ON RECORD

Right Heart Bypass in 1952: An Early Attempt by Gibbon's Team to Treat a Suspected Right Atrial Tumor

***Kelly D. Hedlund**, CCP*
***Scott L. Tucker**, CCP*

Great Plains Perfusion Company

Hays, Kansas

Author's Note: Paul Dillon is a fictitious name used to protect the patient's identity. All other names used in this article are real.

Introduction

Paul Dillon was a steelworker from Bethlehem, Pennsylvania. By all accounts, he was a giant of a man with huge hands and a thick upper torso. In the weeks prior to his 41st birthday, he noticed increasing shortness of breath and swelling in his lower extremities. A local physician diagnosed him with active rheumatic fever and placed him on a cardiac regimen of digitalis, mercurials, and diuretics. Within a month, Paul's symptoms worsened to include hepatomegaly, gallop rhythm, and persistent cough. He was subsequently transferred to Pennsylvania Hospital in Philadelphia and scheduled to undergo invasive studies (such as cardiac catheterization) which were just becoming available in select centers.

At least four Philadelphia physicians, considered cardiology experts at the time, participated in Paul's workup. Cardiac enlargement was confirmed by x-ray, and pulsating peripheral veins suggested tricuspid insufficiency. A murmur was evident during both systole and diastole, and electrocardiogram showed right axis deviation. Cardiac angiography, accomplished using a series of film cassettes, revealed a suspicious "space-taking" lesion in the center of the right atrium. Considering the complexity of Paul's diagnosis, a phone call was made to Dr. John Gibbon's office. There was general consensus that a surgical consultation was appropriate, and Gibbon did have an experimental "heart-lung machine" that might prove useful in correcting Paul's condition. One of Gibbon's associates, Dr. Frank F. Allbritten, Jr., agreed to review Paul's case.

Case Review

Allbritten was Gibbon's closest associate. Not only were they partners in surgical practice, but together they owned office space, furniture, and even several automobiles. From the outset, Allbritten believed that Paul's only hope was to undergo high risk surgical removal of the suspected right atrial tumor. Paul's condition was deteriorating with each passing day, and on more than one occasion he became apneic and turned ashen blue in color. In addition to removing the "suspicious" lesion in the right atrium, Allbritten was also faced with the obvious tricuspid regurgitation that caused most of Paul's symptoms. Inflow occlusion as a means of creating a dry, bloodless field was out of the question. This case would take hours, not minutes.

But what about Gibbon's experimental heart-lung apparatus? It had worked in animals with limited success. Could it be used to bypass Paul's right heart and provide the necessary exposure for such a bold and daring operation? The man most familiar with Gibbon's pump, aside from Gibbon himself, was Dr. Bernard J. Miller. Like Allbritten, Miller was part of Gibbon's research team and had contributed greatly to the design and operation of nearly every component. For instance, Miller had developed an automatic level control system to reduce the chance of massive arterial air embolism. It was air embolism, sadly, that occurred during Clarence Dennis' second attempt at mechanically bypassing a human at the University of Minnesota in 1951.

Miller also incorporated capacitor circuits with shut-off switches into the pumps to monitor high or low pressure situations. He developed a reverse flow arterial line filter, a cardiotomy suction system, and numerous other safety features commonly seen in today's heart-lung machines. Miller, ever the optimist, believed that a right heart bypass circuit could be designed to facilitate the operation and give Paul a chance at survival.

