathy (especially loss of vision, hearing, smell, or taste). Cancer risk factors include past or family history of cancer, history of smoking, or social/environmental exposure to carcinogens. Early diagnosis and treatment of the neoplasm favor less neurological morbidity and offer the best hope for survival.

### Reference Values

| Test ID | Reporting Name                   | Methodology* | Reference Value |
|---------|----------------------------------|--------------|-----------------|
| AGNBC   | AGNA-1 Immunoblot, CSF           | IB           | Negative        |
| AINCC   | Alpha Internexin CBA, CSF        | CBA          | Negative        |
| AMPCC   | AMPA-R Ab CBA, CSF               | CBA          | Negative        |
| AMPHC   | Amphiphysin Ab, CSF              | IFA          | Negative        |
| AMIBC   | Amphiphysin Immunoblot, CSF      | IB           | Negative        |
| AN1BC   | ANNA-1 Immunoblot, CSF           | IB           | Negative        |
| AN2BC   | ANNA-2 Immunoblot, CSF           | IB           | Negative        |
| AGN1C   | Anti-Glial Nuclear Ab Type 1     | IFA          | Negative        |
| ANN1C   | Anti-Neuronal Nuclear Ab, Type 1 | IFA          | Negative        |
| ANN2C   | Anti-Neuronal Nuclear Ab, Type 2 | IFA          | Negative        |
| ANN3C   | Anti-Neuronal Nuclear Ab, Type 3 | IFA          | Negative        |
| APBCC   | AP3B2 CBA, CSF                   | CBA          | Negative        |

|       |   |     |          |
|-------|---|-----|----------|
| APBIC | AP3B2 IFA, CSF                          | IFA | Negative |
| CS2CC | CASPR2-IgG CBA, CSF                     | CBA | Negative |
| CRMWC | CRMP-5-IgG Western Blot, CSF            | WB  | Negative |
| CRMC  | CRMP-5-IgG, CSF                         | IFA | Negative |
| DPPCC | DPPX Ab CBA, CSF                        | CBA | Negative |
| DPPIC | DPPX Ab IFA, CSF                        | IFA | Negative |
| GABCC | GABA-B-R Ab CBA, CSF                    | CBA | Negative |
| GFACC | GFAP CBA, CSF                           | CBA | Negative |
| GFAIC | GFAP IFA, CSF                           | IFA | Negative |
| GRFCC | GRAF1 CBA, CSF                          | CBA | Negative |
| GRFIC | GRAF1 IFA, CSF                          | IFA | Negative |
| IG5CC | IgLON5 CBA, CSF                         | CBA | Negative |
| IG5IC | IgLON5 IFA, CSF                         | IFA | Negative |
| ITPCC | ITPR1 CBA, CSF                          | CBA | Negative |
| ITPIC | ITPR1 IFA, CSF                          | IFA | Negative |
| LG1CC | LGI1-IgG CBA, CSF                       | CBA | Negative |
| GL1CC | mGluR1 Ab CBA, CSF                      | CBA | Negative |
| GL1IC | mGluR1 Ab IFA, CSF                      | IFA | Negative |
| NCDCC | Neurochondrin CBA, CSF                  | CBA | Negative |
| NCDIC | Neurochondrin IFA, CSF                  | IFA | Negative |
| NFHCC | NIF Heavy Chain CBA, CSF                | CBA | Negative |
| NFIC  | NIF IFA, CSF                            | IFA | Negative |
| NFLCC | NIF Light Chain CBA, CSF                | CBA | Negative |
| NMDCC | NMDA-R Ab CBA, CSF                      | CBA | Negative |
| PC1BC | PCA-1 Immunoblot, CSF                   | IB  | Negative |
| PCTBC | PCA-Tr Immunoblot, CSF                  | IB  | Negative |
| PCTRC | Purkinje Cell Cytoplasmic Ab Type<br>Tr | IFA | Negative |
| PCA1C | Purkinje Cell Cytoplasmic Ab Type<br>1  | IFA | Negative |
| PCA2C | Purkinje Cell Cytoplasmic Ab Type<br>2  | IFA | Negative |
| SP5CC | Septin-5 CBA, CSF                       | CBA | Negative |
| SP5IC | Septin-5 IFA, CSF                       | IFA | Negative |
| SP7CC | Septin-7 CBA, CSF                       | CBA | Negative |
| SP7IC | Septin-7 IFA, CSF                       | IFA | Negative |
| PDEIC | PDE10A Ab IFA, CSF                      | IFA | Negative |
| T46CC | TRIM46 Ab CBA, CSF                      | CBA | Negative |
| T46IC | TRIM46 Ab IFA, CSF                      | IFA | Negative |

