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ASSESSMENT OF AMPUTEE REHABILITATION USING A TEXT-GENERATING DATA PROCESSING SYSTEM

Peter H. Stern, M.D.

In 1974, The Burke Rehabilitation Center began a major effort to computerize its medical record system in an endeavor to simplify the ever increasing demands for documentation in health care. Previous experience with a terminal-oriented, time-sharing computer system called APL *(1)* convinced us of the practicality of using computer-generated English-text discharge summaries for major disease categories that can be described in a relatively finite number of variables. In a previous publication *(2)* the procedures required for stroke rehabilitation discharge summaries were described.

This paper is concerned with discharge summaries for lower-limb amputees that were referred to the Burke Rehabilitation Center during the period between 1/1/74 and 9/20/75 and with the concurrent establishment and analysis of a data base accumulated during this period.

METHOD

The computer system, APL (A Programming Language), consists of a terminal connected by telephone equipment to a remotely located central IBM-370 computer (Fig. 1). It is a time sharing system; that is, many terminals are connected simultaneously. A new general purpose program, APG (A Program Generator), is added for our purposes. The APL/APG system is highly interactive, user oriented, and does not require any special knowledge in computer sciences or mathematics. At the Burke Rehabilitation Center medical, nursing, and clerical personnel are able to operate the terminals with very little instruction.

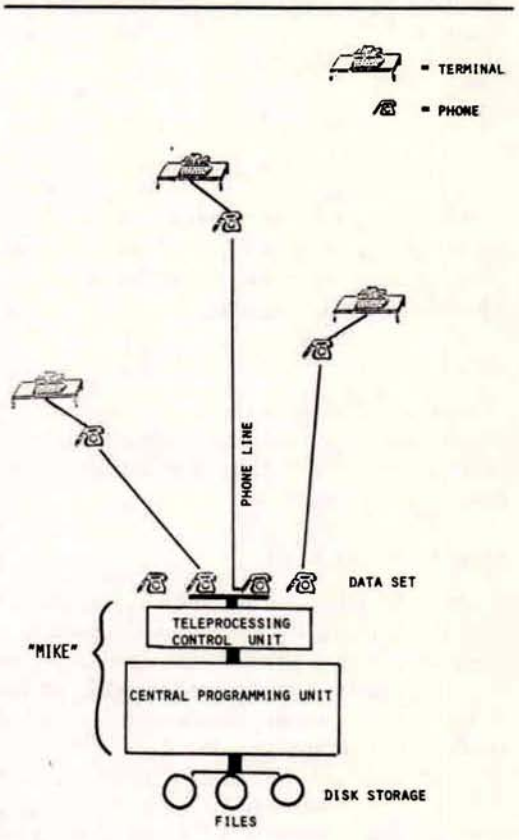

Fig. 1. Schematic of the text generating data processing system. MIKE is the name assigned to the program reported here.

Preprogramming

The user, in this case the physician in charge of the Amputee Service, constructs a questionnaire type discharge summary work sheet as shown in Appendix A. The encircled numbers are used to generate the English text discharge summary. The programmer is provided with a sample prose; upper and lower bounds for queries such as laboratory values for the inclusion of validity checks, and a general idea of the data that might be subject to calculations, correlations, or tabulations.

Operation

In order to generate a discharge summary the attending physician simply encircles the appropriate answers to the prepared series of queries and if necessary completes the free text provisions which are of fixed character length. The data is then entered by a terminal operator or the physician himself. It is retrieved either as an English text discharge summary (Fig. 2) or as part of a statistical report, the format of which are predetermined in the preprogramming and programming phases (Table 1).

RESULTS

During the period between January 1, 1974 and September 20, 1975, 127 amputee patients were discharged from the Burke Rehabilitation Center. The tabulated results follow.

Age, Sex

Equal sex distribution and an average of 65 years (range 17–90) shows that the elderly "vascular" amputee is the major public health problem in amputee rehabilitation.

Length of Stay (L.O.S.)

