Protocol for the Examination of Plasma Cell Malignancies and Immunoglobulin Deposition Related Disorders

Version: 1.0.0.0
Protocol Posting Date: September 2023
The use of this protocol is recommended for clinical care purposes but is not required for accreditation purposes.
This protocol applies to plasma cell malignancies and immunoglobulin deposition-related disorders involving bone marrow, blood, lymph node, extranodal/mucosal site, and any other anatomic site.

The following tumor types should be reported using this protocol:

Tumor Type
Plasma cell neoplasms including plasma cell myeloma/ multiple myeloma, Smoldering (asymptomatic) myeloma, Solitary plasmacytoma of bone, Extramedullary plasmacytoma, Plasma cell leukemia
Immunoglobulin-related (AL) amyloidosis including Systemic AL amyloidosis, Localized AL amyloidosis, Heavy chain amyloidosis
Monoclonal immunoglobulin deposition disease including Light chain deposition disease, Light and heavy chain deposition disease, Heavy chain deposition disease
Heavy chain diseases including Mu heavy chain disease, Gamma heavy chain disease, Alpha heavy chain disease

The following tumor types should NOT be reported using this protocol:

Tumor Type
Monoclonal gammopathies including cold agglutinin disease, IgM monoclonal gammopathy of undetermined significance, Non-IgM monoclonal gammopathy of undetermined significance
Plasmablastic lymphoma (use Precursor and Mature Lymphoid malignancies protocol)

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Accreditation Requirements

The use of this case summary is recommended for clinical care purposes but is not required for accreditation purposes. The core and conditional data elements are routinely reported. Non-core data elements are indicated with a plus sign (+) to allow for reporting information that may be of clinical value.

Replaced by version 1.0.0.1 on September 17, 2025, Obsolete as of June 2026 (8 months after newest release date)

Summary of Changes

v 1.0.0.0

- New protocol replacing retired Plasma Cell Neoplasms protocol

Reporting Template

Protocol Posting Date: September 2023
Select a single response unless otherwise indicated.

CASE SUMMARY: (PLASMA CELL MALIGNANCIES AND IMMUNOGLOBULIN DEPOSITION RELATED DISORDERS)

TUMOR

Site(s) of Tumor Involvement in Sample (Note A) (select all that apply)
___ Bone marrow (non-targeted)
Specify Percent Involvement of Clonal Cells, if possible: _____ %
___ Blood
Specify Percent Involvement of Clonal Cells, if possible: _____ %
___ Bone (targeted biopsy, specify location): _____
___ Lymph node (targeted biopsy, specify location): _____
___ Extranodal / mucosal site (targeted biopsy, specify location): _____
___ Other (specify): _____

Final Integrated Diagnosis (Note B)
Plasma cell neoplasms and other diseases with paraproteins
___ Plasma cell neoplasms
___ Solitary plasmacytoma of bone
___ Extramedullary plasmacytoma
___ Plasma cell neoplasm involving bone marrow (clinical information required)
___ Plasma cell myeloma / multiple myeloma
___ Smoldering (asymptomatic) myeloma
___ Plasma cell leukemia
___ Other plasma cell neoplasm (specify): _____
___ Immunoglobulin-related (AL) amyloidosis
___ Systemic AL amyloidosis
___ Localized AL amyloidosis
___ Heavy chain amyloidosis
___ Monoclonal immunoglobulin deposition diseases
___ Light chain deposition disease
___ Light and heavy chain deposition disease
___ Heavy chain deposition disease
___ Heavy chain diseases
___ Mu heavy chain disease
___ Gamma heavy chain disease
___ Alpha heavy chain disease

SPECIAL STUDIES (Note C)

Immunoglobulin Depositions
___ Not detected on routine (H&E) stain
___ Not detected on Congo Red stain
___ Positive for amyloid on Congo Red
___ Positive for non-amyloid deposition (specify): _____

Immunohistochemistry
___ Not performed
___ Performed (specify results): _____
___ Pending

Flow Cytometry
___ Not performed
___ No aberrancy detected at level of sensitivity of assay
___ Positive for abnormal population (specify immunophenotype, if possible): _____
___ Pending

