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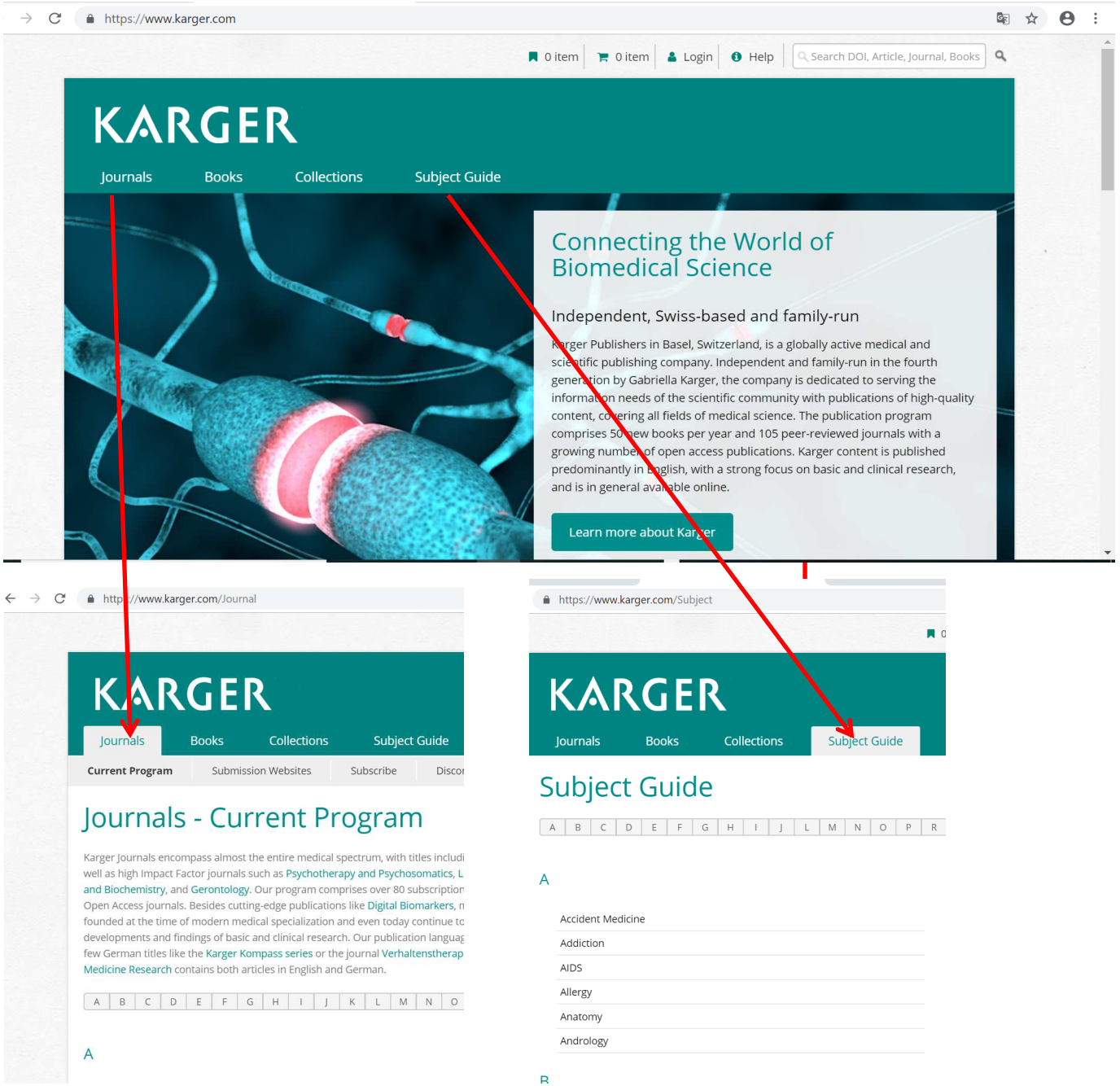