The mean L.O.S. of the entire group was 45 days (median 39). If bilateral and asymmetrical amputees are separated out, the mean length of stay dropped to 35.8 days. The L.O.S. of the bilateral below-knee amputees was 56 days and of the asymmetrical amputees 96.4 days.

The median L.O.S. of 39 days on the Amputee Service of a rehabilitation hospital compares favorably with national P.S.R.O. standards. Our data was influenced by a long-term (284 days) stay of a bilateral traumatic amputee. The mode of 28 days signifies a trend towards shorter L.O.S.

Functional Outcome

The achievement scale of Russek *(3)* was selected to assess outcome. The results appear gratifying since 13 bilateral and 5 asymmetrical amputees are included. The majority (more than 90%) of the patients were discharged with a temporary prosthesis with a plaster-of-Paris socket (Figs. 3 & 4), applied almost immediately following admission. These devices are worn for an average of 6–8 weeks. It can be assumed that most patients will achieve a higher rating once supplied with the permanent device. Only about half of the bilateral below-knee amputees achieved a classification III rating. The rest remained Class IV. Of the asymmetrical amputees only two achieved Classification III.

Employment Status

The results, not encouraging, are attributable to the retirement age of most male patients and the presence of a variety of associated medical conditions which are listed in section II(*3*).

Level of Amputation

The classification recommended by the task force on standardization of prosthetic-orthotic terminology was used *(4)*. Over two-thirds of the patients had either short or standard length below-knee (B/K) amputations as opposed to above knee (A/K).

This signifies a laudable trend for surgeons to carry out B/K amputations in preference to A/K amputations, which only 15 years ago was the preferred operative site if popliteal pulses were absent. Knee disarticulation, thought to be a suitable alternative to long A/K or a very short B/K amputation, was encountered only once.

Description of Amputation

The slightly higher incidence of right versus left amputation is probably statistically insignificant. There were 11 bilateral B/K amputees, 5 asymmetrical, but only 2 bilateral A/K amputees. The admission of this category of patients is generally discouraged as successful prosthetic application is usually not possible for older persons.

Interval of Amputation to Walking

It takes about two months after amputation before patients can walk again with a prosthesis. The mode of 48 days indicates a trend towards a much shorter interval.

Reason for Amputation

As expected, diabetic arteriosclerosis obliterans (ASO) is the most frequently encountered reason

THE BURKE REHABILITATION HOSPITAL SUMMARY

[redacted]

43242

Admitted: 07/08/75 Discharged: 08/21/75
Length of stay: 44 days Date of amputation: 06/25/75 (LL)

PRIMARY DIAGNOSIS: Amputation left upper tibia secondary to vascular disease

ASSOCIATED CONDITIONS: heart disease, hypertension, and diabetes mellitus

COMPLICATION: stump injury, wound resutured

CONDITION ON DISCHARGE: improved

ABILITY TO USE LOWER LIMB PROSTHESIS: Class III Fair functional outcome; job modification required.

DISCHARGE NOTE:

1. Reason for entering hospital: This 66 year old black male was admitted for amputee rehabilitation because of a left upper tibia amputation secondary to vascular disease as a result of diabetic ASO. Associated with this was heart disease, hypertension, and diabetes mellitus.

2. Pertinent Past History: The amputation was performed on 06/25/75 for the lower left limb at NYH. Complications because of blood-loss anemia were encountered.

3. Pertinent Physical, X-ray and Lab Findings on Admission: BP was 150/100; PR was 80; temp. was 37.0 C.; weight was 63 Kg. General condition was fair. The lower left stump condition was bulbous, not healed, and edematous. The remaining limbs showed impaired circulation, and weakness. Sensory findings were: normal. Tests: HCT 37.0; WBC 6500.0; FBS 129.0; BUN 28.0; Creatinine 1.1; Uric acid 7.6; K+ 4.0. Chest X-ray was not done. ECG showed CAD.

