Henry Ford Hospital Medical Journal

Volume 32
Number 3 *Special Issue on Medical Computing*

Article 4

9-1984

Computer Applications in the Vascular Registry of Henry Ford Hospital: Use of a Simplified Access Method

Joseph P. Elliott Jr.

Kunwar Kapoor

John G. Hageman

D. Emerick Szilagyi

Roger F. Smith

See next page for additional authors

Computer Applications in the Vascular Registry of Henry Ford Hospital: Use of a Simplified Access Method

Authors

Joseph P. Elliott Jr., Kunwar Kapoor, John G. Hageman, D. Emerick Szilagyi, Roger F. Smith, and Michalene McPharlin

Henry Ford Hosp Med J
Vol 32, No 3, 1984

Computer Applications in the Vascular Registry of Henry Ford Hospital: Use of a Simplified Access Method

Joseph P. Elliott, Jr, MD,* Kunwar Kapoor, PhD,* John H. Hageman, MD,* D. Emerick Szilagyi, MD,* Roger F. Smith, MD,* and Michalene McPharlin, RN*

The Vascular Registry of Henry Ford Hospital was initiated by one of the authors in 1957 to provide a consistent and accurate method of documenting and correlating the clinical results of the treatment of occlusive and aneurysmal arterial diseases.

Data collection for each patient includes demographic information, treatment of clinical problems, and follow-up observations. Initially, the system consisted of keypunch cards and eventually magnetic tape processing. By 1980, it was necessary to further update the system because of the increase in patient volume, the need to minimize manual manipulations, and the demand for research data. The present system uses institutional mainframe computers (IBM 3031 and 3033), a video terminal, and a printer. Functions such as data management and clinical reporting are controlled by easy-to-understand programs that can be operated by noncomputer professionals. Currently, the Vascular Registry allows vascular surgeons to obtain information rapidly about patients who have had operative or nonoperative treatment of arterial problems. It is used to ensure complete patient follow-up, to manage clinical activities, and to monitor and control the quality of care.

During the last thirty years, Henry Ford Hospital has made a significant contribution to the development of vascular surgery largely because the founders of the Vascular Surgery Division insisted on consistently documenting and correlating the clinical results with the treatment of occlusive and aneurysmal arterial diseases. Evaluating the implications of the collected data allowed surgeons to modify their practice in a logical manner, especially selection of patients for various diagnostic and surgical procedures. In addition, this form of data collection directed research efforts into fruitful areas, provided for self-instruction and enabled publication of conclusions based on reliable data.

Documenting results includes several separate tasks: 1) developing a routine for long-term observation of patients and their operations; 2) choosing and measuring significant variables; 3) recording data systematically, in a form permitting ready tabulations; and 4) using a method to store and retrieve the information that is readily accessible without involving computer professionals.

Vascular Follow-Up Methods

After a vascular surgical procedure has been completed, the patient is evaluated during the operation and again before the patient is discharged from the hospital 10 to 14 days later. We use a combination of clinical, noninvasive, and angiographic methods.

Patients are then evaluated in the outpatient clinic at one-, three-, and six-month intervals, then annually. Those who fail to return are sent recall letters, or if necessary, traced personally in order to evaluate the current patency of the operated artery, the duration of its survival, or the cause of death.

The Vascular Registry at Henry Ford Hospital initially consisted of keypunch cards. In the 1960s, the database was transferred to electronic computer files, originated by Jack S. Guyton, MD, using programs in Assembler language. The Assembler programs allowed routine distributions between two or three categories of information. For instance, the age, type of operation, and clinical result could be correlated with two- or three-way distributions, and subsets could be correlated by restricting any one of the categories without resorting to a programmer for each new request. Edits within the documentation for each operation and between documents for a single patient were established. Twice a year, the information was arranged in alphabetical order by patient names to verify that each patient had only one medical record number. A number of innovative steps were taken. For example, programs developed to alert us to the admission of vascular patients to other services required matching the hospital admission files with the Vascular Registry.

Submitted for publication: April 26, 1984
Accepted for publication: November 20, 1984
*Department of Surgery, Vascular Surgery Division, Henry Ford Hospital
Address reprint requests to Dr. Elliott, Department of Surgery, Vascular Surgery Division, Henry Ford Hospital, 2799 W Grand Blvd, Detroit, MI 48202.