Conventional Cytogenetics
___ Not performed
___ No valid result(s) / no growth
___ Normal diploid karyotype
___ Abnormal karyotype (specify, if possible): _____
___ Pending

Fluorescence in situ Hybridization (select all that apply)
___ Not performed
___ Normal probes (specify loci tested): _____
___ Hyperdiploidy
___ 13q (RB1) deletion
___ 1q21 gain / amplification (CKS1B, ADAR1)
___ 1p32 deletion (CDKN2C)
___ t(11;14) (q13;q32) (CCND1::IGH) translocation
___ t(4;14) (p16;q32) (FGFR3::IGH) translocation
___ t(14;16) (q32;q23) (IGH::MAF) translocation
___ t(6;14) (p25;q32) (CCND3::IGH) translocation
___ t(12;14) (p13;q32) (CCND2::IGH) translocation
___ t(14;20) (q32;q11) (IGH::MAFB) translocation
___ t(8;14) (q24;q32) (MYC::IGH) translocation
___ 17p13 (TP53) deletion
___ Abnormal probes (specify loci tested): _____

+Molecular Alterations Detected
___ Not performed
___ No alterations detected
___ Abnormality detected (specify): _____

+Specify Molecular Alterations Assayed: _____

COMMENTS

Comment(s): _____

Explanatory Notes

A. Site of Involvement in Sample

Specify the site of involvement in the sample. Each of the choices includes if this is a targeted (directed at a particular bony or extramedullary lesion) or non-targeted biopsy. For bone marrow specimens accompanied with a blood sample, both bone marrow and blood can be selected if desired to facilitate reporting of any circulating clonal plasma cells in plasma cell myeloma. Report the percentage of clonal cells for bone marrow and/or blood-typically plasma cells for PCM/MM, abnormal clonal B-cells in heavy chain diseases. For targeted biopsies, specify the location of the biopsy.

B. Final Integrated Diagnosis

The final integrated diagnosis for plasma cell neoplasms and immunoglobulin deposition disorders are derived from the WHO 5th edition of Haematolymphoid tumors.[1] Many of the new entities incorporated into the WHO 5th edition represent additions to the entities recognized in the category of monoclonal gammopathies, such as cold agglutin disease (CAD) or monoclonal gammopathy of renal significance (MGRS). In addition, paraneoplastic syndromes recognized to occur in association with plasma cell myeloma have been incorporated in WHO 5th edition including TEMPI syndrome (telangiectasia, elevated erythropoietin and erythrocytosis, monoclonal gammopathy, perinephric fluid collection and intrapulmonary shunting) and AESOP syndrome (adenopathy and extensive skin patch overlying plasmacytoma). While these are important clinically, since they either represent clinical manifestations of premalignant or overt plasma cell myeloma, they are not included as specific diagnostic entities in the cancer case summary.

Updates to the diagnostic criteria for plasma cell myeloma and staging using the Revised International Staging System for Multiple Myeloma proposed by the International Myeloma Working Group (IMWG) has been incorporated in the WHO 5th edition.

The full diagnostic criteria for the diagnostic categories in the WHO 5th edition are well summarized in the WHO monograph and beyond the scope of the explanatory notes. Essential diagnostic information is included in the explanatory notes to serve as a quick reference. Specific categories that may benefit from additional explanation, particularly regarding use of the cancer case summary, are discussed.

Plasma cell neoplasms

Solitary plasmacytoma of bone (SPB)/extramedullary plasmacytoma (EMP)

Plasmacytoma is a solitary, clonal neoplasm of plasma cells without clinical or pathologic evidence of plasma cell myeloma/multiple myeloma or evidence of end-organ damage attributable to plasma cell neoplasia. There are two subtypes of plasmacytoma that are listed in the diagnostic choices in the cancer case summary: solitary plasmacytoma or bone (SPB) and extramedullary plasmacytoma (EMP). Biopsies for solitary plasmacytoma of bone are typically targeted at a lytic lesion involving the axial/hematopoietic skeleton, frequently spine, pelvis, ribs, or skull.

