Table \$8.2 Major pathological features and prognosis of neuroendocrine tumour (NET) at various anatomical sites^a (continued on next page)

Site	Macroscopic appearance	Histopathology	IHC	Grading	Cytology	Diagnostic molecular pathology	Diagnostic criteria	Staging	Prognosis
ead and neck									
Middle ear {30069842; 22964339; 27166275}	Reddish bulging mass	Classic NE patterns	Positive: pancytokeratin, chromogranin A, synaptophysin	G1: < 2 mitoses/2 mm²; no necrosis G2: 2–10 mitoses/2 mm² and/or foci of necrosis	Not clinically relevant	No	Essential: NE morphology; diffuse and intense expression of cytokeratin(s) and chromogranin A or two other NE markers Desirable: Ki-67 and SSTR2–5	Not performed	Few cases
Sinonasal tract, nasopharynx {17481837; 29103747; 26830400; 26622884; 30332658; 33474978; 33770323}	n/a	Classic NE patterns	Positive: pancytokeratin, chromogranin A, synaptophysin, S100 Negative: TTF1	n/a	n/a	No	Essential: NE morphology; diffuse and intense expression of cytokeratin(s) and chromogranin A or other NE markers Desirable: Ki-67, SSTR2, and SSTR5	Not performed	Not sufficiently reported
Oropharynx, oral cavity, and salivary glands {14720139; 21493041; 27840746; 28116178; 22614165; 23456649}	Bulging/palpable mass, 10–50 mm	Classic NE patterns	Positive: pancytokeratin, chromogranin A, synaptophysin	n/a	n/a	No	Essential: NE morphology; diffuse and intense expression of cytokeratin(s) and chromogranin A or two other NE markers Desirable: Ki-67, SSTR2, and SSTR5	The same as for non-NE carcinomas	Not sufficiently reported
Hypopharynx, larynx, trachea, and parapharyngeal space {12071530; 15053292; 15098009; 15995505; 18617341; 19172557; 20580173; 20961285; 23397781; 24220389; 24596175; 26622884; 26854777; 26886629; 30974468; 31012344; 33167723}	Submucosal polypoid or sessile mass	Classic NE patterns for G1 G2: epithelioid; nested, moulded in some cases; surface involvement; focal necrosis may be seen; mitoses are not defined; spotty necrosis for atypical carcinoid	Positive: pancytokeratin, chromogranin A, synaptophysin, INSM1, various hormones (calcitonin, serotonin, bombesin [GRP], somatostatin) Negative: TTF1	Mitoses not used at present; tumour necrosis places in G2	n/a	No	Essential: NE morphology; diffuse and intense expression of cytokeratin(s) and chromogranin A or two other NE markers Desirable: Ki-67, SSTR2, and SSTR5	The same as for non-NE carcinomas	5-year survival rates: 80% for G1 typical carcinoid, 50% for G2 atypical carcinoid
horax									
Lung	Well-circumscribed round to ovoid lesion	Classic NE patterns; spotty necrosis for atypical carcinoid	Positive: pancytokeratin, chromogranin A, synaptophysin, INSM1 TTF1+ in peripheral tumours, TTF1- in central tumours	Typical carcinoid: < 2 mitoses/ 2 mm²; no necrosis Atypical carcinoid: 2–10 mitoses/ 2 mm² and/or foci of necrosis	Tumour cells are discohesive and small, with round, oval, or spindle-shaped nuclei with finely granular chromatin and inconspicuous nucleoli; background is clean	No	Essential: NE morphology; diffuse and intense expression of cytokeratin(s) and chromogranin A or two other NE markers Desirable: Ki-67, SSTR2, and SSTR5	The same as for non-NE lung carcinomas	5-year survival rates: > 90% for typical carcinoi 60% for atypical carcinoid