Because of the increase in patient volume, the system was revised in 1980 with two basic intentions: to minimize the manual manipulation of information required to administer the Vascular Surgery Clinic and to improve our clinical research capability. Functions such as data management and clinical reporting are arranged in an easily understood, explicit manner which can be accessed with on-line menus (Fig. 1).

Fig. 1

A registered nurse maintaining the vascular registry system. Minimal training is required to become proficient in manipulating, adding, and retrieving data from the computer.

Software and Hardware

Selection of suitable software and hardware was determined by the requirements of the system. The amount of data collected during previous years, the requirements for interfacing with other hospital systems, and the unavailability of a single software package to encompass the variety of required jobs determined the need to utilize the existing hospital mainframe computers (IBM 3031 and 3033). Coaxial and telephone connections were employed along with an IBM 3278 video terminal and an IBM 3298 printer located in the Vascular Surgery Clinic Registry. A microfiche reader was obtained for backup activities in case of computer downtime. Reports can be printed directly in the vascular clinic, or when necessary, by the high-speed printer in the hospital data processing department.

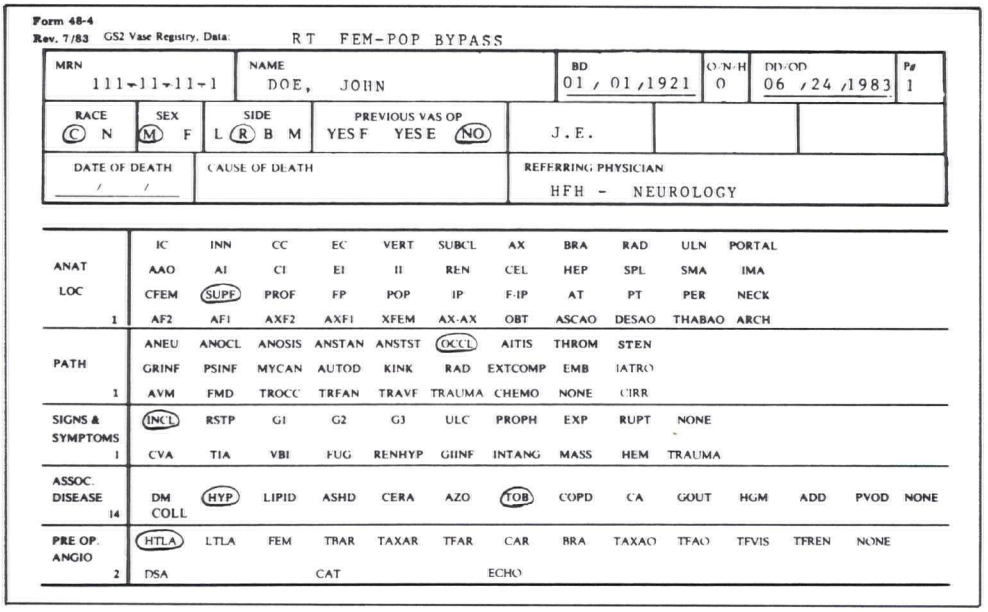
Several well-known databased management systems (DBMS) software packages are available on the hospital computers: IMS, CICS, PCS, FOCUS, and TOTAL. Any of these systems could meet all of our needs with the exception of ad hoc reporting for research purposes, information essential to support research as well as educational and programmatic purposes. For research, we required a DBMS with a user-friendly interactive inquiry capability so that ad hoc reporting would not require major programming help. The English-like syntax of the FOCUS language, as well as the availability of hierarchical and relational database management, statistical analysis and graphic capabilities made FOCUS a flexible and self-sufficient tool for an independent clinical system. Accordingly, almost all of the programs for our system were written in the FOCUS language, significantly reducing development costs. Less than one man-year was required to write the present system with its easy access menus. Other languages were used when FOCUS did not prove effective. For example, COBOL was used to write programs to select required records from files belonging to other hospital systems; PL/1 was used to write subroutines/functions (which could be called from FOCUS) to do statistical and other special work; and the statistical analysis system graphics package was used to write the graphics programs. The FOCUS program which we have used for one year has potential use for other institutions with similar situations.

