

CONTENTS

Preface	11
Acknowledgements	13
Chapter 1. Introduction. Developing the Concept. Notes on the History	15
I. Extracorporeal heart assist	24
II. Blood propulsatory devices	27
a) Intraaortic balloon counterpulsation	27
b) Periaortic pressure stimulation	28
c) Extracorporeal counterpulsation using pulsating bags . .	28
d) Cardiac massager	29
e) Other devices	30
III. Devices combining the method based on the deviation of the blood transport with blood propulsatory methods . .	31
References	32
Chapter 2. Biomaterials	35
1. Changes in the material induced by the organism	36
2. Affection of the body by the material	37
a) Local effect, at the site of implantation.	37
b) General, systemic influence of the recipient organisms by the biomaterial	38
c) Some special interrelationships between soft tissue and the implant	39
3. Interaction of blood with the implanted material on its sur- face	41
References	47
Chapter 3. Mechanical heart assist devices	51
Counterpulsatory devices	51
References	62
Bypass heart assist system	65
References	78
Chapter 4. The development of the research on mechanical heart assist in the Research Center in the Institute of Pathological Physio- logy — Medical Faculty — Purkyně University and Regional Institute of National Health (KÚNZ) Brno	83
A. Mechanical heart assist — research project	83
B. Total heart substitution	84

Mechanical heart assist	84
Intraaortic counterpulsation balloons (IAB)	98
Counterpulsation pump and balloons. Bypass pumps	99
Experiments with the heart assisting pumps, performed on the normotonic animals, without induced experimental heart failure	100
Long term left heart bypass experiments in the normotonic calves	112
The evaluation of the mechanical heart assist in experiments with animals with induced heart failure. Clinical case	119
Combination of the bypass and counterpulsation mechanical heart assist	125
The combination of the bypass and counterpulsation mechanical heart assist which is not united in one device, but used separately	138
The total biventricular heart bypass with the extrathoracic two-chamber pump B-60-K8	145
Surgical procedure	146
Transplantation experiments. Experimental heart transplantation	148
Surgical procedure	151
Experimental procedures, developed in the Brno Research Centre to induce different kinds of heart failure	157
Experimental procedures aimed to prove the positive influence of mechanical and pharmacological heart assist and their combination upon the cardiac metabolism from the point of reduction of the size of infarction	162
The evaluation of the mechanical heart assist systems on the basis of changes in the catecholamine metabolism of the infarcted myocardium	167
Changes of the aortic wall after short and long lasting intra-aortic balloon counterpulsation	171
Changes in the aortic wall in the short lasting IABP experiments	171
Changes in the aortic wall in the long lasting IABP experiments	173
References	175

Chapter 5. Total artificial heart. Present status of the research on total artificial heart in the world	185
The recent accomplishments in various world research centres on TAH project	188
Salt Lake City	188
The Cleveland group	199
The Hershey group	202
The research work of Tetsuzo Akutsu, dedicated to the development of the total artificial heart. Atsumi's artificial heart	204
Pathological examination of these animals	207
Taguchi's group in Hiroshima	208
The Moscow research on artificial heart performed by Shumakov and his group	208
Bücherl's group in West-Berlin, its contribution to the development of the artificial heart research	211
The research group in Vienna led by Navrátil	213
Other places in the world engaged in the research on the total artificial heart	214
References	215

Chapter 6. Total artificial heart research in the Czechoslovak Socialist Republic	227
Czechoslovak TAH-TNS-BRNO-I, II, III	228
Technical problems of artificial heart	228

Chief requirements on artificial heart pump	229
Pumps	229
TNS-BRNO I.	230
Pump characteristics	236
TNS-BRNO II.	237
TNS-BRNO III.	237
Selection of technology for the pump chamber manufacture	238
Drive units and power supply units	238
Control and regulation of artificial heart	239
Methods of acquiring information for control and regulation of artificial heart	240
Working regime of pumps	242
Basic version of control and drive unit	243
Automatic system of the control unit	243
Elevation of Starling's curve slope of artificial heart by in- stantaneous control of drive pressure (Governor of suction)	244
Time of systole controller	247
Amplitude of systole controller	247
Heart rate controller	248
Blocking the right half of drive in case of left half failure	248
I. First period — experiments performed with the Soviet total artificial heart, type "KEDR"	249
The course of experiments	250
Surgical procedure	250
Postoperative course	252
Evaluation of our problems in this period of experiments	253
Autopsy findings	254
Discussion and conclusions	255
II. The second period of experiments with the Czechoslovak TAH TNS-BRNO-I with the longest survival in this group of 46 hours	256
III. The third period of experiments with the total artificial heart (TAH), using the TAH type TNS-BRNO-I, TNS- -BRNO-II and partially TNS-BRNO-III	260
Preoperative management of the calves	260
The regime of anesthesia	260
Surgical procedure	262
Postoperative course	264
Comment	266
The results in the IIIrd series of experiments	266
Evaluation of experiments in the IIIrd group	270
Jarvik-3 TAH combined in experiment with the Czechoslovak control and driving unit Chirasist TN	274
Postoperative course	274
Autopsy findings	276
Ultrastructural finding	277
Conclusions	277
Comparative study of ultrastructural organ changes including the selected cases from the Ist and IIIrd group and the ex- periment with the TAH Jarvik-3	278
Results	278
Summary and conclusion	282
Changes in monoaminergic innervation of the biological atrial remnants after implantation of TAH (Total Artificial Heart)	283
IV. Fourth group of experiments which represent the calves living more than 1 month with the TAH (Total Artificial Heart)	287
Calf No. 50/79 — Hasan	287
Material and methods	287
Respiratory regime during surgery	288
Surgical procedure	288

Tests and parameters monitored	289
Hemodynamic parameters	289
Hematological data	289
Biochemical data	289
Bacteriological data	290
Respiratory measurements	290
Postoperative course	290
Regime of TAH control and driving	296
Laboratory findings	297
Hematological data	297
Coagulation values	297
Biochemical data	302
Blood proteins	302
Blood electrolyte values	302
Serum enzymes	302
Urine findings	308
Autopsy findings	308
Discussion	317
Conclusion	319
Calf No. 51/80 — Dalibor	320
Dalibor — postoperative course	323
Addendum	357
Closing remarks	360
References	362
Summary (in English)	367
(in Czech)	373
(in Russian)	379
Recent results on the TAH research in the BRNO research centre — Years 1981—1982	385