Thymus	Most are unencapsulated and either circumscribed or grossly invasive; mean size: 80–100 mm; calcifications are frequent	Classic NE patterns; spotty necrosis for atypical carcinoid	Positive: pancytokeratin, chromogranin A, synaptophysin Negative: often TTF1 Hormones can be detected	Typical carcinoid: < 2 mitoses/ 2 mm²; no necrosis Atypical carcinoid: 2–10 mitoses/ 2 mm² and/or foci of necrosis	Loose clusters or small strands of tumour cells with indistinct cell borders; cells are uniformly small and round to oval, with scant cytoplasm	No	Essential: NE morphology; diffuse and intense expression of cytokeratin(s) and chromogranin A or two other NE markers Desirable: Ki-67, SSTR2, and SSTR5	The same as for other non-NE thymic carcinomas	5-year survival rates: 50–70% for typical carcinoid, 20–70% for atypical carcinoid
Digestive system									
Oesophagus	Polypoid or nodular submucosal mass; mean size: 24 mm	Classic NE patterns; spotty necrosis rare	Positive: cytokeratin, chromogranin A, synaptophysin, hormones (serotonin, PP, gastrin, enteroglucagon), VMAT2	G1: < 2 mitoses/2 mm² and Ki-67 < 3% G2: 2–20 mitoses/2 mm² and/or Ki-67 3–20% G3: > 20 mitoses/2 mm² and/or Ki-67 > 20% G3: > 20 mitoses/ 2 mm² and/or Ki-67 > 20%	Usually not performed / not clinically relevant	No	Essential: NE morphology; diffuse and intense expression of cytokeratin(s) and chromogranin A or two other NE markers; Ki-67 Desirable: SSTR2, SSTR5	The same as for non-NE carcinoma	Good prognosis (few reports)
Stomach	Polypoid or nodular lesions; type I and type II ECL-cell NETs are mostly multiple; type III are single	Classic NE patterns; spotty necrosis rare	Positive: pancytokeratin, chromogranin A, synaptophysin, CDX2, SSTR2 ECL-cell NET: VMAT2+ and ghrelin G-cell NET: gastrin EC-cell NET: serotonin D-cell NET: somatostatin	G1: < 2 mitoses/2 mm² and Ki-67 < 3% G2: 2–20 mitoses/2 mm² and/or Ki-67 3–20% G3: > 20 mitoses/2 mm² and/or Ki-67 > 20%	Usually not performed / not clinically relevant	No	Essential: NE morphology; diffuse and intense expression of cytokeratin(s) and chromogranin A or two other NE markers; Ki-67 Desirable: SSTR2, SSTR5	Gastric NET-specific	Largely depends on stage and grade; variable according to type: type I, excellent prognosi type III, worst; type II, intermediate
Small intestine and ampulla	Submucosal nodules; often multiple; small in the duodenum; larger in the ileum, with muscular wall invasion	Classic NE patterns; usually solid islets; spotty necrosis rare; glandular pattern with psammoma bodies in duodenum (D-cell NETs)	Positive: pancytokeratin, chromogranin A, synaptophysin, CDX2, and SSTR2–5 G-cell NET: gastrin EC-cell NET: VMAT1 and serotonin D-cell NET: somatostatin	G1: < 2 mitoses/2 mm² and Ki-67 < 3% G2: 2–20 mitoses/2 mm² and/or Ki-67 3–20% G3: > 20 mitoses/2 mm² and/or Ki-67 > 20%	Usually not performed / not clinically relevant	No	Essential: NE morphology; diffuse and intense expression of cytokeratin(s) and chromogranin A or two other NE markers; Ki-67 Desirable: SSTR2, SSTR5	Duodenal-ileal NET-specific	Largely depends on stage and grade Ampullary NET: 10-year survival rate of 71% Benign NET of ileum: 5-year survival rates of 70–100% when localized, 35–60% with distant metastases