Data Collection and Storage

All collected information resides in the hierarchical FOCUS database in three logical segments: 1) demographic information about patients; 2) data about clinical problems which were treated either surgically or nonsurgically; and 3) follow-up observations. This was an obvious choice for the database structure because of the "one-to-many" relationship between demographic data and clinical problems as well as between clinical problems and their multiple follow-up observations. These data elements are defined so that correlation of clinical problems into major classes is possible. The available data elements are listed in abbreviated form on 5 x 7 pocket-sized cards which are used as check lists for gathering data (Figs. 2A-C). As they are keypunched in the registry, they are automatically validated according to edit criteria. For example, the date of a follow-up must logically follow the length of follow-up and the date of operation.

Some elements are changed or updated automatically according to their relationship with new information entered into the system. For instance, the date and cause of death must be entered if follow-up information indicates the death of a patient. Such editing procedures are needed to ensure the integrity of clean data.

The security of the system is maintained by code words for operators as well as their careful screening and training. Offsite storage and microfiche storage are also important parts of security for the database. It is essential that data managers within a registry of this sort have significant medical background in order to code data from patients' records in a reasonable way.



Form 48-4
Rev. 7/83 GS2 Vase Registry, Data: RT FEM-POP BYPASS

MRN	NAME	BD	O/N/H	DD/OD	P#
111-11-11-1	DOE, JOHN	01 / 01 /1921	0	06 / 24 /1983	1

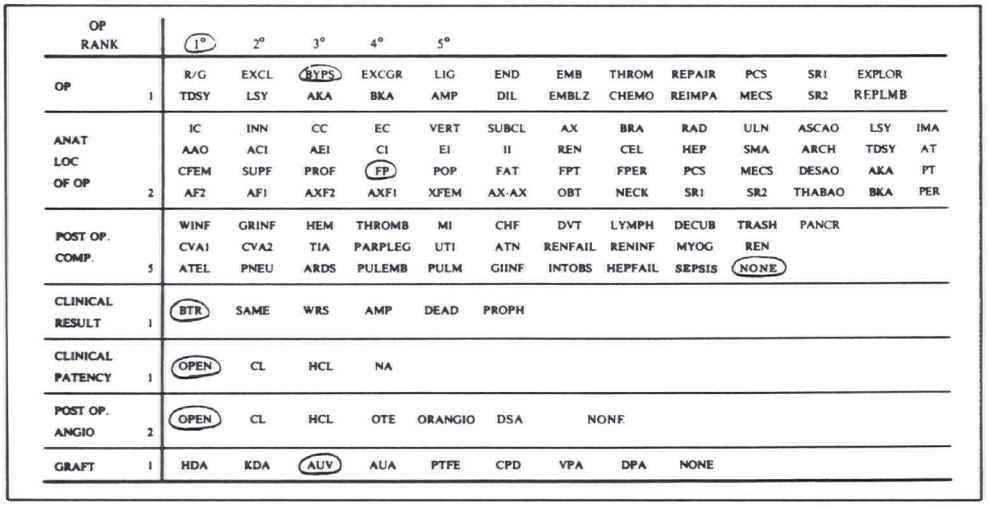
RACE	SEX	SIDE	PREVIOUS VAS OP		
(C) N	(M) F	L (R) B M	YES F YES E (NO)	J.E.	

DATE OF DEATH	CAUSE OF DEATH	REFERRING PHYSICIAN
/ /		HFH - NEUROLOGY

ANAT LOC 1	IC	INN	CC	EC	VERT	SUBCL	AX	BRA	RAD	ULN	PORTAL		
	AAO	AI	CI	EI	II	REN	CEL	HEP	SPL	SMA	IMA		
	CFEM	(SUPF)	PROF	FP	POP	IP	F-IP	AT	PT	PER	NECK		
	AF2	AF1	AXF2	AXF1	XFEM	AX-AX	OBT	ASCAO	DESAO	THABAO	ARCH		
PATH 1	ANEU	ANOCL	ANOSIS	ANSTAN	ANSTST	(OCCL)	AITIS	THROM	STEN				
	GRINF	PSINF	MYCAN	AUTOD	KINK	RAD	EXTCOMP	EMB	IATRO				
	AVM	FMD	TROCC	TRFAN	TRAVF	TRAUMA	CHEMO	NONE	CIRR				
SIGNS & SYMPTOMS 1	(INCL)	RSTP	G1	G2	G3	ULC	PROPH	EXP	RUPT	NONE			
	CVA	TIA	VBI	FUG	RENHYP	GIINF	INTANG	MASS	HEM	TRAUMA			
ASSOC. DISEASE 14	DM	(HYP)	LIPID	ASHD	CERA	AZO	(TOB)	COPD	CA	GOUT	HGM	ADD	PVOD	NONE
	COLL													
PRE OP. ANGIO 2	(HTLA)	LTLA	FEM	TBAR	TAXAR	TFAR	CAR	BRA	TAXAO	TFAO	TFVIS	TFREN	NONE	
	DSA			CAT			ECHO							

Fig. 2A

The face of the "problem card" contains the data elements providing demographic and clinical information. Specific items relating to the patient's preoperative data are circled on the card. In this example, they indicate that John Doe, born January 1, 1921, had disabling intermittent claudication due to superficial femoral artery occlusion confirmed by a lumbar aortogram.