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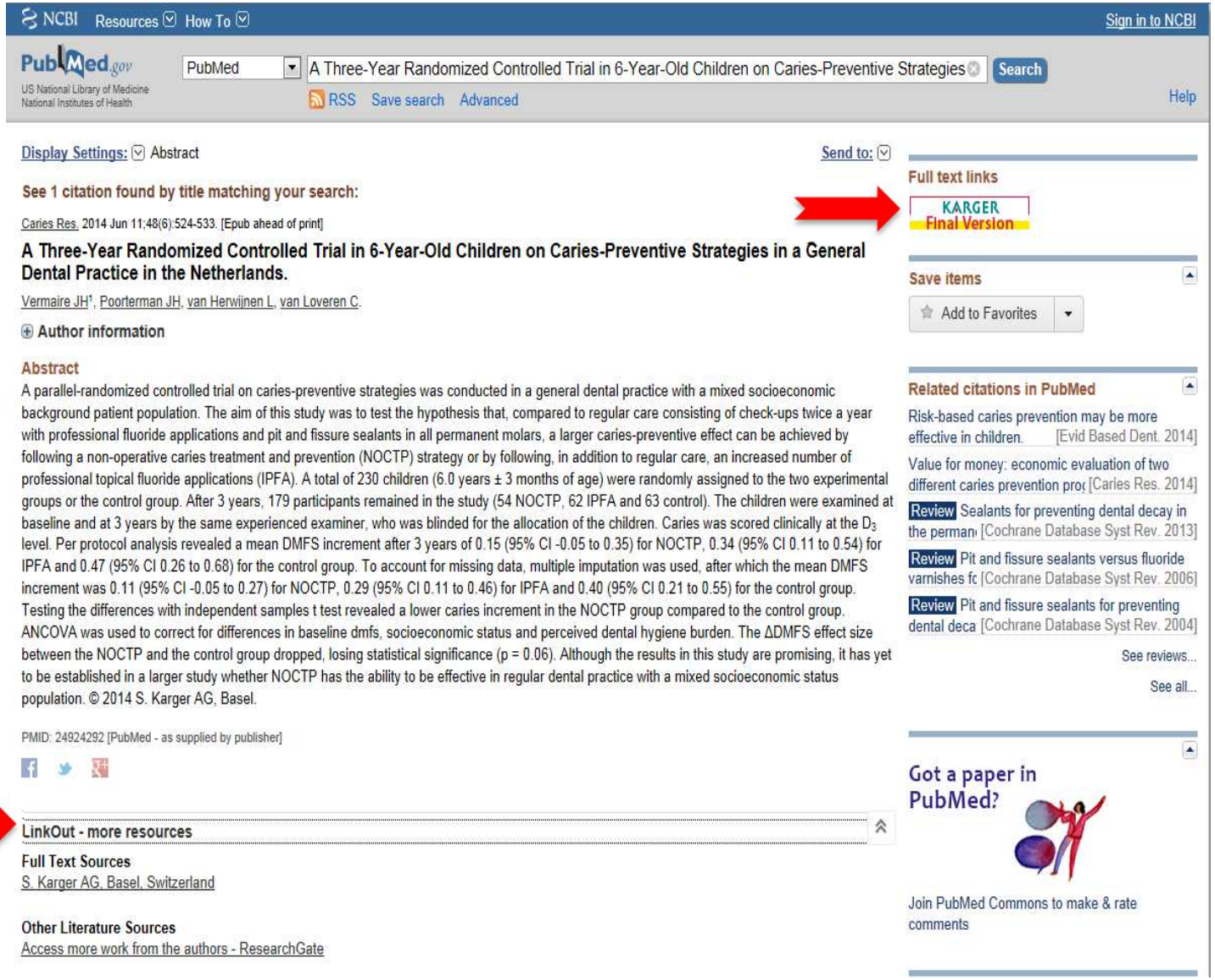

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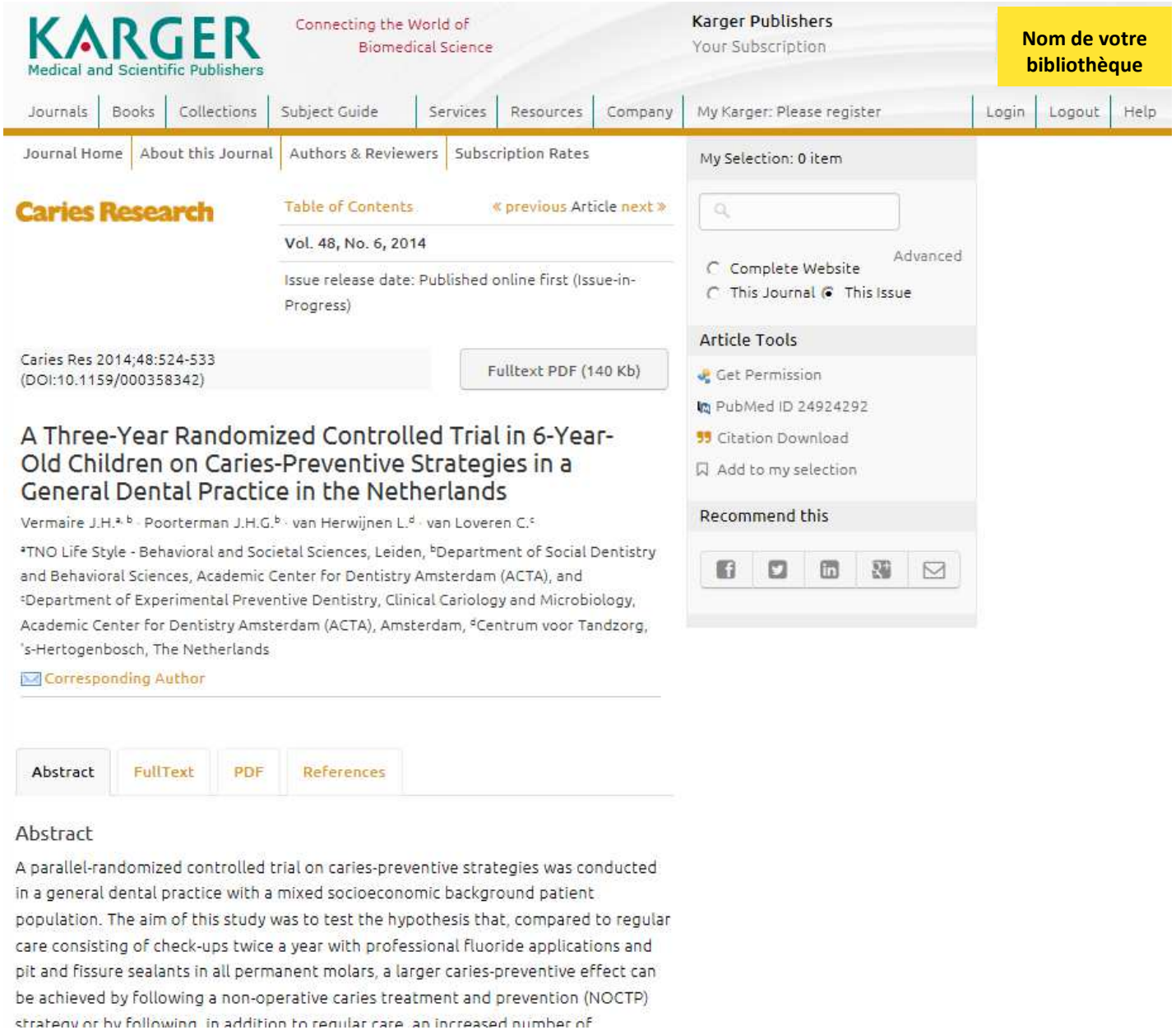