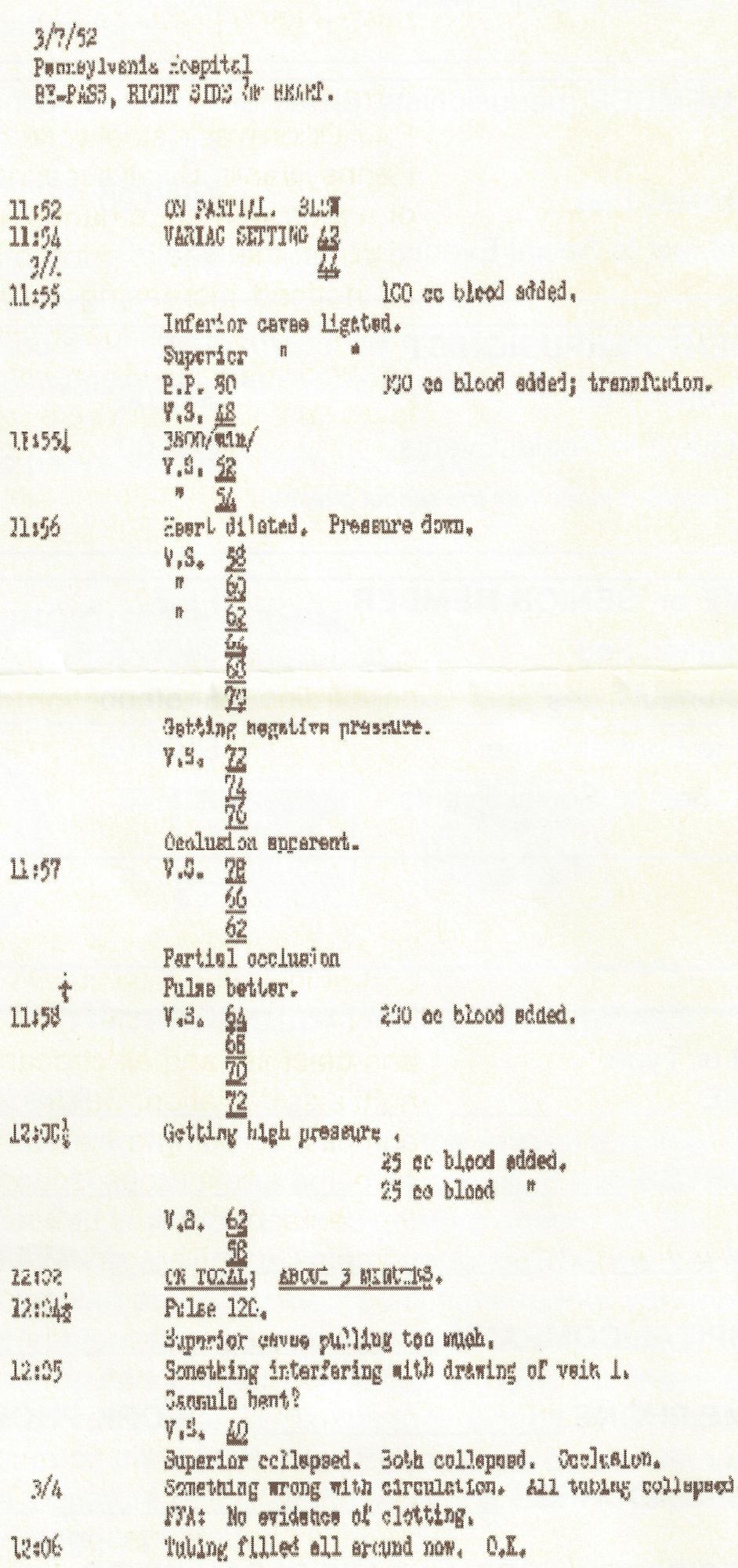
Right Heart Bypass Circuit

A glass collection chamber was made by a local neon sign company to serve as the venous reservoir. Tubing, a portable DeBakey-type roller pump, and Miller's cardiotomy suction system were also incorporated into the circuit. Nearly every key component had to be moved

moved across town from Jefferson to Pennsylvania Hospital and reassembled. Venous return to the special reservoir would occur by way of gravity from both superior and inferior vena cava, as well as the coronary sinus. Cannulation of the right main pulmonary artery would complete the circuit and allow total bypassing of the right heart. Miller made sure that the necessary laboratory equipment was available for measuring hemolysis, oxygen saturation, and even the degree of anticoagulation (Lee-White Test). There was also a person assigned to take notes during the bypass period so that a "pump record" could later be generated (See Figure 1). With everything seemingly in order, the operation was officially scheduled. A surgical consent form, declaring that extracorporeal circulation was still in its "developmental stage", was presented to Paul one week before his scheduled surgery date (See Figure 2). He signed the form.

The Operation

Paul was placed on the operating room table in the supine position in the early morning hours of March 7, 1952. A large polyethylene catheter was placed through his right femoral vein into the inferior vena cava by Allbritten. A slow drip of saline containing 20 milligrams of heparin to the liter was started through this catheter. Paul was then rolled onto this left side, and a lateral thoracotomy incision was made. The pleural space was opened and the right lung retracted to expose the pericardium. The right atrium appeared tremendously large even prior to the pericardium being opened. Allbritten carefully palpated the atrium, noting that it appeared tense, thin-walled, and "on the verge of rupture". No obvious intra-atrial mass could be felt, but the only way to be sure was to open the heart and explore it. Allbritten continued by placing a metal cannula in the superior vena cava adjacent to the azygos vein. A polyethylene catheter was then inserted into the right main pulmonary artery, and all connections secured. Additional heparin was administered (2 milligrams per kilogram) and Allbritten ordered that extracorporeal circulation commence. Miller eased the pump flow up to nearly 4 liters per minute without difficulty. Allbritten then snared both the superior and inferior vena cava vessels such that total right heart bypass could be accomplished. Gradually, the heart's right side began to distend. Was there back flow of blood through the pulmonary valve into the right ventricle? Was something kinked off? Perhaps the coronary sinus return was more than they had anticipated. Miller announced that the patient's blood pressure was falling and that venous return to the pump was diminished. Allbritten released the vena caval snares and manually compressed Paul's heart. Within seconds, the venous return to the pump improved and Paul's systemic blood pressure returned to an acceptable level. Allbritten quickly placed traction sutures in the right atrial wall. Following a small stab wound, he thrust his index finger into Paul's right atrium and searched for the suspected tumor. There was nothing. No mass or clot of any sort. There was, however, considerable dilation of the tricuspid valve. Allbritten estimated that Paul's tricuspid valve area could easily accommodate four fingers. Now what? This was a disease process that was poorly understood and beyond anyone's repair. Allbritten removed his finger, closed the right atrial incision, and ordered the pump stopped. Miller brought the machine to a hault and clamped the lines. Total extracorporeal time to this point was 44 minutes.