OP RANK													
	(1°)	2°	3°	4°	5°								
OP 1	R/G	EXCL	(BYPS)	EXCGR	LIG	END	EMB	THROM	REPAIR	PCS	SR1	EXPLOR	
	TDSY	LSY	AKA	BKA	AMP	DIL	EMBLZ	CHEMO	REIMPA	MECS	SR2	REPLMB	
ANAT LOC OF OP 2	IC	INN	CC	EC	VERT	SUBCL	AX	BRA	RAD	ULN	ASCAO	LSY	IMA
	AAO	ACI	AEI	CI	EI	II	REN	CEL	HEP	SMA	ARCH	TDSY	AT
	CFEM	SUPF	PROF	(FP)	POP	FAT	FPT	FPER	PCS	MECS	DESAO	AKA	PT
	AF2	AF1	AXF2	AXF1	XFEM	AX-AX	OBT	NECK	SR1	SR2	THABAO	BKA	PER
POST OP. COMP. 5	WINF	GRINF	HEM	THROMB	MI	CHF	DVT	LYMPH	DECUB	TRASH	PANCR		
	CVA1	CVA2	TIA	PARPLEG	UTI	ATN	RENFAIL	RENINF	MYOG	REN			
	ATEL	PNEU	ARDS	PULEMB	PULM	GIINF	INTOBS	HEPFAIL	SEPSIS	(NONE)			
CLINICAL RESULT 1	(BTR)	SAME	WRS	AMP	DEAD	PROPH							
CLINICAL PATENCY 1	(OPEN)	CL	HCL	NA									
POST OP. ANGIO 2	(OPEN)	CL	HCL	OTE	ORANGIO	DSA	NONE						
GRAFT 1	HDA	KDA	(AUV)	AUA	PTFE	CPD	VPA	DPA	NONE				

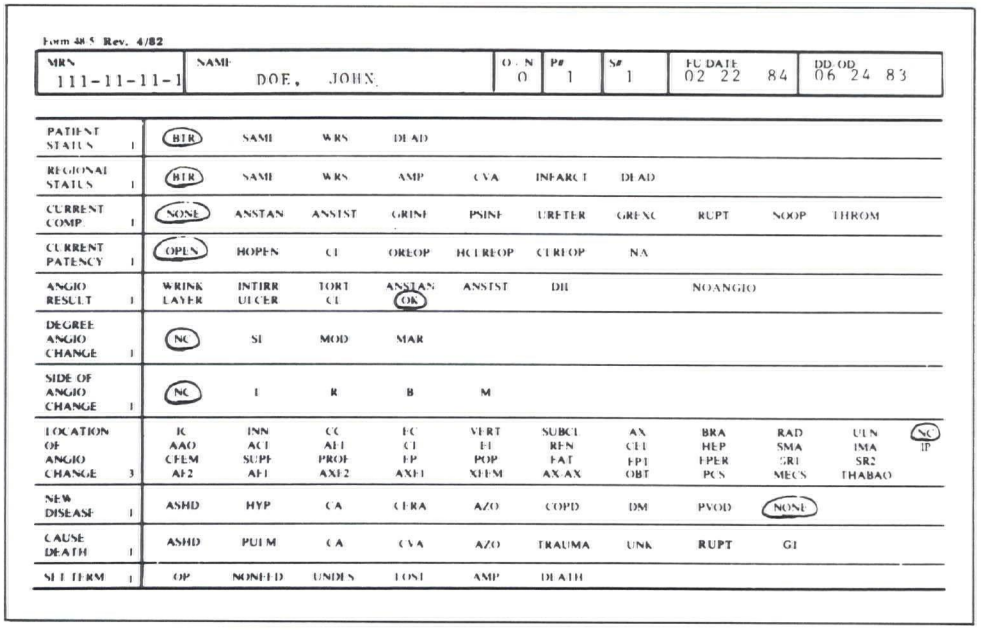
Fig. 2B

The reverse side of the problem card contains the data elements providing operative information about Mr. Doe. The first operation for this problem consisted of an uncomplicated femoropopliteal autogenous vein bypass on June 24, 1983, with an improved clinical result. A patent graft was demonstrated by a postoperative angiogram.