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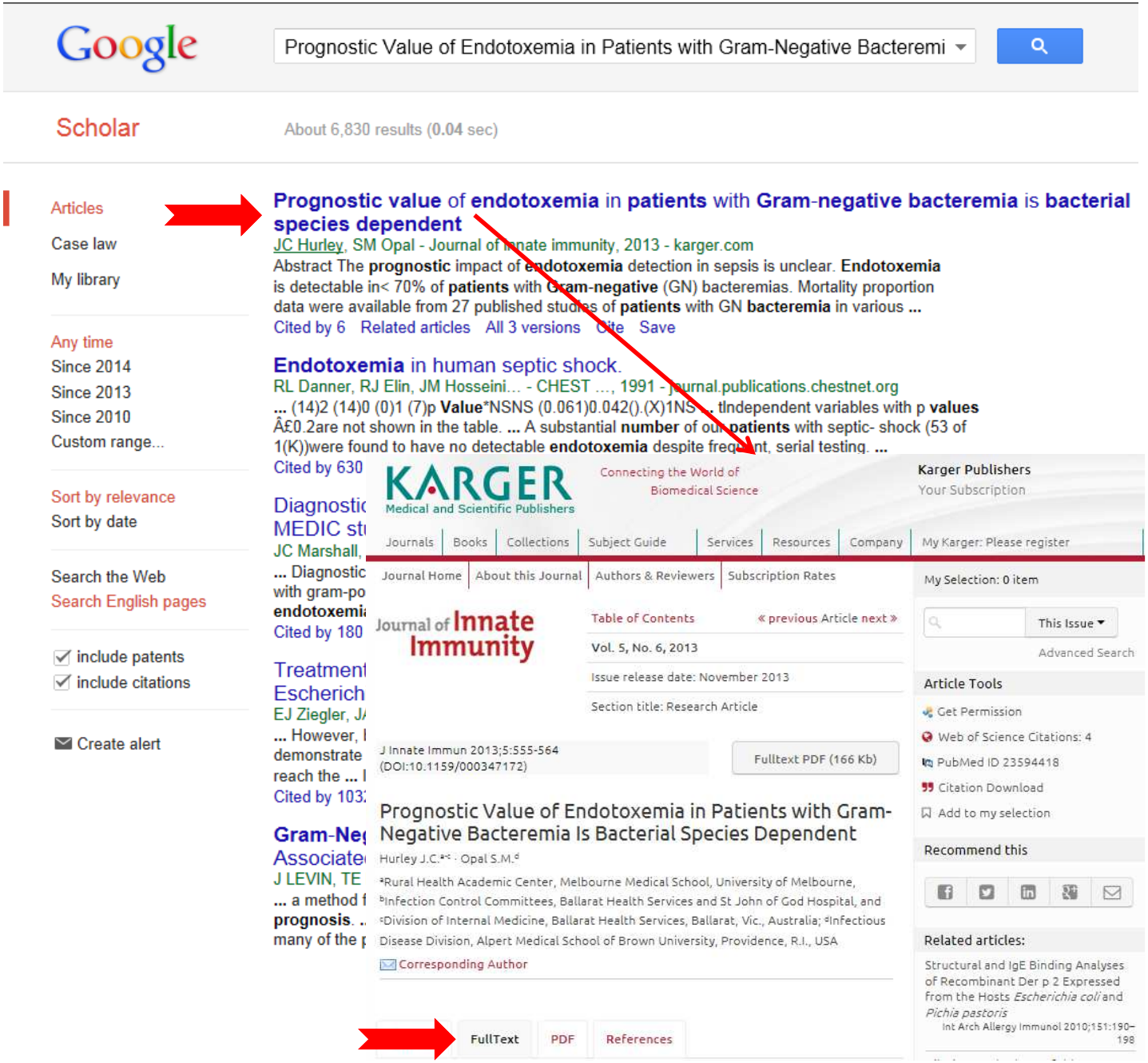