EC, enterochromaffin; ECL, enterochromaffin-like; IHC, immunohistochemistry; n/a, not available; NE, neuroendocrine; OS, overall survival; TTF1, thyroid transcription factor 1.

aSee also the relevant site-specific volumes of the WHO Classification of Tumours series; 5th ed.; vol. 9). https://publications.iarc.who.int/629.]], Thoracic tumours [[WHO Classification of Tumours Series; 5th ed.; vol. 9). https://publications.iarc.who.int/595.]], Digestive system tumours. Lyon (France): International Agency for Research on Cancer; 2021. (WHO classification of Tumours Series, 5th ed.; vol. 5). https://publications.iarc.who.int/595.]], Digestive system tumours. Lyon (France): International Agency for Research on Cancer; 2019. (WHO classification of Tumours Series, 5th ed.; vol. 1). https://publications.iarc.who.int/579.]], Female genital tumours. Lyon (France): International Agency for Research on Cancer; 2020. (WHO classification of Tumours Series, 5th ed.; vol. 4). https://publications.iarc.who.int/592.]], Breast tumours. Lyon (France): International Agency for Research on Cancer; 2020. (WHO classification of Tumours Series, 5th ed.; vol. 4). https://publications.iarc.who.int/591.]], Breast tumours. Lyon (France): International Agency for Research on Cancer; 2019. (WHO classification of Tumours Series, 5th ed.; vol. 2). https://publications.iarc.who.int/581.]], Urinary and male genital tumours. Lyon (France): International Agency for Research on Cancer; 2022. (WHO classification of tumours Series, 5th ed.; vol. 8). https://publications.iarc.who.int/610.]], and Skin tumours [[WHO Classification of Tumours Series, 5th ed.; vol. 12). https://tumourclassification.iarc.who.int/610.]], and Skin tumours Series, 5th ed.; vol. 12). https://tumourclassification.iarc.who.int/610.]], and Skin tumours Series, 5th ed.; vol. 12). https://tumourclassification.iarc.who.int/610.]], and Skin tumours Series, 5th ed.; vol. 12). https://tumourclassification.iarc.who.int/610.]], and Skin tumours Series, 5th ed.; vol. 12). https://tumourclassification.iarc.who.int/610.]], and Skin tumours Series, 5th ed.; vol. 12). https://tumourclassification.iarc.who.int/610.]], and Skin tumours Series, 5th ed.; vol. 12). https:/

References: The in-text citations provided within curly brackets are PubMed reference numbers (PMIDs), searchable at https://pubmed.ncbi.nlm.nih.gov/.

Table \$8.2 Major pathological features and prognosis of neuroendocrine tumour (NET) at various anatomical sites (continued from previous page, continued on next page)

