and b) one cannot measures absolute CBF values. These difficulties can be overcome by Xe-133. It, on the other hand, does not allow high image resolution.

The lecture ends by emphasizing the value of CBF tomography in the clinical routine: it gives direct information of an important functional parameter—the blood flow through the tissue—that cannot be imaged by the essentially structure-related CT or MR scanning techniques.

III

Immunoscintigraphy (IS)

Gustav Hör*

Department of Radiology, Division of General Nuclear Medicine, University Clinics Frankfurt/Main, F.R.G.

IS belongs to the most important features of progress in nuclear medicine. Although preliminary attempts date back nearly 40 years ago the actual breakthrough was achieved by introducing radioactively labeled monoclonal antibodies (RAMAK) applied especially as “radioimmunococktails” (RIC) of a mixture of \( ^{131}I \)-Anti-CEA** and \( ^{131}I \)-Anti-CA-19-9** as first proposed by CHATAL et al in France and further promoted by our group in Federal Republic of Germany.\(^{1-4}\)

The following aspects are reviewed:

1. **History** based on the discoveries of EHRLICH, EDELMAN and PORTER, JERNE, MILSTEIN and KÖHLER, all honored by the NOBEL-PRICE.

2. **Radioactive Antibodies (RAB)**
   We used the above mentioned \( ^{131}I \)-cocktail. The spectrum of previous and present RAB’s is presented with detailed specifications on our RIC (Tables 1 and 2).
   Some of our own experimental data are shown in Fig. 1.

3. **Techniques**
   Planar (double radionuclide-double compound-isocountour-technique) and tomographic (SPECT) methods:
   
   A. **SKELETAL IMAGING/URINARY BLADDER**
      Tc-99m-HMDP 150–300 MBq i.v. RECORDING TIME: 5 MINUTES
   
   B. **LIVER/SPLEEN/BONE MARROW**
      Tc-99m-NANOCOLLOIDE 37–300 MBq i.v. RECORDING TIME: 3–5 MINUTES
   
   C. **KIDNEY/URETER/URINARY BLADDER**
      Tc-99m-DTPA 74–285 MBq i.v. RECORDING TIME: 3–5 MINUTES

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* Professor of Nuclear Medicine, Director Div. Gen. Nucl. Med.
** Imacis I
### Table 1  Immunoscintigraphy (II)
— Colorectal carcinoma —

<table>
<thead>
<tr>
<th>Polyclonal Antibodies</th>
<th>1965</th>
<th>I-131-anti-CEA</th>
<th>Gold Freedman</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1974 to 1980</td>
<td></td>
<td>Goldenberg et al, Hoff et al, Mach et al</td>
</tr>
<tr>
<td>Monoclonal Antibodies</td>
<td>1979</td>
<td>anti-CEA</td>
<td>Mach et al</td>
</tr>
<tr>
<td>EXPERIMENTAL</td>
<td>1982</td>
<td>Inhibition of tumor by MAB (nude mice)</td>
<td>Herlyn et al</td>
</tr>
<tr>
<td></td>
<td>1982</td>
<td>In-111-anti-CEA-MAB, I-131-anti-CEA-MAB</td>
<td>Halpern et al</td>
</tr>
<tr>
<td>Monoclonal Antibodies</td>
<td>1982</td>
<td>I-131-anti-CEA/19-9 &quot;Radioimmunococktail&quot;</td>
<td>Chatal et al</td>
</tr>
<tr>
<td>CLINICAL</td>
<td>I-131-17-1 A</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### Table 2 Immunoscintigraphy (I)