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- Key Words
- Abstract
- Introduction
- Methods
- Overview of Available Molecular Imaging Techniques
  - Somatostatin Receptor Scintigraphy
  - ^{123}I-Metaiodobenzyl-Guanidine Scintigraphy
  - Positron Emission Tomography
  - Novel Imaging Techniques
- Results of the International Survey
- Recommendations for Specific Clinical Scenarios
  - Assessment of Patients with Poorly Differentiated NEC
  - Assessment of Patients with NET of Unknown Primary Location and Patients with Suspected NET
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  - Molecular Imaging before and after PRRT
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Key Words

- Gastroenteropancreatic neuroendocrine tumors
- Molecular imaging
- Somatostatin receptor scintigraphy
- Positron emission tomography

Abstract

Molecular imaging modalities exploit aspects of neuroendocrine tumors (NET) pathophysiology for both diagnostic imaging and therapeutic purposes. The characteristic metabolic pathways of NET determine which tracers are useful for their visualization. In this review, we summarize the diagnostic value of all available molecular imaging studies, present data about their use in daily practice in NET centers globally, and finally make recommendations about the appropriate use of those modalities in specific clinical scenarios. Somatostatin receptor scintigraphy (SRS) continues to have a central role in the diagnostic workup of patients with NET, as it is also widely available. However, and despite the lack of prospective randomized studies, many NET experts predict that Gallium-68 (^{68}Ga)-DOTA positron emission tomography (PET) techniques may replace SRS in the future, not only because of their

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...Ga-DOTA-TATE PET (Fig. 1) seems to be superior to ...F-FDG PET in the detection of G1- and G2-grade NET, with median SUV_{max} values for ^{68}Ga-DOTA-TATE PET of 29 and 15.5, respectively, compared with values for ^{18}F-FDG PET of 2.9 and 10.5. In contrast, there is a much higher uptake of ^{18}F-FDG than ^{68}Ga-DOTA-TATE in high-grade (G3) NET (SUV_{max} of 11.7 for FDG vs. 4.4 for DOTA-TATE) [26]. Only one small study has compared ^{68}Ga-DOTA-NOC with ^{18}F-DOPA directly; in this study, ^{68}Ga-DOTA-NOC revealed more lesions and more occult primary tumors [27]. Compared with CT, ^{68}Ga-DOTA-NOC PET has demonstrated a higher sensitivity (80 vs. 100%, respectively) and specificity (98 vs. 100%) in the detection of NET bone metastases [30]. Finally, Kabasakal et al. [31] compared ^{68}Ga-DOTA-TATE and ^{68}Ga-DOTA-NOC in the same NET patient group. Both tracers demonstrated physiologic uptake in SSTR-2-expressing organs (e.g. pituitary, salivary, thyroid, and prostate glands), but the physiologic uptake in pituitary and salivary glands was much higher for ^{68}Ga-DOTA-TATE than ^{68}Ga-DOTA-NOC. Although the tracers seem to have similar diagnostic accuracy, ^{68}Ga-DOTA-TATE seems to provide a significantly higher lesion uptake than ^{68}Ga-DOTA-NOC [31].