Extramedullary plasmacytoma (EMP) frequently involves the upper respiratory tract with much less frequent involvement of lymph nodes, lung, or other sites. An important consideration for extramedullary plasmacytoma (EMP) is to exclude the presence of a B-cell lymphoma that displays marked plasma cell differentiation, typically nodal or extranodal marginal zone lymphomas. These can be distinguished by mature B-cell immunophenotype (CD19+, CD20 more than moderate intensity), IgM expression, and absence of typical immunophenotype for plasma cell neoplasms.[2] In addition, flow cytometry can demonstrate monotypic light chain expression on B-cells. In cases displaying plasmablastic morphology characterized by enlarged, atypical plasmacytoid cells with high proliferative fraction as determined by Ki-

67 immunohistochemistry, it is important to exclude plasmablastic lymphoma. These typically occur in immunosuppressed or elderly with frequent demonstration of Epstein Barr virus (EBV), (EBV early RNA by in-situ hybridization, EBER), and MYC rearrangements.

Following biopsy, these patients should undergo a thorough evaluation to exclude PCM/MM. For use of the cancer case summary, it is still acceptable to diagnose SBP or EMP with a notation in the narrative report or comment that this diagnosis requires exclusion of PCM/MM.

Plasma cell neoplasm involving bone marrow
Plasma cell myeloma/multiple myeloma (PCM/MM) is a bone marrow-based, multifocal neoplastic proliferation of plasma cells very frequently associated with production of a monoclonal immunoglobulin in serum and/or urine with associated evidence of end-organ damage. The diagnosis of PCM/MM relies on the integration of pathologic findings and clinical findings. The diagnostic criteria for PCM/MM are summarized in Table 1. Briefly, PCM/MM is defined by ≥ 10% clonal plasma cells on a non-targeted bone marrow sampling or biopsy proven plasmacytoma on targeted biopsy and one or more myeloma defining events, either end-organ damage (CRAB criteria outlined below) or myeloma defining biomarkers.

Since the diagnosis is based on the integration of clinical findings, such as radiographic studies or laboratory values that may not be available to the pathologist; the cancer case summary includes a diagnostic category of “Plasma cell neoplasm involving bone marrow (clinical information required)”. The percentage of clonal plasma cells is to be specified in the morphologic findings.

If clinical criteria are available or provided, PCM/MM may be selected in the cancer case summary. The subtype of smoldering (asymptomatic) myeloma is an optional selection if it is known there is no evidence of end-organ damage, amyloidosis or myeloma defining biomarkers, and sufficient serum or urine monoclonal protein (IgG or IgA ≥ 3% gm/dL in serum, ≥ 500 mg per 24h in urine).

The WHO 5th edition lowered the threshold to diagnose plasma cell leukemia (PCL) to require only ≥ 5% circulating plasma cells in blood in patients otherwise diagnosed with PCL/MM. If blood smears meeting criteria are available for review as part of a bone marrow specimen. It is recommended to perform a minimum 100-200 nucleated cell count on blood for newly diagnosed PCM/MM patients.[3]

The diagnostic category “Plasma cell neoplasm, other specify” can be used for those who wish to use this cancer case summary to render a preliminary diagnosis prior to receipt of all the pending ancillary studies. Ideally, when this approach is used a final integrated report would be issued that includes all the pertinent information.

Table 1: SUMMARY OF DIAGNOSTIC CRITERIA FOR PLASMA CELL NEOPLASM[1]

Subtype	Essential diagnostic criteria
Plasmacytoma	• Biopsy-proven clonal plasma cell neoplasm of bone or extramedullary site • No clonal B cells • No other lesions on physical examination or radiographic studies • No end-organ damage (hyper**C**alcemia, **R**enal insufficiency, **A**nemia or **B**one lesions [CRAB]) due to plasma cell neoplasm • <10% clonal plasma cells on non-targeted bone marrow sampling. Plasmacytomas with no marrow involvement must be distinguished from those with minimal (<10%) marrow involvement.
Smoldering multiple myeloma	**Both criteria must be met:** • Serum monoclonal protein (IgG or IgA) ≥3gm/dL, or urinary monoclonal protein ≥ 500 mg per 24h and/or clonal bone marrow plasma cells 10-60% • Absence of myeloma defining events or amyloidosis