4. Course in Hospital: This patient was on a program of amputee rehabilitation including preprosthetic activities, stump shaping, wound healing, functional training, and self-care training. A left B/K plaster of paris pylon was issued on 07/29/75. He first walked on 07/30/75. Lower left surgical treatment included stump care, and debridement. Medications: antihypertensives, diuretics, and analgesics. Complications because of stump injury, wound resutured were reported.

DISCHARGE DISPOSITION: home, and OPD
EMPLOYMENT STATUS: retired

DISCHARGE ORDERS:

1. Hydrodiuril 50mg QD
2. Phenobarb 15mg TID
3. Diet: 2000C diabetic

Physician: Peter H. Stern M.D.

RETURN TO OPD ON 09/04/75 AT NYH-K7
HOME CARE COORDINATOR: Mary Ellen Gibson, R.N. TELEPHONE: (212) 472-5907

Fig. 2. A typical English-text discharge summary provided by the APL/APG system.

TABLE I. BURKE REHABILITATION HOSPITAL
AMPUTEE REHABILITATION REPORT (LOWER LIMB)
DISCHARGES DURING THE PERIOD 01/01/74 THROUGH 09/20/75

	PATIENTS DISCHARGED (all diagnoses)				127
	Male				65
	Female				62
	AGE (127 patients):				
1.	Maximum				90
	Minimum				17
	Mean				65
	Median				67
	Mode				75
	LENGTH OF STAY (127 patients):				
2.	Maximum				284
	Minimum				6
	Mean				45
	Median				39
	Mode				28
	ABILITY TO USE LOWER LIMB PROSTHESIS				
3.	Class I	Excellent functional outcome; not handicapped			1
	Class II	Good functional outcome; some restriction			19
	Class III	Fair functional outcome; job modification required			52
	Class IV	Walking with assistance and for short distances only			38
	Class V	No significant improvement of mobility			11
	Class VI	Rejection of prosthesis			5
	EMPLOYMENT STATUS				
4.	Retired				71
	Full time, usual work				2
	Part time, usual work				9
	Job modification or retraining				10
	Unable to work				34
	LEVEL OF AMPUTATION		RIGHT	LEFT	TOTAL
5.	Pelvic, complete		2	0	2
	Hip, complete		1	0	1
	Thigh, upper		2	6	8
	Thigh, middle		23	13	36
	Thigh, lower		1	1	2
	Knee disarticulation		1	0	1
	Below knee, upper		13	12	25
	Below knee, middle		33	33	66
	Below knee, lower		1	0	1
	Foot, complete		2	1	3
	Foot, partial		0	0	0
	Other		0	0	0
	DESCRIPTION OF AMPUTATION				
6.	Right				61
	Left				48
	Bilateral, below the knee				11
	Bilateral, above the knee				2
	Assymetrical				5

TABLE I. (Continued)

	INTERVAL—AMPUTATION TO WALKING (114 patients):			
	Maximum			360
7.	Minimum			12
	Mean			69
	Median			49
	Mode			48
	REASON FOR AMPUTATION			
8.	TRAUMATIC			
	Industrial			1
	Traffic			2
	Gunshot			1
	Recreational			0
	Other			0
	VASCULAR			
	Diabetic ASO			71
	ASO			34
	TAO			2
	Thrombo-embolism			6
	Other			6
	CONGENITAL			
	All			0
	TUMOR			
	All			4
	PRECEDING SURGICAL PROCEDURES			
9.	Sympathectomy			20
	Embolectomy			13
	By-pass			30
	Previous amputation			27
	Other			0
	COMPLICATIONS AT ACUTE HOSPITAL			
10.	None			41
	Blood-loss anemia			47
	Pulmonary embolism			6
	Infection			30
	All			4
	Pneumonia			2
	Other			33
	STUMP CONDITION	RIGHT	LEFT	TOTAL
11.	Good	14	22	36
	Bulbous	27	20	47
	Not healed	33	21	54
	Edematous	42	28	70
	Infected	17	7	24
	Other	13	7	20
	ASSOCIATED CONDITIONS			
12.	None			10
	Dementia			27
	Parkinsonism			2

TABLE I. (Continued)

	Stroke	1
	Heart disease	65
	Hypertension	17
	Pulmonary disease	12
	Renal disease	9
	GI disease	10
	Diabetes mellitus	61
	GU disease	11
	Fractures	3
	Depression	12
	Eye disease	20
	Peripheral neuropathy	4
	Other	43
	INTERVAL—AMPUTATION TO ADMISSION (127 patients):	
13.	Maximum	306
	Minimum	<18
	Mean	58
	Median	38
	Mode	21

for amputation, followed by other vascular conditions.