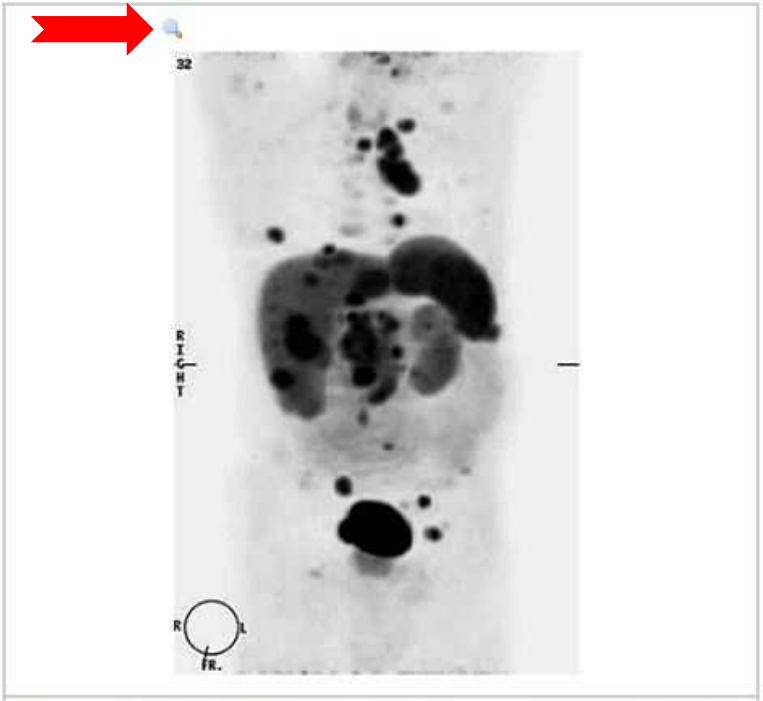

Fig. 1. ^{68}Ga-DOTA-TATE PET scan of a patient with a metastatic pNET, demonstrating the pancreatic primary tumor, multiple hepatic, lung, and bone metastases, and intra-abdominal and mediastinal lymphadenopathy.

Novel Imaging Techniques

A number of new agents are currently under investigation. In a study by Gotthardt et

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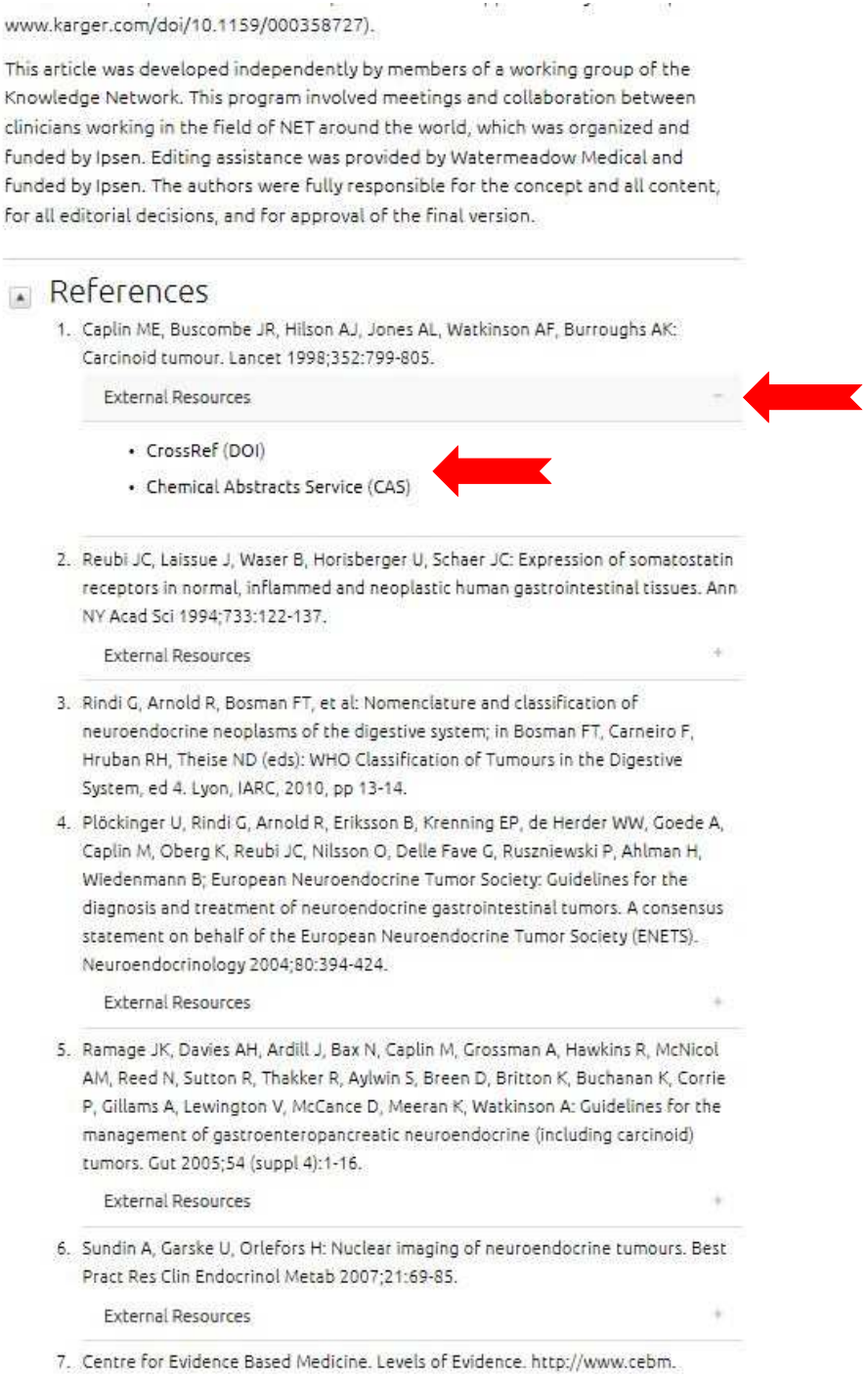