Plasma cell myeloma/ Multiple Myeloma	**Both criteria must be met:** • Clonal bone marrow plasma cells ≥10% or biopsy-proven bony or extramedullary plasmacytoma • Any one or more of the following myeloma defining events: ▪ Evidence of end organ damage that can be attributed to the underlying plasma cell proliferative disorder, specifically: ○ Hypercalcemia: serum calcium >0·25 mmol/L (>1 mg/dL) higher than the upper limit of normal or >2·75 mmol/L (>11 mg/dL) ○ Renal insufficiency: creatinine clearance <40 mL per minute or serum creatinine >177 µmol/L (>2 mg/dL) ○ Anemia: hemoglobin value of >2 g/dL below the lower limit of normal, or a hemoglobin value <10 g/dL ○ Bone lesions: one or more osteolytic lesions on skeletal radiography, computed tomography (CT), or positron emission tomography-CT (PET-CT) ▪ Clonal bone marrow plasma cell percentage ≥60% ▪ Involved: uninvolved serum free light chain (FLC) ratio ≥100 (involved free light chain level must be ≥100 mg/L) ▪ >1 focal lesions on magnetic resonance imaging (MRI) studies (at least 5mm in size)
Plasma cell leukemia	• Presence of 5% or more circulating plasma cells in blood smears in patients otherwise diagnosed with PCM

Immunoglobulin-related (AL) amyloidosis

Immunoglobulin light chain related amyloidosis (AL amyloidosis) is the abnormal extracellular accumulation of linear non-branching fibrils produced by clonal plasma cell or B-cells resulting in end-organ dysfunction. On routine-stained H&E sections, amyloid is an amorphous, pink substance often with apparent artifactual "cracking"; adjacent histiocytes and foreign body type giant cells may be seen adjacent to such deposits. Congo red staining using bright field and polarized microscopy looking for apple green birefringence is more sensitive than H&E while Congo red fluorescence microscopy provides higher sensitivity in tissue evaluations.[4] Laser microdissection/tandem mass spectrometry has virtually 100% sensitivity and specificity for typing amyloid and allows confirmation of AL type amyloidosis and more definitive exclusion of hereditary amyloidosis.[5]

Monoclonal immunoglobulin deposition disease

Monoclonal immunoglobulin deposition disease is the accumulation of non-amyloidogenic immunoglobulin in tissues secondary to plasma cell neoplasia or less frequently B-cell neoplasia (2-3%, usually lymphoplasmacytic lymphoma or chronic lymphocytic leukemia).[6] The three subtypes are listed in the cancer case summary: Light chain deposition disease, light and heavy chain deposition disease, and heavy chain deposition disease. Determination of the type of immunoglobulin deposition is frequently accomplished by fluorescence microscopy on renal biopsies and immunohistochemistry and mass spectrometry on other samples.[1]

TABLE 2. SUMMARY OF DIAGNOSTIC CRITERIA FOR DISEASES WITH IMMUNOGLOBULIN DEPOSITION DISEASE[1]

Subtype	Essential diagnostic criteria	Desirable diagnostic criteria/ Notes
Immunoglobulin light chain amyloidosis (AL amyloidosis)	• Documentation of amyloid related end organ dysfunction by clinical examination (soft tissue deposition, polyneuropathy, autonomic neuropathy), supported by abnormality on tests	• Typing of amyloid fibril protein by laser capture followed by mass spectrometry or immunohistochemistry/immunoelectron microscopy • Confirmation of organ involvement by

	for organ function in blood or urine • Monoclonal protein in serum or urine or abnormal serum free light chains • Demonstration of amyloid deposition on tissue biopsy (abdominal fat or bone marrow or salivary gland or affected organ biopsy) by Congo red (or similar thioflavin) stain or typical fibrils on electron microscopy	imaging (echocardiography or cardiac magnetic resonance imaging for the heart) • Mutation of one or more genes associated with hereditary amyloidosis if demonstration of light chain involvement is uncertain (especially when typing by mass spectrometry unavailable or inconclusive)
Monoclonal immunoglobulin deposition disease	• Demonstration of monoclonal immunoglobulin deposition in tissue. • In the kidney, this should be demonstrated by immunohistochemistry and electron microscopy. • In cases where there is coexistence of light chain cast nephropathy, monoclonal immunoglobulin deposition disease may be demonstrated by immunohistochemistry only. • Diagnosis in other tissues relies on immunohistochemistry as electron microscopy is not commonly used. Besides light chain cast nephropathy, AL amyloidosis and light chain proximal tubulopathy have been found to coexist with monoclonal immunoglobulin deposition disease in the same kidney.	