Preceding Surgical Procedures

The data show a trend in surgery away from the once popular sympathectomies towards vascular surgical efforts such as by-pass procedures or embolectomies to restore failing circulation. Twenty-seven patients had previous amputations such as partial foot, conversions or amputations on the other side.

Complications at Acute Hospital

Reported complications which occurred at the referring hospital were frequent and ranged from mild (blood loss anemia) to pulmonary or myocardial infarctions. Only 41 patients had no complications. Wound infections occurred in 24 patients.

Stump Conditions

Only 36 patients had optimal stump conditions. Bulbous (47), not healed (54), edematous (70), or infected (24) stumps were noted. These significantly affected L.O.S. data.

Associated Conditions

This tabulation shows that practically all patients have one or more significant associated disorders, including 27 patients who had mild to moderate dementia.

Interval of Amputation to Admission

Mean and median values show that this interval is between 6–8 weeks with a trend towards a shorter interval (mode 21 days). Some of the reasons for delay in transfer to a rehabilitation hospital can be explained by the data presented in Sections 8, 9, 10, and 11.

DISCUSSION

The utilization of the described APG/APL application is not only time-saving and convenient for the physician, but has a direct, beneficial effect on health care delivery.

The patient's summary is available at the time of discharge and contains vital information concerning his medication schedule and appointment place and time for outpatient re-evaluation.

The interactive questionnaire type program

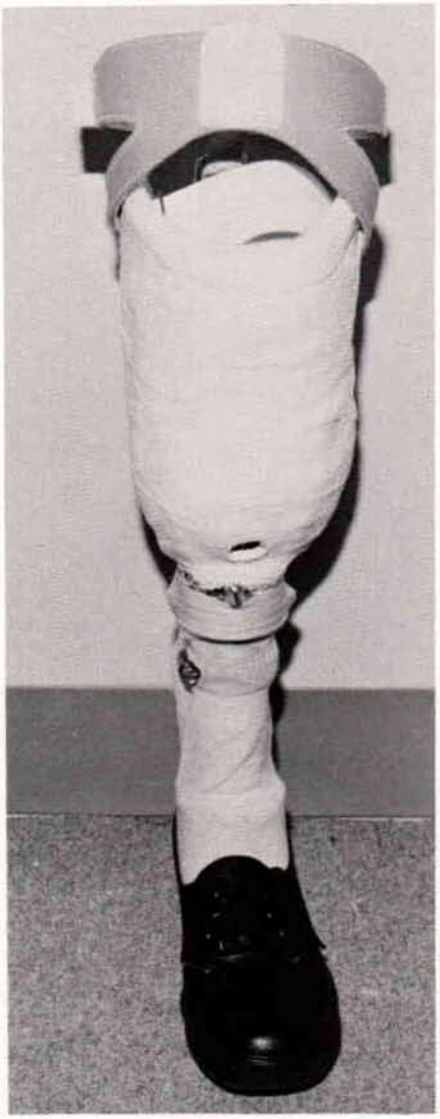

Fig. 3 A typical temporary prosthesis provided below-knee amputees. A Sach foot, an adjustable "pylon," and a plaster-of-Paris socket are used.

Fig. 4. A typical temporary prosthesis provided above-knee amputees. A Sach foot, an adjustable AK "pylon" with manual knee lock, and a plaster-of-Paris socket are used.

will remind the physician and allied health personnel of possible omissions in record keeping or care.