Current Functions

Patient management

To accurately track vascular patients, the Vascular Registry interfaces with the HFH inpatient census data bank which provides information about patients who are admitted to any service in the hospital. A similar process automatically prints a complete set of registry data on each patient who is scheduled for an angiogram, facilitating the recording of angiographic follow-up data during daily conferences. The registry, on a daily basis, reads the computerized outpatient appointment list and generates a full profile on any patient for whom it requires additional current data. These profiles are used by the surgeons when the patients are seen in the clinic.



Form 48.5 Rev. 4/82

MRN	NAME	O:N	P#	S#	FU DATE	DD OD
111-11-11-1	DOE, JOHN	0	1	1	02 22 84	06 24 83

PATIENT STATUS 1	(BTR)	SAME	WRS	DEAD							
REGIONAL STATUS 1	(BTR)	SAME	WRS	AMP	CVA	INFARCT	DEAD				
CURRENT COMP 1	(NONE)	ANSTAN	ANSTST	GRINF	PSINF	URETER	GRENC	RUPT	NOOP	THROM	
CURRENT PATENCY 1	(OPEN)	HOPEN	CL	OREOP	HCLREOP	CLREOP	NA				
ANGIO RESULT 1	WRINK LAYER	INTIRR ULCER	TORT CL	ANSTAN (OK)	ANSTST	DIL		NOANGIO			
DEGREE ANGIO CHANGE 1	(NC)	SL	MOD	MAR							
SIDE OF ANGIO CHANGE 1	(NC)	L	R	B	M						
LOCATION OF ANGIO CHANGE 3	IC AAO CFEM AF2	INN ACI SUPF AFI	CC AEI PROF AXF2	EC CI FP AXFI	VERT FI POP XFEM	SUBCL REN FAT AX-AX	AX CEL FP1 OBT	BRA HEP FPER PCS	RAD SMA SRI MECS	ULN IMA SR2 THABAO	(NC) IP
NEW DISEASE 1	ASHD	HYP	CA	CERA	AZO	COPD	DM	PVOD	(NONE)		
CAUSE DEATH 1	ASHD	PULM	CA	CVA	AZO	TRAUMA	UNK	RUPT	GI		
SET TERM 1	OP	NONEED	UNDES	LOST	AMP	DEATH					

Fig. 2C

The follow-up card contains the data elements providing information obtained from postoperative clinic visits, hospital admissions, letters, and telephone calls. On February 22, 1984, Mr. Doe required a follow-up admission for an angiogram, which indicated that his condition was improved. The graft was clinically patent without angiographic evidence of deterioration. No associated new disease was found.

Follow-up and recall management

The registry computer, on a weekly basis, calls attention to any patient who has incomplete data. In addition, recall letters are automatically printed every month for patients who have not been seen for specified periods of time. When recall efforts by mail are unsuccessful, the patient is reported on a monthly tardy list which sorts patients by the date last seen, and appropriate information provided so that the patient can be traced. These recall efforts can be directed by appropriate restrictions to group patients who have certain classes of operations in order to advance a research project.

Clinical research

On request, using simple commands, the registry produces ad hoc reports on specified subsets of patients. These reports can be made either complete or variable by using two simple methods: 1) the subsets can be restricted by the surgeon's name, operation, or any other variable in the registry; 2) in addition to supplying simple counts of data elements, the program will easily generate two- and three-way distributions of data. For example, in a specified area of arterial reconstruction, the effect of the type of graft and severity of occlusive disease on the immediate graft patency can be demonstrated. The program also will construct cumulative survival or patency tables. Graphic display of such information is also provided.

A review of the steps in the completion of a clinical research project will illustrate the usefulness of the registry. For instance, it was recently desired to study the limits of the effectiveness of femoropopliteal vein bypass grafting for the treatment of lower limb atherosclerotic occlusive disease. The registry was given a request for names and case numbers of patients with the operations to be studied. It was programmed to provide subgroups of patients according to the completeness of the follow-up in addition to the clinical results, symptoms, and associated diseases.