<table>
<thead>
<tr>
<th>1. HEART</th>
<th>Infarction</th>
<th>I-131-Anti cardiac-Myosin F (ab')-Fragments</th>
<th>Khaw 1978</th>
</tr>
</thead>
<tbody>
<tr>
<td>3. LYMPH-NODES</td>
<td>Cutaneous T-Cell Lymphoma</td>
<td>In-111 T 101</td>
<td>Carrasquillo/Larson 1985</td>
</tr>
<tr>
<td>4. PROSTATE</td>
<td>Carcinoma</td>
<td>In-111 antiprostatic acid phosphatase</td>
<td>Halpern 1985</td>
</tr>
<tr>
<td>5. LYMPHOCYTES</td>
<td>B Cell Lymphoma</td>
<td>I-125/I-131 anti B1</td>
<td>Atkins 1985</td>
</tr>
<tr>
<td>6. THROMBOCYTES</td>
<td>Thrombi</td>
<td>Tc-99m IgG 2a</td>
<td>Som 1985</td>
</tr>
<tr>
<td>8. BREAST</td>
<td>Carcinoma</td>
<td>In-111-DTPA-MAB</td>
<td>Rainsburg/Ehrenfeldt 1983</td>
</tr>
<tr>
<td>9. OVARIAN</td>
<td>Carcinoma</td>
<td>I-123-HMFG2</td>
<td>Thompson 1984, Granowska 1984</td>
</tr>
</tbody>
</table>
Fig. 1 Tumor-to-blood ratios for several monoclonal antibodies (ordinate) 24 to 144 hours after injection in nude mice. (SENKOWITSCH et al, 1985).

Fig. 2 Immunoscintigram with "radioimmunococktail" 3 days after injection: solitary metastasis of liver in a patient with colorectal carcinoma.
D. STOMACH
Tc-99m-PERTECHNETATE 74–100 MBq i.v. or 37 MBq PER OS. RECORDING TIME: 5 MINUTES

4. Clinical Results
Between Dec. 1984 and 1986 about 300 patients were examined in our hospital.

4.1 Prospective Studies
Group A (n=100) patients with colorectal carcinoma, other gastro-intestinal tumors, breast cancer.

Group B (n=55) before and after implantation of Infusaid® pumps resp . . . Infuse-a-ports for regional chemotherapy of liver metastases. More than 95% of all patients had a recurrence of or metastases subsequent to a primary tumor, the largest group being represented by colorectal and gynecological cancer (n=120).

Histologically most of the tumors were adenocarcinomas. Sensitivity, Specificity, positive and negative predictive value (PPV, NPV) (%) were

for pelvic tumors: 83, 85, 88, 93
liver metastases: 93, 85, 93, 85
peritoneal/abdominal: 90, 98, 94, 95
lung tumors: 83, 94, 77, 96

4.2 Retrospective Studies (n=133)
In a selected number of patients Se, Spe, PPV, NPV (%) were also determined in dependance on tumor site

for pelvic tumors: 86, 94, 86, 94
liver metastases: 73, 86, 94, 50
peritoneal/abdominal: 85, 82, 79, 88
lung tumors: 67, 96, 80, 91

4.3 IS and Tumor Markers (TM) (n=97)
Positive IS and elevated TM were detected in 78%, positive IS and normal TM in 8%, negative IS and elevated TM in 5%, negative IS and normal TM in 6%.

4.4 Clinical Indications
Although IS is still considered to persist in a pre-clinical trial phase we are well advised to approach clinical indications in which IS is competing or complementing CT and US. At present we pursue a priority list, which will be confirmed by clinical case presentations:

4.4.1 Local recurrence of primary tumor vs. scar vs. corpus alienum (after surgery). Prognostication of recurrence was possible in singular cases up to 7 months before CT and in 10% of our patients IS was the only oncologic investigation to precisely diagnose recurrence or extrahepatic metastases.

4.4.2 Detection or exclusion of solitary liver metastases (Fig. 2).
4.4.3 Detection of extrahepatic metastases in CT/US confirmed liver metastases to plan intraarterial chemotherapy.

4.4.4 Control of the expansion of resected tumors.
4.4.5 Ovarian cancer.

5. Problems and Outlook

Factors interfering with tumor localization of antibody radionuclide conjugates are discussed according to LARSON (s. Year Book Nucl. Med. 1985, p. 22).

Finally our preliminary experiences using $^{111}$In-MAB and OC-125* are presented.

6. Conclusion

The impact of IS on clinical oncology is remarkable. It may be expected for the 90ties, that nuclear oncology will extend in a way comparable to nuclear cardiology.

References


* Imacis II