

Mortality of Diabetic Patients Treated Surgically for Lower Limb Infection and/or Gangrene

Otto Kahn, M.D., F.R.C.P.(c), William Wagner, M.D., and
Alice N. Bessman, M.D., Downey, California

SUMMARY

A retrospective study was made to ascertain the mortality rate among 100 consecutive patients with diabetes mellitus who had undergone lower limb amputations for infection and/or gangrene in the combined medical-orthopedic service of a county hospital. The medical and orthopedic staffs functioned as equal members, and combined decision-making conferences were held regularly. The over-all mortality rate was 9 per cent, a substantial decrease from the 22 to 25 per cent previously reported in similar studies. The mortality rate among patients with below-knee procedures was 1 per cent versus the 7 to 9 per cent reported by others. Close medical-surgical liaison on a service specializing in the care of these often fragile patients with diffuse multisystem disease results in decreased mortality. *DIABETES* 23:287-92, April, 1974.

It has been estimated that there are more than ten million "diabetics" in the United States—two million known, two and one-half million with carbohydrate intolerance, and five and one-half million who are prediabetic.¹ As the longevity of the diabetic patient increases, we are increasingly exposed to the challenge of treating the long-term complications of this relentless and progressive metabolic disease.

The controversy over treatment programs always brings up the question of mortality, the "yardstick" of optimal therapy. With the advent of insulin in the 1930's, the mortality of diabetics undergoing amputation was recorded at 50 per cent.² It is naturally understood that, prior to insulin usage, most diabetics died before the need for surgery arose. In the 1940's,

with the use of chemotherapy and antibiotics, the mortality rate dropped to 32.8 per cent.³ In the 1950's, with improved medical treatment, technics of surgery and anesthesiology, newer and more effective antibiotics, anticoagulants, and better pre- and post-operative care, mortality rates continued to fall, but plateaued at 22 to 25 per cent in the other reported series.⁴⁻⁶

The current study originates from a combined medical-orthopedic service where both orthopedic and medical house staff as well as full-time senior staff are in daily attendance and hold joint conferences and bedside consultations. In light of previously reported mortality rates in excess of 20 per cent, this retrospective study was conceived to determine if such close medical-surgical liaison might affect the over-all mortality.

METHODS AND RESULTS

The records of 100 consecutive diabetic patients who had had a surgical amputation for uncontrolled infection, nonhealing ulcer, osteomyelitis, or gangrene of one or both extremities, on a combined medical-orthopedic service in a large county hospital (Rancho Los Amigos Hospital) were reviewed. These patients were treated between May, 1971 and August, 1972. A conservative approach to treatment of the ischemic lesion, as outlined by Pratt,⁷ was adhered to for the most part, although it was apparent that most of our patients had irreversible changes with little chance of significant salvage.

The average duration of the lesion prior to our medical consultation was 3.2 months, with a variation of three days to sixty months. Osteomyelitis was evident by X ray in 34 per cent, with subcutaneous emphysema in 10 per cent, only one case of which was due to *Clostridium welchii* by culture. The average patient age was 59.5 years, with a range of twenty-nine to eighty-nine years. Forty-one per cent were males and 59 per cent females.

From the Departments of Medicine and Surgery, University of Southern California School of Medicine, Los Angeles, California and Rancho Los Amigos Hospital, Downey, California.

Address reprint requests to: Alice N. Bessman, M.D., Chief, Diabetes Service, Rancho Los Amigos Hospital, 7601 East Imperial Highway, Downey, California 90242.

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The duration of diabetes, as diagnosed by carbohydrate intolerance, averaged thirteen years, with twelve newly discovered cases. Obesity was present in 48 per cent of the cases by actuarial standards; 46 per cent had normal weight. In 6 per cent, data were not recorded.

In most of the patients in our series, the diabetes was controlled by diet and a hypoglycemic agent. Forty-three per cent required diet and an oral agent. A surprisingly equal number (43 per cent) required diet and parenteral insulin. A small number (13 per cent) were controlled by diet alone. One per cent were of the "brittle" variety. Diabetes became more difficult to manage (needing greater dosages of hypoglycemic agents) in over 80 per cent of our treatment group with the acute stress of their illness.

Almost all of our patients had clinical evidence of vascular disease. Cardiovascular disease was foremost at 63 per cent, overt renovascular disease was next at 50 per cent, ophthalmologic vascular (retinopathy and cataracts) disease was noted in 59 per cent, peripheral vascular disease in 44 per cent, and cerebrovascular disease was evident in 24 per cent (see table 1). The above vascular diseases were diagnosed in cases of organ infarction or ischemia and/or abnormal historical-physical findings, or objective laboratory tests. Usually, several abnormalities were evident with a great deal of overlapping complications. The distribution of limb lesions was found to be greatest in the toes at 44 per cent, 38 per cent involved the whole foot, 13 per cent the legs, and 9 per cent the heel only. Overt gangrene was present in over 41 per cent of patients at time of admission, increasing slightly during in-hospital treatment. Right lower limbs were more often affected than left, 64 per cent versus 59 per cent (see table 2).