The periodic exploration of a cumulative data base allows not only the detection of trends but the constant monitoring of the amputee service activities for the purposes of quality control.

SUMMARY

This is a description of an APL/APG system oriented towards use by medical personnel essentially unskilled in computer sciences. An interactive questionnaire type input allows the generation of English-text summaries of patients

discharged from The Burke Rehabilitation Center. Variables contained in the summary are stored to form a data base for concurrent statistical analysis.

LITERATURE CITED

1. Stern, P.H. and Miller, J.M. *Quantitative evaluation of long term L-DOPA treated patients with Parkinsonism using a computer terminal, 6° Congreso International de Medicina Fisica,* 2–6 July 1972, Vol. II.

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4. Kay, Hector W. Assistant Executive Director, National Research Council. Committee on Prosthetics Research and Development, Washington, D.C.—*personal communication.*

APPENDIX A

THE BURKE REHABILITATION HOSPITAL [1] UNIT NUMBER: 43242

AMPUTEE DISCHARGE SUMMARY WORKSHEET [2] NAME:

LOWER LIMB(S)

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[3] TRANSFERRED FROM:

(1) NYH, (2) NYC Hospital, (3) Local Hospital, (4) Other Hospital, (5) Home

(6) Other:_____ 20 ch.

[4] ADMITTED ON: 7 / 8 / 75 . [5] DATE OF DISCHARGE: 8 / 21 / 75 . [6] DAYS AWAY: 0

[7] AGE 66 , [8] SEX: ETHNIC ORIGIN: (1) Male, (2) Female, (3) White, (4) Black (5) PR

(6) Oriental, (7) Other:_____ 15 ch.

[9] UPPER LIMB: (0) NOT UPPER LIMB

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[13] LOWER LIMB: (1) Right, (2) Left, (3) Bilateral B/K, (4) Bilateral A/K, (5) Asymetrical

[14] ETIOLOGY: (1) Vascular, (2) Traumatic, (3) Congenital, (4) Tumor,

(5) Other:_____ 30 ch.

SIDE, RIGHT:

[15] LOWER RIGHT LEVEL
(1) PELVIC, COMPLETE
(2) HIP, COMPLETE
THIGH
(3) Upper
(4) Middle
(5) Lower
(6) KNEE DISARTICULATION
BELOW KNEE
(7) Upper
(8) Middle
(9) Lower
(10) FOOT, COMPLETE
(11) FOOT, PARTIAL
(12) Other:_____ 30 ch

SIDE, LEFT:

[16] LOWER LEFT LEVEL
(1) PELVIC, COMPLETE
(2) HIP, COMPLETE
THIGH
(3) Upper
(4) Middle
(5) Lower
(6) KNEE DISARTICULATION
BELOW KNEE
(7) Upper
(8) Middle
(9) Lower
(10) FOOT, COMPLETE
(11) FOOT, PARTIAL
(12) Other:_____ 30 ch

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[17] ASSOCIATED CONDITIONS:

(0) None
(1) Dementia
(2) Parkinsonism
(3) Stroke
(4) Heart disease
(5) Hypertension
(6) Pulmonary disease
(7) Renal desease
(8) GI disease
(9) Diabetes mellitus
(10) GU disease
(11) Fractures
(12) Depression
(13) Eye disease
(14) Peripheral neuropathy
(15) Other:_____ 30 ch

HISTORY OF PRESENT ILLNESS:

DATE OF AMPUTATION(S): [20] LOWER RIGHT / / . [21] LOWER LEFT: 6/25/75

[22] REASON FOR AMPUTATION(S)

TRAUMATIC:
(1) Industrial
(2) Traffic
(3) Gunshot
(4) Recreational
(5) Other:_____ 30 ch

VASCULAR:
(6) Diabetic ASO
(7) ASO
(8) TAO
(9) Thrombo-embolism

[23] Vascular, other:_____ 30 ch [24] CONGENITAL_____ 30 ch

[25] TUMOR Dg:_____ 50 ch

AMPUTEE DISCHARGE WORKSHEET *Continued, Page 2*

[26] PRECEDING SURGICAL PROCEDURE(S):
(0) None
(1) Sympathectomy
(2) Embolectomy
(3) By-pass
(4) Other _____ 30 ch