Site	Macroscopic appearance	Histopathology	IHC	Grading	Cytology	Diagnostic molecular pathology	Diagnostic criteria	Staging	Prognosis
Appendix	Well-demarcated yellowish nodules, mostly < 20 mm	Classic NE patterns; usually solid islets (EC-cell NET); trabeculae/ glands (L-cell NET)	Positive: pancytokeratin, chromogranin A, synaptophysin, CDX2, and SSTR2 EC-cell NET: serotonin+ L-cell NET: chromogranin A- and enteroglucagon/PYY+	G1: < 2 mitoses/2 mm² and Ki-67 < 3% G2: 2–20 mitoses/2 mm² and/or Ki-67 3–20% G3: > 20 mitoses/2 mm² and/or Ki-67 > 20%	Usually not performed / not clinically relevant	No	Essential: NE morphology; diffuse and intense expression of cytokeratin(s) and chromogranin A or two other NE markers; Ki-67 Desirable: SSTR2, SSTR5	Appendiceal NET-specific	Largely depends on stage and grade; excellent outcome (10-year survival rate of 92%)
Colorectum	Well-demarcated submucosal nodules	Classic NE patterns; usually solid islets (EC-cell NET); trabeculae/ glands (L-cell NET)	Positive: pancytokeratin, chromogranin A, synaptophysin, CDX2, and SSTR2 EC-cell NET: serotonin+ L-cell NET: chromogranin A- and enteroglucagon/PYY+ and PAP	G1: < 2 mitoses/2 mm² and Ki-67 < 3% G2: 2–20 mitoses/2 mm² and/or Ki-67 3–20% G3: > 20 mitoses/2 mm² and/or Ki-67 > 20%	Usually not performed / not clinically relevant	No	Essential: NE morphology; diffuse and intense expression of cytokeratin(s) and chromogranin A or two other NE markers; Ki-67 Desirable: SSTR2, SSTR5	Colorectal NET-specific	Largely depends on stage and grade; for low-stage G1–G2, median OS is 30 years (rectum) or 12 years (colon); G3 NET has poor OS (12 months)
Liver	Well-demarcated nodules	Classic NE patterns	Positive: pancytokeratin, chromogranin A, synaptophysin	G1: < 2 mitoses/2 mm² and Ki-67 < 3% G2: 2–20 mitoses/2 mm² and/or Ki-67 3–20% G3: > 20 mitoses/2 mm² and/or Ki-67 > 20%	Loose clusters or small strands of tumour cells with indistinct cell borders; cells are uniformly small and round to oval, with scant cytoplasm	No	Essential: NE morphology; diffuse and intense expression of cytokeratin(s) and chromogranin A or two other NE markers; Ki-67 Desirable: SSTR2, SSTR5	The same as for non-NE carcinoma	Long survival when amenable for surgery; 18–47% metastatic disease (G2)
Gallbladder and bile ducts	Submucosal nodules	Classic NE patterns	Positive: pancytokeratin, chromogranin A, synaptophysin	G1: < 2 mitoses/2 mm² and Ki-67 < 3% G2: 2–20 mitoses/2 mm² and/or Ki-67 3–20% G3: > 20 mitoses/2 mm² and/or Ki-67 > 20%	Lesions are seldom aspirated	No	Essential: NE morphology; diffuse and intense expression of cytokeratin(s) and chromogranin A or two other NE markers; Ki-67 Desirable: SSTR2, SSTR5	The same as for non-NE carcinoma	Limited data; depends on size (larger tumours extend into the liver); 36% OS at 10 years
Female genital tract									
Ovary {28735441}	Usually a unilateral and small nodule within a dermoid cyst	Classic NE patterns admixed with thyroid follicles (strumal), associated with mucin pools with goblet cells (mucinous)	Positive: pancytokeratin, chromogranin A, synaptophysin Strumal carcinoids: TTF1+ and thyroglobulin+ Insular carcinoids: CDX2+	Well-differentiated; grade not defined	Seldom undertaken	No	Essential: NE morphology; diffuse and intense expression of cytokeratin(s) and chromogranin A or two other NE markers Desirable: Ki-67	The same as for non-NE carcinoma	Generally excellent
Fallopian tube	Polypoid/nodular lesion	Classic NE patterns	Positive: pancytokeratin, chromogranin A, synaptophysin	G1 tumours show rare mitotic figures, whereas G2 tumours can show 2–20 mitoses/2 mm² (10 mitoses/10 HPF of 0.5 mm in diameter and 0.2 mm² in area) and foci of necrosis	Seldom undertaken	No	Essential: NE morphology; diffuse and intense expression of cytokeratin(s) and chromogranin A or two other NE markers Desirable: Ki-67	The same as for non-NE carcinoma	Very few studies
Endometrium {28735441}	Mass	Classic NE patterns	Positive: pancytokeratin, chromogranin A, synaptophysin	G1 tumours show rare mitotic figures, whereas G2 tumours can show 2–20 mitoses/2 mm² (10 mitoses/10 HPF of 0.5 mm in diameter and 0.2 mm² in area) and foci of necrosis	Seldom undertaken	No	Essential: NE morphology; diffuse and intense expression of cytokeratin(s) and chromogranin A or two other NE markers Desirable: Ki-67	The same as for non-NE carcinoma	Very few studies
Cervix {28735441}	Polypoid/nodular lesion	Classic NE patterns	Positive: pancytokeratin, chromogranin A, synaptophysin	G1 tumours show rare mitotic figures, whereas G2 tumours can show 2–20 mitoses/2 mm² (10 mitoses/10 HPF of 0.5 mm in diameter and 0.2 mm² in area) and foci of necrosis	Pap smear: cuboidal/columnar/ polygonal cells with variable amounts of pale, granular cytoplasm and monotonous nuclei	No	Essential: NE morphology; diffuse and intense expression of cytokeratin(s) and chromogranin A or two other NE markers Desirable: Ki-67	The same as for non-NE carcinoma	Very few studies
Vagina {28735441}	Mass	Classic NE patterns	Positive: pancytokeratin, chromogranin A, synaptophysin	G1 tumours show rare mitotic figures, whereas G2 tumours can show 2–20 mitoses/2 mm² (10 mitoses/10 HPF of 0.5 mm in diameter and 0.2 mm² in area) and foci of necrosis	Seldom undertaken	No	Essential: NE morphology; diffuse and intense expression of cytokeratin(s) and chromogranin A or two other NE markers Desirable: Ki-67	The same as for non-NE carcinoma	Very few studies