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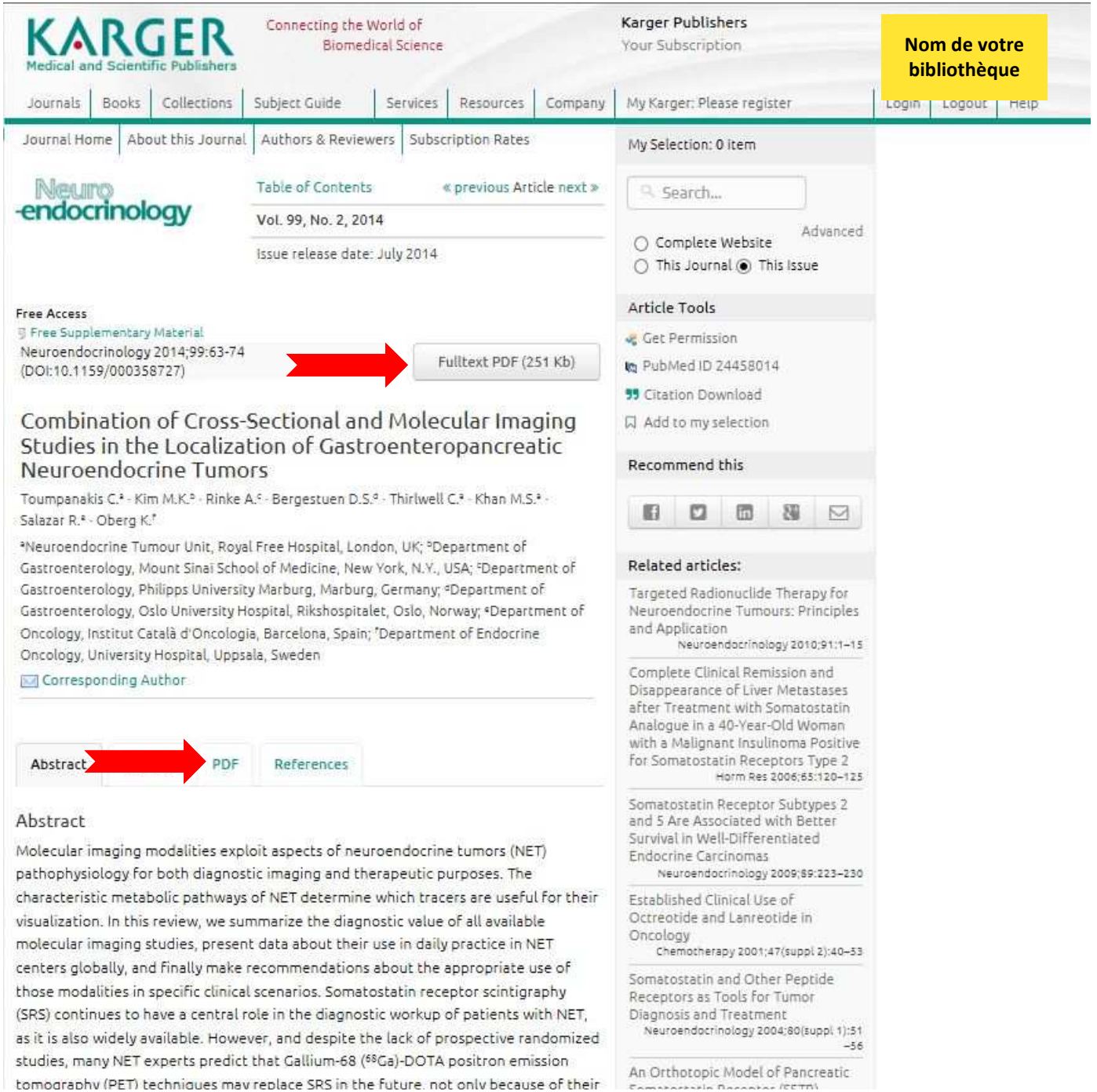

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Combination of Cross-Sectional and Molecular Imaging Studies in the Localization of Gastroenteropancreatic Neuroendocrine Tumors

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Key Words
Gastroenteropancreatic neuroendocrine tumors · Molecular imaging · Somatostatin receptor scintigraphy · Positron emission tomography