Forty-three per cent of patients in our study had systemic toxemia on admission, as judged by leukocytosis, tachycardia, and febrile reaction. Mild

TABLE 1
Complicating Factors

Vascular Disease*	Per cent	Infections*	Per cent
Cardiac	63	Staphylococcus Aureus	28
Renal	50	Proteus Vulgaris	28
Eye	59	Klebsiella	23
Peripheral Vascular	44	Escherichia Coli	18
Cerebral	24	Enterococci	18
		Alpha Streptococcus	16
		Bacteroides	9
		Pseudomonas	7

*Patients had more than one vascular complication or infecting organism.

TABLE 2
Sites of Lesion and Amputation

Lesions*	Per cent of total	Amputation*	Per cent of total
Toes	44	Below knee	44
Heel	9	Local resections	25
Foot	38	Symes I	19
Leg	13	Symes II	17
		Above knee	14
		Trans-knee	13
		Incision & drainage	5
		Transmetatarsal	5

*Patients had more than one lesion and procedure.

ketoacidosis was present in only 3 per cent; this was treated aggressively on admission and consequently became well compensated prior to surgery.

Almost all amputations, however minor, were administered under general "endotracheal closed circuit" anesthesia with intravenous barbiturate induction. The choice of anesthesia was solely that of the anesthesiologist and was predicated primarily on past experience, proficiency, and familiarity of the chosen method. The below-knee (BK) site was the most prevalent at 44 per cent, local resections were next at 25 per cent. These resections consisted of toe amputations, metatarsal head resections and ray resections. Symes I and II were performed in 19 per cent and 17 per cent of the patients, respectively. Above-knee (AK) amputation was often a secondary procedure undertaken in 14 per cent of the patients, trans-knee (TK) next in 13 per cent, and other sites with various combinations (except formal Gritti-Stokes⁸) were performed in 6 per cent. Transmetatarsal and primary incision and drainage were 5 per cent each (table 2). Many of the above procedures were primary, needing a secondary and even tertiary procedure before ultimate control and healing of the basic problem were accomplished.

The site of amputation was determined by a single group of orthopedists in consultation with their medical colleagues, usually without the aid of angiography. Incision and drainage were done if it was felt that there was no offending bony prominence and no underlying osteomyelitis. Local resections were performed if (1) it was thought that an underlying bony prominence was the precipitating cause of the lesion, or (2) osteomyelitis was diagnosed, and (3) more radical surgery was not necessary. Symes procedures were felt to be indicated where local resection would be inadequate if (1) infection was limited to the forefoot, (2) a good heel pad was present, and (3) hair growth

was present distally (toes, lower part of leg), indicating adequate blood supply. Presence of peripheral pulses (dorsalis pedis) was preferred but not mandatory. Absence of symptoms of intermittent claudication was required. Below-knee operations were performed in patients in whom the criteria for Symes procedures were not met, who were candidates for procedure below the knee, and who were potential ambulators. Trans-knee surgeries were carried out primarily in patients who were not potential ambulators. Above-knee amputations were done as secondary procedures in 60 per cent of the cases and for the usual indications. The lowest level which was thought to permit stump viability was selected in order to maximize rehabilitation potential.

Angiography was not accomplished for the most part because of the extent of clinically apparent small vessel disease. Angiography was done in those patients with absent dorsalis pedis pulses and symptoms of large vessel disease.

The average length of in-hospital care was 2.03 months, with a range of four days to nine months, for each patient illness.

Even though most patients were taking antibiotics systemically, cultures of the lesions were obtained on admission. These revealed *Staphylococcus aureus* and *Proteus vulgaris* most common at 28 per cent each, *Klebsiella* 23 per cent, *E. coli* and *enterococci* 18 per cent each, *alpha streptococci* 16 per cent, *bacteroides* 9 per cent, and *pseudomonas* 7 per cent. Mixed flora of the lesions were in the majority (table 1).

The over-all in-hospital mortality was 9 per cent with six cardiac and three septicemic-pneumonic deaths postulated (postmortem examination was obtainable in 56 per cent). A summary of the data of the patients who died can be seen in table 3.

DISCUSSION

This retrospective study, although limited in many respects, has revealed some interesting and provocative trends.