\*Methodology abbreviations:

CBA: Cell-binding assay

IB: Immunoblot

IFA: Immunofluorescence assay

WB: Western blot (WB)

### Interpretation

Antibodies directed at onconeural proteins shared by neurons, muscle, and certain cancers are valuable serological markers of a patient's immune response to cancer. They are not found in healthy subjects and are usually accompanied by subacute neurological signs and symptoms. Several autoantibodies have a syndromic association, but no known autoantibody predicts a specific neurological syndrome. Conversely, a positive autoantibody profile has 80% to 90% predictive value for a specific cancer. It is not uncommon for more than one paraneoplastic autoantibodies to be detected, each predictive of the same cancer.

### Cautions

This test should only be utilized when the presence of paraneoplastic autoantibodies has been previously documented.

This test should not be requested in patients who have recently received radioisotopes, therapeutically or diagnostically, because of potential assay interference. The specific waiting period before specimen collection will depend on the isotope administered, the dose given and the clearance rate in the individual patient. Specimens will be screened for radioactivity prior to analysis. Radioactive specimens received in the laboratory will be held 1 week and assayed if sufficiently decayed, or canceled if radioactivity remains.

### Clinical Reference

1. Lancaster E, Martinez-Hernandez E, Dalmau J. Encephalitis and antibodies to synaptic and neuronal cell surface proteins. *Neurology*. 2011;77(2):179-189. doi:10.1212/WNL.0b013e318224afde
2. Horta ES, Lennon VA, Lachance DH, et al. Neural autoantibody clusters aid diagnosis of cancer. *Clin Cancer Res*. 2014;20(14):3862-3869
3. Gilligan M, McGuigan C, McKeon A..Paraneoplastic neurologic Disorders. *Curr Neurol Neurosci Rep*. 2023;23(3):67-82. doi:10.1007/s11910-023-01250-w
4. Graus F, Vogrig A, Muniz-Castrillo S, et al. Updated diagnostic criteria for paraneoplastic neurologic syndromes. *Neurol Neuroimmunol Neuroinflamm*. 2021;8(4):e1014. doi:10.1212/NXI.0000000000001014

### Performance

#### Method Description

Indirect Immunofluorescence Assay (IFA):

The patient's specimen is tested by a standardized immunofluorescence assay that uses a composite frozen section of mouse cerebellum, kidney, and gut tissues. After incubation with the specimen and washing, fluorescein-conjugated goat-antihuman IgG is applied. Neuron-specific autoantibodies are identified by their characteristic fluorescence staining patterns. Specimens that are scored positive for any neuronal nuclear or cytoplasmic autoantibody are titrated. Interference by coexisting non-neuron-specific autoantibodies can usually be eliminated by serologic absorption.(Honorat JA, Komorowski L, Josephs KA, et al. IgLON5 antibody: Neurological accompaniments and outcomes in 20 patients. *Neurol Neuroimmunol Neuroinflamm*. 2017;4[5]:e385. Published 2017 Jul 18. doi:10.1212/NXI.0000000000000385)

**Cell-Binding Assay (CBA):**

Patient specimen is applied to a composite slide containing transfected and nontransfected HEK-293 cells. After incubation and washing, fluorescein-conjugated goat-antihuman IgG is applied to detect the presence of patient IgG binding. (Unpublished Mayo method)

**Immunoblot (IB):**

All steps are performed at ambient temperature (18-28 degrees C) utilizing the EUROBlot One instrument. Diluted patient specimen (1:101) is added to test strips (strips containing recombinant antigen manufactured and purified using biochemical methods) in individual channels and incubated for 30 minutes. Positive samples will bind to the purified recombinant antigen, and negative samples will not bind. Strips are washed to remove unbound antibodies and then incubated with anti-human IgG antibodies (alkaline phosphatase-labelled) for 30 minutes. The strips are again washed to remove unbound anti-human IgG antibodies, and nitroblue tetrazolium chloride/5-bromo-4-chloro-3-indolyl phosphate substrate is added. Alkaline phosphatase enzyme converts the soluble substrate into a colored insoluble product on the membrane to produce a black band. Strips are digitized via picture capture on the EUROBlot One instrument and evaluated with the EUROLineScan software. (O'Connor K, Waters P, Komorowski L, et al. GABAA receptor autoimmunity: A multicenter experience. *Neurol Neuroimmunol Neuroinflamm*. 2019;6[3]:e552. doi:10.1212/NXI.000000000000552)