Abstract
Molecular imaging modalities exploit aspects of neuroendocrine tumors (NET) pathophysiology for both diagnostic imaging and therapeutic purposes. The characteristic metabolic pathways of NET determine which tracers are useful for their visualization. In this review, we summarize the diagnostic value of all available molecular imaging studies, present data about their use in daily practice in NET centers globally, and finally make recommendations about the appropriate use of those modalities in specific clinical scenarios. Somatostatin receptor scintigraphy (SRS) continues to have a central role in the diagnostic workup of patients with NET, as it is also widely available. However, and despite the lack of prospective randomized studies, many NET experts predict that Gallium-68 (^{68}Ga)-DOTA positron emission tomography (PET) techniques may replace SRS in the future, not only because of their technical advantages, but also because they are superior in patients with small-volume disease, in patients with skeletal metastases, and in those with occult primary tumors. Carbon-11 (^{11}C)-5-hydroxy-L-tryptophan (5-HTP) PET and ^{18}F-dihydroxyphenylalanine (^{18}F-DOPA) PET are new molecular imaging techniques of limited availability, and based on retrospective data, their sensitivities seem to be inferior to that of ^{68}Ga-DOTA PET. Glucagon-like-peptide-1 (GLP-1) receptor imaging seems promising for localization of the primary in benign insulinomas, but is currently available only in a few centers. Fluorine-18 (^{18}F)-fluorodeoxyglucose (^{18}F-FDG) PET was initially thought to be of limited value in NET, due to their usually slow-growing nature. However, according to subsequent data, ^{18}F-FDG PET is particularly helpful for visualizing the more aggressive NET, such as poorly differentiated neuroendocrine carcinomas, and well-differentiated tumors with Ki67 values >10%. According to limited data, ^{18}F-FDG-avid tumor lesions, even in slow-growing NET, may indicate a more aggressive disease course. When a secondary malignancy has already been established or is strongly suspected, combining molecular imaging techniques (e.g. ^{18}F-FDG PET and ^{68}Ga-DOTA PET) takes advantage of the diverse avidities of different tumor types to differentiate lesions of different origins. All the above-mentioned molecular imaging studies should always be reviewed and interpreted in a multidisciplinary (tumor board) meeting in combination with the conventional cross-sectional imaging, as the latter remains the imaging of choice for the evaluation of treatment response and disease follow-up.

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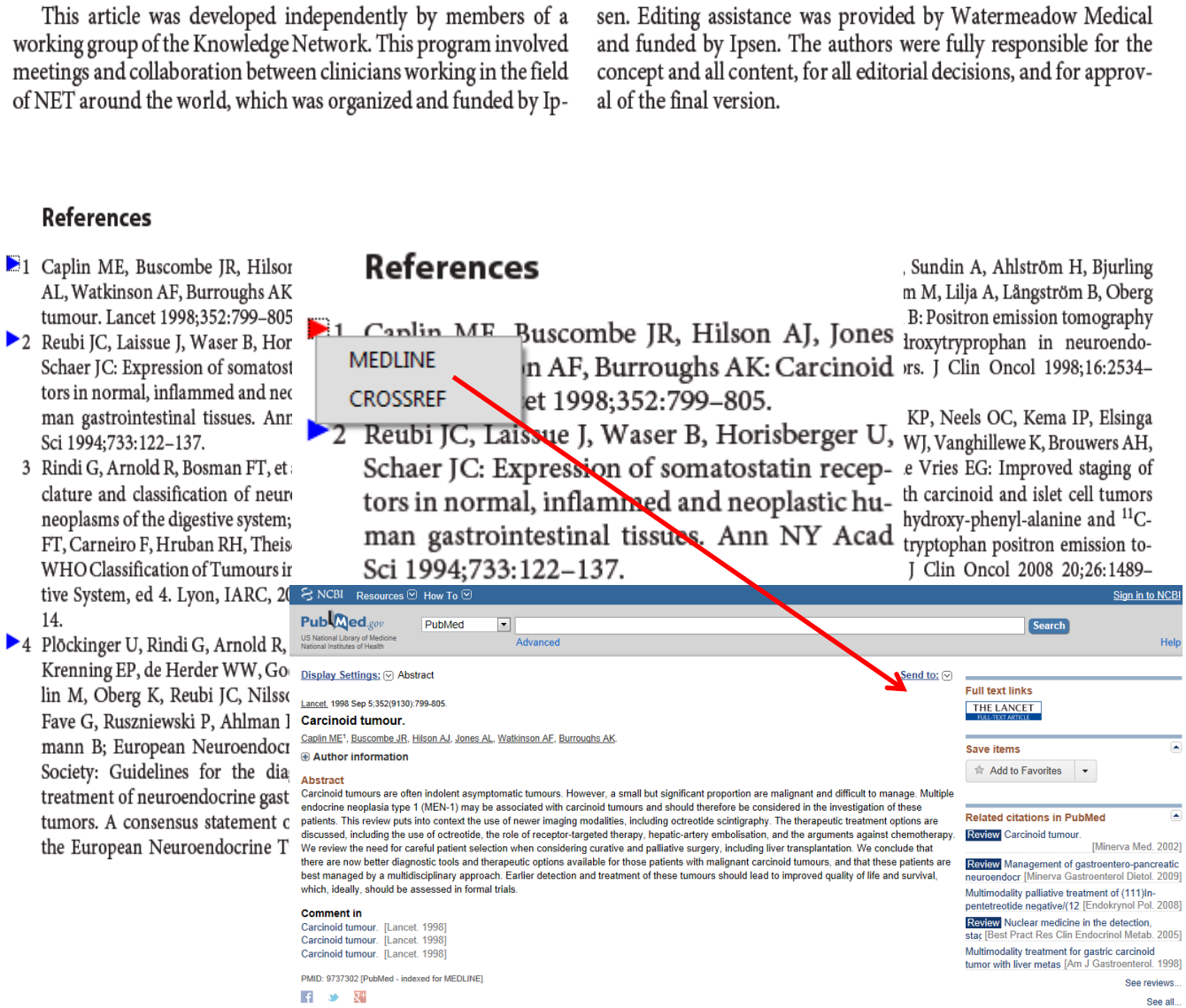