Heavy chain disease

Heavy chain diseases are rare B-cell neoplasms characterized by the production of an abnormally truncated monotypic immunoglobulin heavy chain without associated light chain production. Mutations in heavy chain result in lack of assembly of intact immunoglobulin and prevent normal degradation.[7] The three types are mu, gamma, and alpha, and while similar to other B-cell lymphomas (mu-CLL, gamma-lymphoplasmacytic lymphoma, MALT, alpha-variant of MALT lymphoma), they are considered distinct entities.

Mu heavy chain disease is a very rare B-cell neoplasm morphologically composed of vacuolated plasma cells and small round lymphocytes resembling chronic lymphocytic leukemia (CLL) with secretion of a defective mu heavy chain (IgM); spleen, liver, nodal, and bone marrow disease may be present in that order of frequency. Lytic bone lesions may be present.

Gamma heavy chain disease is more morphologically heterogeneous and may resemble lymphoplasmacytic lymphoma or marginal zone lymphoma; lymph node, bone marrow, and extranodal involvement may occur. Underlying autoimmune disease may be present in some patients.

Alpha heavy chain disease is a variant of extranodal marginal zone lymphoma typically involving the gastrointestinal tract that presents clinically with chronic watery diarrhea. It is thought to be related to inability to clear certain infections such as Campylobacter jejuni and has higher prevalence in Mediterranean countries.

Salient diagnostic features are summarized in Table 3.

TABLE 3. SUMMARY OF DIAGNOSTIC CRITERIA FOR HEAVY CHAIN DISEASES[1]

Subtype	Essential diagnostic criteria	Desirable diagnostic criteria/ Notes
Mu heavy chain disease (HCD)	• Serum immunofixation demonstrating anti-mu reactivity without associated light chain • Bone marrow or tissue involvement by small round lymphocytes and vacuolated plasma cells	• Frequent kappa Bence Jones proteinuria; B-cells with cytoplasmic IgM staining that are negative for light chains
Gamma heavy chain disease (HCD)	• Serum or urine immunofixation electrophoresis demonstrating gamma monoclonal band without associated light chain; may be only manifestation in patients with autoimmune disease	• FNA or tissue biopsy demonstrating atypical lymphoplasmacytic proliferation expressing IgG without light chains • MYD88 wild-type
Alpha heavy chain disease (HCD)	• Tissue biopsy with features of extranodal marginal zone lymphoma with extensive plasmacytic differentiation expressing IgA without light chains	• Serum immunofixation demonstrating anti-alpha reactivity without associated light chain

References

1. WHO Classification of Tumours Editorial Board. Haematolymphoid tumours [Internet; beta version ahead of print]. Lyon (France): International Agency for Research on Cancer; 2022 [cited 2023 06 13]. (WHO classification of tumours series, 5th ed.; vol. 11). Available from: https://tumourclassification.iarc.who.int/chapters/63.
2. Kremer M, Ott G, Nathrath M, Specht K, Stecker K, Alexiou C, Quintanilla-Martinez L, Fend F. Primary extramedullary plasmacytoma and multiple myeloma: phenotypic differences revealed by immunohistochemical analysis. *J Pathol*. 2005 Jan;205(1):92-101. doi: 10.1002/path.1680. PMID: 15586381.
3. Fernández de Larrea, C., Kyle, R., Rosiñol, L. et al. Primary plasma cell leukemia: consensus definition by the International Myeloma Working Group according to peripheral blood plasma cell percentage. *Blood Cancer J*. 11,192 (2021). https://doi.org/10.1038/s41408-021-00587-0.
4. Marcus A, Sadimin E, Richardson M, Goodell L, Fyfe B. Fluorescence microscopy is superior to polarized microscopy for detecting amyloid deposits in Congo red-stained trephine bone marrow biopsy specimens. *Am J Clin Pathol*. 2012 Oct;138(4):590-3. doi: 10.1309/AJCP6HZI5DDQTCRM. PMID: 23010714.
5. Julie A. Vrana, Jeffrey D. Gamez, Benjamin J. Madden, Jason D. Theis, H. Robert Bergen, Ahmet Dogan; Classification of amyloidosis by laser microdissection and mass spectrometry–based proteomic analysis in clinical biopsy specimens. *Blood* 2009; 114 (24): 4957–4959. doi: https://doi.org/10.1182/blood-2009-07-230722.
6. Pozzi C, D'Amico M, Fogazzi GB, Curioni S, Ferrario F, Pasquali S, Quattrocchio G, Rollino C, Segagni S, Locatelli F. Light chain deposition disease with renal involvement: clinical characteristics and prognostic factors. *Am J Kidney Dis.* 2003 Dec;42(6):1154-63. doi: 10.1053/j.ajkd.2003.08.040. PMID: 14655186.