[27] Previous amputation(s) _____ 30 ch

[28] COMPLICATION(S):
(0) None
(1) Blood-loss anemia
(2) Pulmonary embolism
(3) Infection
(4) MI
(5) Pneumonia
(6) Other _____ 50 ch

PERTINENT PHYSICAL, LAB. AND X-RAY FINDINGS ON ADMISSION:

[29] BP 150/100, [30] PR 80, [31] TEMP. 98.6, [33] WEIGHT 139 lbs.

[34] GENERAL CONDITION: (1) Good, (2) Fair, (3) Poor, (4) Other: _____ 30 ch

[37] STUMP CONDITION, LOWER RIGHT:
(1) Good
(2) Bulbous
(3) Not healed
(4) Edematous
(5) Infected
(6) Other: _____ 30 ch

[38] LOWER LEFT:
(1) Good
(2) Bulbous
(3) Not healed
(4) Edematous
(5) Infected
(6) Other: _____ 30 ch

[39] REMAINING LIMB(S): (1) Normal, (2) Impaired circulation, (3) Contractures, (4) Weakness, (5) Other: _____ 30 ch

[40] SENSORY FINDINGS: (1) Normal, (2) Impaired vision, (3) Impaired hearing, (4) Impaired proprioception, (5) Other: _____ 30 ch

[41] HCT 37; WBC 6500; FBS 129; BUN 28; Creatinine 1.1
Uric Acid 7.6; K+ 4.0;

[42] OTHER TESTS: U 50 ch

[43] X-RAY, CHEST:
(0) Not done
(1) Normal
(2) Acute inflam.
(3) Chronic inflam.
(4) Infarction
(5) Emphysema
(6) Malignancy
(7) Other: _____ 30 ch

[44] X-RAY, OTHER: U 30 ch

[45] ECG: (0) Not done, (1) Normal, (2) AF, (3) CAD, (4) BBB, (5) PVC's, (6) MI, (7) LVH, (8) RVH, (9) Other: _____ 50 ch

[46] COURSE IN HOSPITAL; REHABILITATION:
(1) Preprosthetic activities
(2) Stump shaping
(3) Wound healing
(4) Functional training
(5) Self-care training
(6) Other _____ 30 ch

LOWER LIMB(S), PREPARATORY

[69] RIGHT B/K:
(0) None
(1) B/K plaster of paris
(2) Other 30 ch

[70] LEFT B/K:
(0) None
(1) B/K plaster of paris
(2) Other _____ 30 ch

[71] RIGHT A/K:
(0) None
(1) A/K plaster of paris
(2) Other: 30 ch

[72] LEFT A/K:
(0)
(1) A/K plaster of paris
(2) Other: _____ 30 ch

[73] DATE RIGHT ISSUED: / /

[74] DATE LEFT ISSUED: 7/29/75

AMPUTEE DISCHARGE WORKSHEET, *Continued, Page 3*

LOWER LIMB(S), FINAL:

U

[75] DATE RIGHT ISSUED: ____/__/____

[77] DATE LEFT ISSUED: ____/__/____

[80] RIGHT COMPONENTS:
(1) B/K PTB, hard socket
(2) PTB, soft insert
(3) PTB, thigh lacer
(4) Conventional
(5) PTS
(6) Symes
(7) Other_____ 30 ch

[81] LEFT COMPONENTS:
(1) B/K PTB, hard socket
(2) PTB, soft insert
(3) PTB, thigh lacer
(4) Conventional
(5) PTS
(6) Symes
(7) Other_____ 30 ch

[82] A/K SOCKETS, RIGHT
(1) Quadrilateral, wood
(2) Total contact, laminated
(3) Molded plastic, sockets (Canadian)
(4) Hemi-pelvectomy, molded socket
(5) Other_____ 30 ch