EC, enterochromaffin; ECL, enterochromaffin-like; IHC, immunohistochemistry; n/a, not available; NE, neuroendocrine; OS, overall survival; TTF1, thyroid transcription factor 1.

«See also the relevant site-specific volumes of the WHO Classification of Tumours Editorial Board. Head and neck tumours. Lyon (France): International Agency for Research on Cancer; 2024. (WHO Classification of tumours Editorial Board. Digestive system tumours. Lyon (France): International Agency for Research on Cancer; 2019. (WHO classification of Tumours Editorial Board. Pemale genital tumours [WHO Classification of Tumours Editorial Board. Pemale genital tumours. Lyon (France): International Agency for Research on Cancer; 2020. (WHO classification of tumours series, 5th ed.; vol. 4). https://publications.iarc.who.int/592.]], Breast tumours. Lyon (France): International Agency for Research on Cancer; 2020. (WHO classification of Tumours Editorial Board. Urinary and male genital tumours. Lyon (France): International Agency for Research on Cancer; 2022. (WHO classification of tumours series, 5th ed.; vol. 8). https://publications.iarc.who.int/610.]], and Skin tumours [[WHO Classification of Tumours Editorial Board. Skin tumours [Internet; beta version ahead of print]. Lyon (France): International Agency for Research on Cancer; 2023. (WHO classification of tumours series, 5th ed.; vol. 8). https://publications.iarc.who.int/610.]], and Skin tumours [Internet; beta version ah

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Table \$8.2 Major pathological features and prognosis of neuroendocrine tumour (NET) at various anatomical sites^a (continued)