**Western Blot (WB):**

Neuronal antigens extracted aqueously from adult rat cerebellum, full-length recombinant human collapsin response-mediator protein-5 (CRMP-5), or full-length recombinant human amphiphysin protein is denatured, reduced, and separated by electrophoresis on 10% polyacrylamide gel. IgG is detected autoradiographically by enhanced chemiluminescence. (Yu Z, Kryzer TJ, Griesmann GE, et al. CRMP-5 neuronal autoantibody: marker of lung cancer and thymoma-related autoimmunity. *Ann Neurol* 2001 February;49[2]:146-154; Dubey D, Jitprapaikulsan J, Bi H, et al: Amphiphysin-IgG autoimmune neuropathy: A recognizable clinicopathologic syndrome. *Neurology*. 2019;93[20] e1873-e1880. doi:10.1212/WNL.0000000000008472)

**PDF Report**

No

**Day(s) Performed**

Varies

**Report Available**

Varies

**Specimen Retention Time**

2 days

**Performing Laboratory Location**

Mayo Clinic Laboratories - Rochester Main Campus

**Fees & Codes**

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**Fees**

- Authorized users can sign in to [Test Prices](#) for detailed fee information.
- Clients without access to Test Prices can contact [Customer Service](#) 24 hours a day, seven days a week.
- Prospective clients should contact their account representative. For assistance, contact [Customer Service](#).

**Test Classification**

This test was developed and its performance characteristics determined by Mayo Clinic in a manner consistent with CLIA requirements. It has not been cleared or approved by the US Food and Drug Administration.

**CPT Code Information**

84182 AGNBC (if appropriate)  
86255 AINCC (if appropriate)  
86255 AMPCC (if appropriate)  
86255 AMPHC (if appropriate)  
84182 AMIBC (if appropriate)  
84182 AN1BC (if appropriate)  
84182 AN2BC (if appropriate)  
86255 AGN1C (if appropriate)  
86255 ANN1C (if appropriate)  
86255 ANN2C (if appropriate)  
86255 ANN3C (if appropriate)  
86255 APBCC (if appropriate)  
86255 APBIC (if appropriate)  
86255 CS2CC (if appropriate)  
84182 CRMWC (if appropriate)  
86255 CRMC (if appropriate)  
86255 DPPCC (if appropriate)  
86255 DPPIC (if appropriate)  
86255 GABCC (if appropriate)  
86255 GFACC (if appropriate)  
86255 GFAIC (if appropriate)  
86255 GRFCC (if appropriate)  
86255 GRFIC (if appropriate)  
86255 IG5CC (if appropriate)  
86255 IG5IC (if appropriate)  
86255 ITPCC (if appropriate)  
86255 ITPIC (if appropriate)  
86255 LG1CC (if appropriate)  
86255 GL1CC (if appropriate)  
86255 GL1IC (if appropriate)  
86255 NCDCC (if appropriate)  
86255 NCDIC (if appropriate)  
86255 NFHCC (if appropriate)  
86255 NIFIC (if appropriate)

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86255 NFLCC (if appropriate)  
86255 NMDCC (if appropriate)  
84182 PC1BC (if appropriate)  
84182 PCTBC (if appropriate)  
86255 PCTRC (if appropriate)  
86255 PCA1C (if appropriate)  
86255 PCA2C (if appropriate)  
86255 PDEIC (if appropriate)  
86255 SP5CC (if appropriate)  
86255 SP5IC (if appropriate)  
86255 SP7CC (if appropriate)  
86255 SP7IC (if appropriate)  
86255 T46CC (if appropriate)  
86255 T46IC (if appropriate)

**LOINC® Information**

| Test ID | Test Order Name                   | Order LOINC® Value |
|---------|-----------------------------------|--------------------|
| PNEFC   | Neuroimmunology Ab Follow-up, CSF | 80615-8            |

| Result ID | Test Result Name                  | Result LOINC® Value |
|-----------|-----------------------------------|---------------------|
| 84299     | Neuroimmunology Ab Follow-up, CSF | 80615-8             |