[83] A/K SOCKETS, LEFT:
(1) Quadrilateral, wood
(2) Total contact, laminated
(3) Molded plastic, sockets (Canadian
(4) Hemi-pelvectomy, molded socket
(5) Other_____ 30 ch

[84] A/K KNEES, RIGHT:
(1) Knee lock
(2) Single axis
(3) Hydraulic
(4) Variable friction
(5) Other:_____ 30 ch

[85] A/K KNEES, LEFT:
(1) Knee lock
(2) Single axis
(3) Hydraulic
(4) Variable friction
(5) Other:_____ 30 ch

[86] FEET, RIGHT:
(1) Wood foot w. toe break
(2) SACH
(3) Single axis, SACH
(4) Other:_____ 30 ch

[87] FEET, LEFT:
(1) Wood foot w. toe break
(2) SACH
(3) Single axis, SACH
(4) Other:_____ 30 ch

[88] SUSPENSION, RIGHT:
(1) Semi-rigid pelvic belt
(2) Silesian belt
(3) Other:_____ 30 ch

[89] SUSPENSION, LEFT:
(1) Semi-rigid pelvic belt
(2) Silesian belt
(3) Other:_____ 30 ch

[90] DATE PATIENT FIRST WALKED: 7/30/75.

SURGICAL TREATMENT:

[101] LOWER RIGHT:
(0) None
(1) Stump care
(2) Debridement
(3) Stump revision date ____/____/____.

[102] LOWER LEFT:
(0) None
(1) Stump care
(2) Debridement
(3) Stump revision date ____/____/____

[107] MEDICAL TREATMENT:
(0) None
(1) Antihypertensives
(2) Cardiac
(3) Anticoagulants
(4) Diuretics
(5) Antihyperglycemics
(6) Antibiotics
(7) Psychotropics
(8) Analgesics
(9) Other:_____ 25 ch

[108] COMPLICATIONS:
(0) None
(1) Osteomyelitis
(2) Infection (stump)
(3) Contractures
(4) PVD
(5) Pulm. infarct
(6) Pneumonia
(7) URI
(8) GU infection
(9) BPH
(10) MI
(11) CHF
(12) Arrhythmia
(13) Hip fx.
(14) Stroke
(15) GI disease
(16) Renal disease
(17) Other: STUMP INJURY: WOUND RESUTURED
_____ 50 ch

AMPUTEE DISCHARGE WORKSHEET, *Continued, Page 4*

[109] CONDITION ON DISCHARGE: (1) Improved, (2) Unchanged, (3) Worse, (4) Deceased

[111] ABILITY TO USE LOWER LIMB PROSTHES(ES):

(1) Class I	Excellent functional outcome; not handicapped by disability.
(2) Class II	Good functional outcome; some restriction of activities.
(3) Class III	Fair functional outcome; job modification required.
(4) Class IV	Walking with assistance and for short distances only.
(5) Class V	No significant improvement of mobility.
(6) Class VI	Rejection of prosthesis.

[112] DISCHARGE DISPOSITION: (1) Home, (2) Nursing Home, (3) Hospital, (4) Home Health, (5) OPD, (6) Other: _____ 20 ch

EMPLOYMENT STATUS: (7) Retired, (8) Full time, usual work, (9) Part-time, usual work, (10) Job modification or retraining, (11) Unable to work

[113] DISCHARGE ORDERS:

MEDICATIONS: (0) None	DOSAGE	SCHEDULE	AMOUNT:
(1) HYDRODIURIL	50 mg	QD	
(2) PHENOBARBITAL	15 mg	TID	
(3) DIET: 2000C DIABETIC			
(4)			
(5)			

[119] RETURN TO OPD: DATE: 9/4/75

[120] LOCATION: (1) Burke, (2) NYH-K7, (3) Other _____ 25 ch

HOME CARE COORDINATOR: [121] NAME MARY ELLEN GIBSON, R.N.

[122] TELEPHONE: (212) 472-5907

[123] PHYSICIAN: PETER H. STERN M.D.