3/7/52
Pennsylvania Hospital
BY-PASS, RIGHT SIDE OF HEART.

11:52 ON PARTIAL BLOW
11:54 VARIAC SETTING 42
3/4 44
11:55 100 cc blood added.
Inferior cavae ligated.
Superior " "
B.P. 80 300 cc blood added; transfusion.
V.S. 48
11:554 3800/min/
V.S. 52
" 54
11:56 Heart dilated. Pressure down.
V.S. 58
" 60
" 62
64
68
70
72
Getting negative pressure.
V.S. 72
74
70
Occlusion apparent.
11:57 V.S. 78
66
62
Partial occlusion
Pulse better.
11:58 V.S. 64 250 cc blood added.
68
70
72
12:00 Getting high pressure.
25 cc blood added.
25 cc blood "
V.S. 62
58
12:02 (ON TOTAL) ABOUT 3 MINUTES.
12:04 Pulse 120.
Superior cavae pulling too much.
12:05 Something interfering with drawing of vein 1.
Cannula bent?
V.S. 40
Superior collapsed. Both collapsed. Occlusion.
3/4 Something wrong with circulation. All tubing collapsed.
FYA: No evidence of clotting.
12:06 Tubing filled all around now. O.K.

Figure 1a

Continued on Page 8

Continued from Page 5

12:06	300 cc blood given.	
12:07	V.S. 34	
12:09	HEART TO BE OPENED NOW.	
12:10	V.S. 38	
	V.S. 40	
	NOTHING INSIDE ATRIUM, JUST WIDE OPEN VALVE.	
	NO OBSTRUCTION. TRICUSPID INSUFFICIENCY.	
12:10½	V.S. 38	
	Coronary blood going back.	
12:11	V.S. 38	
½	Coronary blood back.	
12:13	FFA: (longer tubing needed.)	
¼	3000 - 3500 running.	
12:15	(Pumping 24 minutes.)	
12:20	BJ: venous blood not bad in color.	
	3200/min. V.S. 35	
12:23	CLOSING AURICLE.	
12:26	250 cc blood added.	
12:28	Sample from machine for Lee White.	
12:29½	V.S. 36	
12:30	250 cc blood added.	
12:32	250 cc blood added.	
12:33	Flow Rate 30.	
12:36	MACHINE STOPPED. TUBES CLAMPED.	
12:37	MACHINE STARTED AGAIN	
½	V.S. 32	
12:39	Patient losing blood.	
	500 cc blood given.	
12:40	ARRHYTHMIA	Heart stopped. Manually
12:49	Ventricular tachycardia	massaged for 10 min.
12:55	Very good heart beat.	CaGluconate
		Epinephrine injected IV
1:05	B.P. 100, V.S. 37 (& some time)	
1:10	Rib spreader loosened.	
1:15	Machine slowed.	
1:17	EVERYTHING OFF.	
1:34	Clotting time - 6 min.	
1:37	Rib spreader removed.	
1:39	Rib cage closed.	
1:48	Sample for hemolysis from machine.	
	x - 152.6	
	y - 149.3	

Figure 1b
Actual pump record of right heart bypass procedure (the typed entries were likely taken from notes made during the procedure by an observing individual according to Mark Kurusz)

Paul's heart struggled to produce even a modest blood pressure. Miller restarted the pump, and calcium and epinephrine were administered. Allbritten manually compressed Paul's heart on and off for ten minutes to keep the right side from distending. Slowly, the heart began to regain function. Miller began the weaning process again, only this time much slower. The operating room turned silent as he methodically announced the pump's flow. Three liters. Now two liters. Now one liter. Now all lines clamped. We're off.

The cannulas were removed, and the rib cage and groin incisions closed. The total period of extracorporeal circulation was 85 minutes. Aside from observation, there was little else to do for the patient. Systolic blood pressure readings remained at 90 to 100 mmHg for the first couple hours following the operation, but a slow deterioration eventually ensued. Despite volume replacement with whole blood, the patient succumbed approximately two hours after the operation and was pronounced dead.

Discussion

Controversy exists as to what Gibbon's exact role was in this case. Most historians believe that Gibbon was involved from the beginning, referred the case to his colleague Allbritten, and was present during the operation (see Harris

Continued on Page 9