Since the data originally entered in the registry could not encompass all the information needed for this specific study, a tally sheet was prepared containing all the details of the desired information. In this case, about 1,000 potential entries were provided, arranged in 13 columns.

The first step in the actual collection of data was to update the follow-up information using the list obtained from the computer. Patients who were behind in their scheduled follow-ups were contacted by letter and phone. The completed case histories of various subgroups of patients were scrutinized in the medical record room, and the required data entered in tally sheets. In this case, approximately 600 tally sheets were used.

The tally sheet data was computerized and used to complete tables and graphs constructed with the aid of

a statistical expert to guide clinical correlations. These tables and graphs included information about clinical characteristics, grade and location of disease, quality of the vein graft available, duration of follow-up, and early and late patency and survival results.

Clinical research projects based on registry information have been used extensively to modify the treatment protocols of the vascular surgery service for arterial reconstructions. Decisions made by this method have withstood the test of time. This careful longitudinal follow-up has added to the general knowledge of the behavior of reconstructive procedures, including the fate of biologic and synthetic vascular prostheses (1). Specific examples of the lessons learned include:

1. A review of patients with aortoiliac and femoropopliteal arterial homografts revealed that the grafts were tolerated but not incorporated by the host. Because of the lack of elastic tissue, the homografts were soon rendered useless in the femoropopliteal area. In the aortoiliac area, integrity was maintained over a somewhat longer period, but here also homografts were found to be unsuitable for arterial substitutes (2).

2. A study of the biologic fate of vein grafts demonstrated some form of angiographic defect in one-third of the cases. The study emphasized the importance of the need for special handling of the delicate tissues as well as a need for regular follow-ups to detect potentially critical lesions in a timely fashion to allow prophylactic repair (3).

3. A study of the management of late graft failures showed that secondary arterial repair was required for 11% of aortoiliac grafts and 14% of femoropopliteal grafts. The problems of degenerating arterial allografts, anastomotic false aneurysms, recurrent atherosclerotic occlusions following endarterectomy, and late thrombotic occlusions of prosthetic grafts were identified. The successful treatment was analyzed, emphasizing again the importance of timely detection by regular follow-up methods (4).

Current studies are underway, using the registry to update earlier reports of the treatment of anastomotic aneurysms of synthetic grafts, as well as the merits and indications for various methods of treating aortoiliac occlusive disease.

Aside from research activities, certain administrative and education program functions within the vascular division have been greatly facilitated by the rapid access to large amounts of clinical data provided by the registry. These program functions have included:

1. The ability to rapidly assemble and correlate large amounts of information about the types and numbers of various operations performed on this service by the staff and residents,

2. Comparing actual counts of diagnostic tests performed, with billing procedures as a check for accuracy,

3. Improving patient satisfaction by detecting vascular surgery patients who are admitted on other services, performing follow-up observations and reducing additional trips to the hospital.

Major research capabilities provided by the vascular surgery registry, some of which have been cited above, and the rapid availability of on-line information about patency rates, mortality rates, and causes of death provide an opportunity to monitor the efficacy of our surgical efforts.

Planned future enhancements of this system include the development of a noninvasive vascular registry to interface with existing systems. A local intracomputer network (LAN) is being installed in the hospital to facilitate interfaces with other computer systems, ie, the pathological laboratory and radiology systems. Once these relationships develop, the Division of Vascular Surgery will have a complete information management system at its disposal.

Acknowledgment

The Division of Vascular Surgery greatly appreciates the teaching, guidance and aid in building the computer programs used by the Vascular Registry, which was provided by Jack S. Guyton, MD, a generous, dedicated physician and mathematician.

References

1. Smith RF. The importance of longitudinal follow-up of clinically implanted vascular grafts. In: Biologic and synthetic vascular prosthesis. New York: Grune & Stratton, 1982:475-81.

2. Szilagyi DE, Rodriquez FJ, Smith RF, et al. Late fate of arterial allografts. Arch Surg 1970;101:721-33.

3. Szilagyi DE, Elliott JP, Hageman JH, et al. Biologic fate of autogenous vein implants as arterial substitutes: Clinical, angiographic, and histopathological observations in femoropopliteal operations for atherosclerosis. Ann Surg 1973;178:232-46.

4. Szilagyi DE, Elliott JP, Smith RF, et al. Secondary arterial repair: Management of late failures in reconstructive arterial surgery. Arch Surg 1975;110:485-93.