Site	Macroscopic appearance	Histopathology	IHC	Grading	Cytology	Diagnostic molecular pathology	Diagnostic criteria	Staging	Prognosis
Vulva {28735441}	Mass	Classic NE patterns	Positive: pancytokeratin, chromogranin A, synaptophysin	G1 tumours show rare mitotic figures, whereas G2 tumours can show 2–20 mitoses/2 mm² (10 mitoses/10 HPF of 0.5 mm in diameter and 0.2 mm² in area) and foci of necrosis	Seldom undertaken	No	Essential: NE morphology; diffuse and intense expression of cytokeratin(s) and chromogranin A or two other NE markers Desirable: Ki-67	The same as for non-NE carcinoma	Very few studies
Breast									
Breast	Infiltrating or expansile tumour	Densely cellular, solid nests and trabeculae of spindle to plasmacytoid cells	Positive: pancytokeratin, chromogranin A, synaptophysin, ER (> 90%) Negative: ERBB2	Nottingham grading G1 or G2	Cell clusters with rigid borders; plasmacytoid aspect; peripheral cytoplasmic granules on Giemsa stain; synaptophysin, chromogranin A, and ER are positive	No	Essential: NE morphology; diffuse and intense expression of cytokeratin(s) and chromogranin A or two other NE markers Desirable: Ki-67, SSTR2, and SSTR5	The same as for non-NE carcinoma	Variable according to grade and stage
Urinary and male genital tracts									
Kidney {33613455; 30732641}	Yellow nodule usually < 80 mm with possible haemorrhage	Classic NE patterns	Positive: pancytokeratin, chromogranin A, synaptophysin Negative: TTF1	Grade not defined	Seldom undertaken	No	Essential: NE morphology; diffuse and intense expression of cytokeratin(s) and chromogranin A or two other NE markers Desirable: Ki-67, SSTR2, and SSTR5	The same as for non-NE carcinoma	Variable, depends on stage
Urinary tract {27334654; 33301750}	Small polypoid masses in the bladder neck or trigone	Classic NE patterns	Positive: pancytokeratin, chromogranin A, synaptophysin Negative: WT1	Grade not defined	Not clinically relevant	No	Essential: NE morphology; diffuse and intense expression of cytokeratin(s) and chromogranin A or two other NE markers Desirable: Ki-67, SSTR2, and SSTR5	The same as for non-NE carcinoma	Rarely muscle-invasive
Prostate {33301750; 31415779}	Not defined	Not defined	Positive: pancytokeratin, chromogranin A, synaptophysin Negative: PSA Immunohistochemistry with chromogranin A or synaptophysin is not recommended in usual prostatic adenocarcinomas	Grade not defined	Seldom undertaken	No	A combination of an NE component (characterized by synaptophysin or chromogranin A immunostaining) and a significant non-NE component	The same as for non-NE carcinoma	Undefined
Testis {28559773; 26027014; 18316560; 22347748}	Mass; average size: 46 mm	Classic NE patterns	Positive: pancytokeratin, chromogranin A, synaptophysin	Grade not defined	Seldom undertaken	No	Essential: NE morphology; diffuse and intense expression of cytokeratin(s) and chromogranin A or two other NE markers Desirable: Ki-67, SSTR2, and SSTR5	The same as for non-NE carcinoma	Usually excellent; depends on tumour size and stage, and presence of syndrome
Skin									
Skin {28169866}	10–40 mm lesion	Classic NE patterns; evident mitoses; Ki-67: < 20%	Positive: pancytokeratin, chromogranin A, synaptophysin, ER, AR, GCDFP-15, GATA3 Positive/negative: mammaglobin	Grade not defined; considered low-grade	Not clinically relevant	No	Essential: NE morphology; diffuse and intense expression of cytokeratin(s) and chromogranin A or two other NE markers Desirable: Ki-67, SSTR2, and SSTR5	The same as for non-NE carcinoma	Depends on stage (2 of 11 reported cases had metastases/recurrence)

EC, enterochromaffin; ECL, enterochromaffin-like; IHC, immunohistochemistry; n/a, not available; NE, neuroendocrine; OS, overall survival; TTF1, thyroid transcription factor 1.

*See also the relevant site-specific volumes of the WHO Classification of Tumours Series; 5th ed.; vol. 9). https://publications.iarc.who.int/629.]], Thoracic tumours Editorial Board. Head and neck tumours. Lyon (France): International Agency for Research on Cancer; 2024. (WHO classification of Tumours Series, 5th ed.; vol. 5). https://publications.iarc.who.int/595.]], Digestive system tumours. Lyon (France): International Agency for Research on Cancer; 2019. (WHO classification of Tumours Series, 5th ed.; vol. 1). https://publications.iarc.who.int/595.]], Female genital tumours [[WHO Classification of Tumours Series, 5th ed.; vol. 4). https://publications.iarc.who.int/592.]], Female genital tumours. Lyon (France): International Agency for Research on Cancer; 2020. (WHO classification of Tumours Series, 5th ed.; vol. 4). https://publications.iarc.who.int/592.]], Breast tumours. Lyon (France): International Agency for Research on Cancer; 2020. (WHO classification of Tumours Series, 5th ed.; vol. 4). https://publications.iarc.who.int/592.]], Urinary and male genital tumours. Lyon (France): International Agency for Research on Cancer; 2020. (WHO classification of Tumours Series, 5th ed.; vol. 2). https://publications.iarc.who.int/591.]], Urinary and male genital tumours. Lyon (France): International Agency for Research on Cancer; 2022. (WHO classification of Tumours Series, 5th ed.; vol. 2). https://publications.iarc.who.int/610.]], and Skin tumours [[WHO Classification of Tumours Series, 5th ed.; vol. 12). https://tumours.iarc.who.int/610.]], and Skin tumours series, 5th ed.; vol. 12). https://tumours.iarc.who.int/610.]], and Skin tumours series, 5th ed.; vol. 12). https://tumours.iarc.who.int/chapters/64.]].

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