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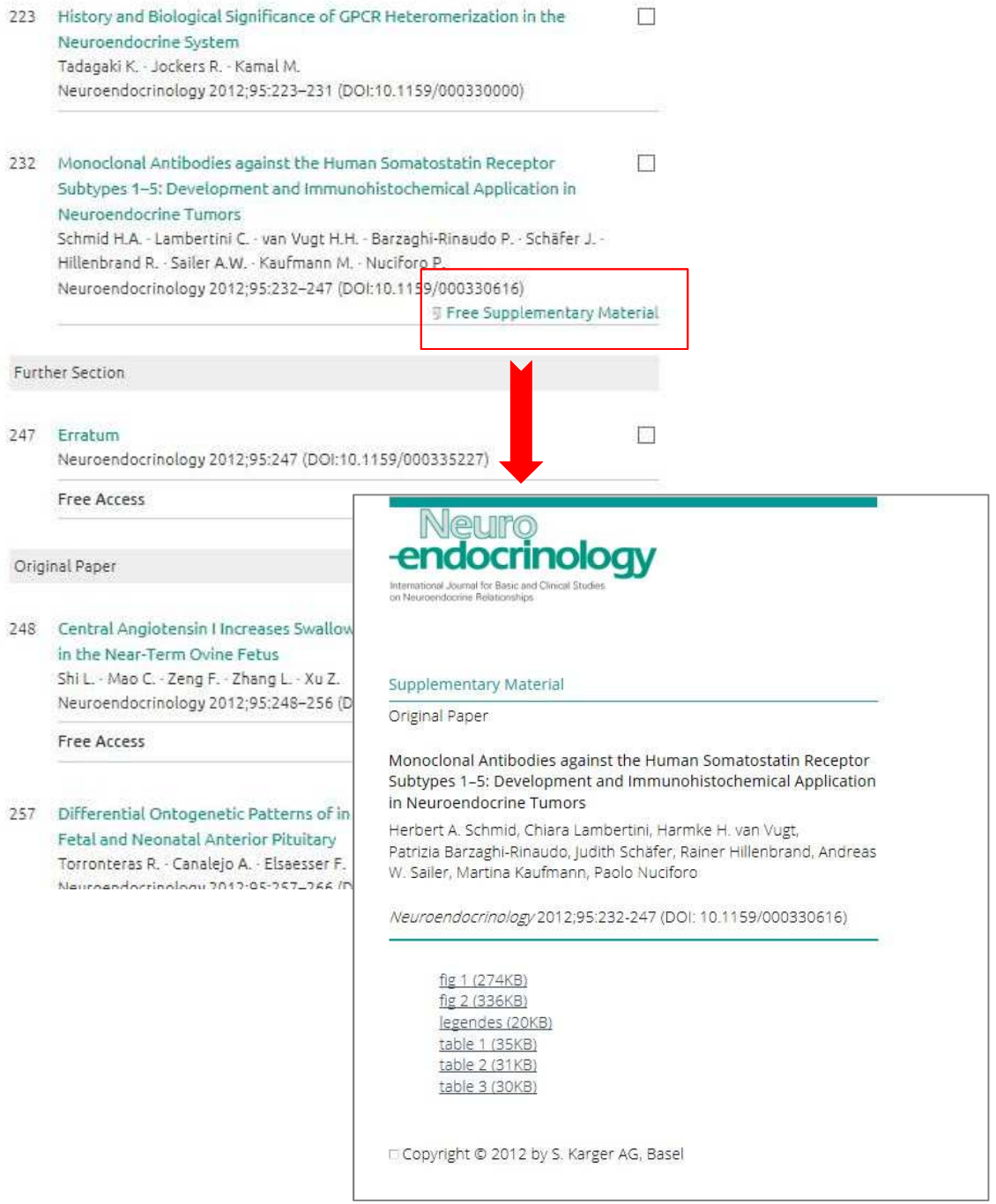

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