7. Wahner-Roedler DL, Kyle RA. Heavy chain diseases. *Best Pract Res Clin Haematol.* 2005;18(4):729-46. doi: 10.1016/j.beha.2005.01.029. PMID: 16026747.

C. Special Studies

Immunoglobulin/amyloid depositions

Report if immunoglobulin/amyloid depositions were detected in the sample. If no special staining was performed (routine H&E only) select "Not detected on routine (H&E) stains, no special stains performed". If Congo Red staining was performed to evaluate for amyloid, specify the corresponding result. For non-amyloidogenic depositions detected select "Positive for non-amyloid" and specify what was identified and method of detection.

Immunohistochemistry

If immunohistochemistry is utilized to immunophenotype the plasma cells, specify the results in the cancer case summary. There is no proscriptive way to accomplish this and can reflect what is used at the institutional level. Suggested reporting methods could utilize (+) for positive result and (-) for negative and include descriptors if there is variability in staining (focal, patchy) or intensity (dim, bright staining). Immunohistochemistry is delineated separately from immunophenotyping by flow cytometry as there might be differences due to the different sensitivities of the assays (flow cytometry is typically more sensitive), differences in antibody used, differences in localization of the antigens (immunohistochemistry may be positive for cytoplasmic antigens that are negative on surface analysis by flow cytometry). To avoid potential confusion, these results are separated out even though some may be redundant.

Flow cytometry

Flow cytometry is a quantitative method for rapid, multiparametric evaluation of the expression of cell surface and cytoplasmic antigens. If flow cytometry was performed, report if there was no aberrancy detected in the sample at the level of sensitivity of the assay or specify what specific alterations were detected. Of note, flow cytometry may significantly underestimate the number of plasma cells in the sample, but quantitation of level of antigen expression is not impacted by the nature of the cells/specimen.

As there is significant variability in the reporting of results, the cancer case summary does not require a specific method. It is recommended to report the result on the tumor cell population in a semi-quantitative method that would allow those reviewing the report to determine if there is heterogenous expression (not all tumor cells are positive) and the level of expression on the population. Examples of this reporting include: CD20 dim+ (low-level expression of CD20), CD56+ (moderate level of expression of CD56), CD38++ (bright expression of CD38), CD45 -/+ het (variable heterogeneous expression of CD45).

Cytogenetics

Report if conventional/ karyotype cytogenetic analysis was performed on the sample, and if it was performed, the result. For those samples with abnormal karyotypes, specify the result.

Fluorescence in situ hybridization

Select all the results of fluorescence in situ hybridization (FISH) that were performed. For probes with normal results specify those in the normal choice; abnormal results can be reported under the respective choice. Common alterations detected by FISH are listed.

Molecular alterations detected

With the advent of increasingly sophisticated molecular genetic techniques such as next-generation sequencing (NGS), chromosomal microarrays and large fluorescence in-situ hybridization panels reporting all these results in a synoptic format is a challenge. As this is an emerging area in evaluation of

plasma cell and paraprotein associated disorders, the reporting is optional. The cancer case summary may be used to report what was performed and positive results along with any pertinent additional information such as method (NGS, RT-PCR, etc.).