Biotelemetry based on CdTe-detectors

J. Bojsen, N. Rossing, O. Soeberg, S. Vadstrup

► To cite this version:

J. Bojsen, N. Rossing, O. Soeberg, S. Vadstrup. Biotelemetry based on CdTe-detectors. Revue de Physique Appliquée, 1977, 12 (2), pp.361-363. 10.1051/rphysap:01977001202036100 . jpa-00244174

HAL Id: jpa-00244174

<https://hal.science/jpa-00244174>

Submitted on 1 Jan 1977

HAL is a multi-disciplinary open access archive for the deposit and dissemination of scientific research documents, whether they are published or not. The documents may come from teaching and research institutions in France or abroad, or from public or private research centers.

L'archive ouverte pluridisciplinaire **HAL**, est destinée au dépôt et à la diffusion de documents scientifiques de niveau recherche, publiés ou non, émanant des établissements d'enseignement et de recherche français ou étrangers, des laboratoires publics ou privés.

BIOTELEMETRY BASED ON CdTe-DETECTORS

J. BOJSEN, N. ROSSING, O. SOEBERG and S. VADSTRUP

The Finsen Laboratory, Department of Clinical Physiology and The Radiophysical Laboratory, The Finsen Institute, 49, Strandboulevard, DK-2100 Copenhagen, Denmark.

Abstract. — Small cadmium telluride radionuclide detectors (CdTe) 2-3 mm³ (developed by C. R. N. Strasbourg) have been tested with special reference to their application in biotelemetry. The temperature dependence, geometry characteristics and efficiency of the detectors have been investigated and preliminary *in vivo* experiments have been performed. The glomerular filtration rate was telemetrically measured by partial body counting of DTPA labeled 99m-Tc. Blood-flow in adipose and muscle tissue was determined by local clearance studies with 133-Xe. In radiocardiographic studies with 99m-Tc, the blood-flow of the heart can be determined. In local clearance and radiographic studies the results obtained with the CdTe-detector were compared with a single NaI(Tl) detector or a γ -camera. The CdTe-detector has been found to fulfil the requirements of a biotelemetric transducer.

1. Introduction. — The fundamental purpose of biotelemetry is to study physiological parameters in man or experimental animals with a minimum of interference. Such studies, however, are difficult to perform when radionuclide tracers are involved because their detection in general demands voluminous stationary equipment.

Small GM-detectors for detection of radionuclide tracers have been used in implanted radiotelemetric equipment [1] or externally attached to the skin for surface detection [2, 3].

Among several new semiconductor materials the cadmium telluride (CdTe) seems to be the most promising in the production of small transducers. We have tested the CdTe-detector [7, 8, 9] with special reference to its use in different biotelemetry applications.

2. The detector. — The detector probe, developed by C. R. N., Strasbourg, France, consists of a CdTe-crystal (2-3 mm³) and a preamplifier (Fig. 1). The detector material is a P-type with resistivity in the range of 10⁴-10⁶ Ω .cm, and it is grown by the traveling heater method, but without external chemical compen-

sation. The detector crystal is directly coupled to a FET transistor, which is biased through a loading resistor. The second stage consists of a voltage amplifier, which is followed by a monostable with a triggering level adjustable to the energy scale of interest. The supply voltage of the detector is 100 V d. c. and the pre-amplifier is supplied by 5.4 V (1.3 mA) [4]. A portable [3, 5] or a stationary taperecorder was used for collecting of data.

3. Physical experiments. — Several requirements have to be fulfilled by a transducer in biotelemetry of radionuclide tracers. The detector must be reliable up to 42 °C. Figure 2 shows the energy spectra of a

FIG. 1. — The CdTe-detector probe. The cover is shown to the left.

FIG. 2. — The spectra of a 241-Am source measured at 22 °C and 41.5 °C.

was removed, the course of the curve from the CdTe-detector was steeper and monoexponential a longer period of time than the curve from the NaI(Tl)-detector. Due to the small tissue volume monitored by the CdTe-detector, it measures more correctly the local clearance of the Xenon depot, even without the need of lead shielding. The NaI(Tl)-detector monitors a rather big tissue volume even when restricted by lead shielding, so the radioactive Xenon is detected with high efficiency also after it has been removed from the depot by the blood.

In a similar experiment the blood flow was measured in the anterior femoral muscles during rest and ergometry (Fig. 6). The CdTe-detector was attached to the skin surface above the injected Xenon depot.

FIG. 6. — Local clearance of ^{133}Xe from the anterior femoral muscles during rest and ergometry.

In cardiographic studies there is a need for measurements of the blood flow in the heart during exercise. By means of this small surface CdTe-detector attached to the skin surface over the heart, it is possible to measure the curve of a radionuclide tracer dose injected as a bolus (Fig. 7), and by proper calibration, the flow rate of the heart or cardiac output can be determined, i. e. during exercise, outside the laboratory. In radio-cardiographic studies the calculation of cardiac output

FIG. 7. — Count rate curve of an i. v. injected bolus dose of $^{99\text{m}}\text{Tc}$, measured over the heart with the CdTe surface detector.

is normally based on γ -camera examinations. The performance of the CdTe-probe was therefore compared with that of a computerized γ -camera with digitalized regions of interest. The count rate curves simultaneously measured were compared and found alike.

5. Conclusion. — The experiments show, that the small CdTe-detector is promising as a new surface detector in nuclear medicine. Furthermore this type of detector used in external equipment in combination with f. i. a C-MOS semiconductor memory system [6] for data compression and storage, or in implantable equipment in combination with radiotransmitters, will extend the field in biotelemetry of radionuclide tracers.

References

- [1] BOJSEN, J., WALLEVIK, K., *Int. J. Appl. Radiat. Isot.* **23** (1972) 505.
- [2] BOJSEN, J., VADSTRUP, S., *Int. J. Appl. Radiat. Isot.* **25** (1974) 161.
- [3] BOJSEN, J., VADSTRUP, S., *Proc. 2nd ISPRA Nucl. Electronics Symp.* Stresa, Italy, 205, 1975 (EUR 5370e).
- [4] BOJSEN, J., VADSTRUP, S., SIFFERT, P., REGAL, R., CORNET, A., *Proc. 3rd Int. Symp. on Biotelemetry*, Asilomar, California, May 1976, Academic Press (in press).
- [5] BOJSEN, J., VADSTRUP, S., *Am. J. Appl. Physiol.* **41** (1976) 416.
- [6] BOJSEN, J., *Proc. 3rd Int. Symp. on Biotelemetry*, Asilomar, California, May 1976, Academic Press (In press).
- [7] CORNET, A., REGAL, R., PONPON, J. P. *et al.*, 2nd ISPRA nuclear electronics Symposium. Stresa, Italy, 169, 1975 (EUR 5370e).
- [8] SIFFERT, P., PONPON, J. P., CORNET, A., *Onde électr.* **55** (1975) 281.
- [9] SIFFERT, P., BERGER, R., SCHARAGER, C. *et al.*, *Trans. Nucl. Sci.* **NS-23** (1976) 159.