The duration of the lesion prior to medical consultation (3.2 months), a very controversial issue,⁷⁻⁹ still remains unresolved by our study. It is felt, however, that early, aggressive treatment of a well localized superficial lesion might be successful with a conservative medical treatment program as outlined by Collens et al.¹⁰ and might postpone surgical amputation for some years. Decreased morbidity-mortality with better rehabilitation potential is also possible.

The patient population considered here is similar to

that of others.⁴⁻⁶ The duration of diabetes, severity of infection, pre-existing illnesses and types of surgeries performed were similar to these parameters in the above-mentioned reports. For example, the ages of the patients were remarkably similar. Ecker⁵ reports that of his patients, the majority were in the sixth and seventh decades with an age range of thirty-seven to eighty-five years (our age range was twenty-nine to eighty-nine, see above).

Contrary to popular belief, less than half of our patients were obese (48 per cent). It would seem, therefore, that exogenous obesity is not the most common etiologic factor in "adult onset diabetes" and has little effect on the genesis of premature diabetic complications, but perhaps makes diabetes easier to diagnose and more difficult to treat. However, the nutritional state of our patients in the earlier course of their disease is unknown.

The diabetes in the study group was relatively stable, and in a small number of patients, was being controlled by diet alone. The majority (86 per cent) needed diet and a hypoglycemic agent; half of these were on oral agents and half on insulin. A surprisingly small fraction (1 per cent) was of the "brittle" variety. It was not surprising, however, to find that almost all the patients needed greater dosages of hypoglycemic agents when challenged with the stress of their illness, even though the illness was of long duration in most cases.

The severity and distribution of the lesions were similar to those reported by Collens et al.¹⁰ Osteomyelitis was present in slightly over one third of the patients, and the average duration of the lesion was 3.2 months. These two factors bespeak an extensive chronic disease process. The incidence of subcutaneous gas in these patients is somewhat high (10 per cent)¹¹ but very plausible in view of the duration of the lesion and probable foot care prior to medical consultation. Wound cultures were obtained whenever possible and revealed mixed flora, usually containing gram negative rods, some very resistant to all antibiotics. Only one patient with subcutaneous gas harbored *Clostridium welchii*.

Almost all of our study group had evidence of severe vascular disease with organ compensation, nevertheless, being present for the most part. Cardiovascular disease was most common at 63 per cent with the highest incidence also of minor decompensation, e.g. mild congestive failure and dysrhythmias. Ophthalmologic and renal disease were second and third with 59 per cent and 50 per cent, respectively, followed by peripheral and cerebrovascular disease at

TABLE 3
Summary of Operative Mortality

Patient	Age	Sex	Diagnosis on admission	Pre-existing conditions	Type of surgery	Postoperative course	Date of surgery	Date of death	Cause of death (* = Autopsy)
1	79	M	wet gangrene, foot	C.H.F. (comp.), old M.I., renal disease	T.K.	benign, sudden death	4-7	4-21	Acute M.I., A.S.H.D., D.M.
2	82	F	wet gangrene, foot	emaciation, myocard. isch., multiple infected pressure sores	T.K.	continued septic, unresponsive	3-18	3-30	*Ventricular fibrillation, A.S.H.D., Septicemia, D.M.
3	81	M	wet gangrene, foot	old M.Ischemia A.S.H.D., septicemia	A.K.	stump healing acute pyelo.	4-26	5-25	*Diffuse myocardial fibrosis, Acute pyelonephritis with sepsis, D.M.
4	66	F	bilateral gangrene, feet	C.B.S. multiple infected pressure sores, contractures	Bilateral A.K.	continued septic	5-15	6-23	<i>Klebsiella pneumoniae</i> , pressure sores, Sepsis, D.M.
5	66	M	gangrene of great toe, cellulitis	A.S.H.D. sympathectomy	Symes	7-7 Acute M.I. 7-8 peripheral embolus, Wound ↓	6-25	7-15	Cardiogenic shock, Acute M.I.—one week duration, D.M.
6	63	M	ulcer, ankle & toe	left A.K. 5 yrs. P.T.A.	T.K. raised to A.K.	A.K. clean by 7-22	6-15	8-15	Cardiac arrest, D.M.
7	64	F	gangrene all toes (one foot)	A.S.H.D., C.H.F., pleural effusion old M.I. (2) A.K. 1 yr. P.T.A.	T.K.	continued C.H.F., wound healing well	7-6 5-19	6-20	*A.S.H.D. (90% closure ant. desc. coronary), Pleural effusion (bilat.), D.M.
8	62	F	bone cyst	B.K. 6 yrs. P.T.A., renal disease, A.S.H.D.	open biopsy	focal seizures 8-3	7-23	8-9	*Bronchopneumonia Uremia—diabetic nephropathy Infarction & degeneration various parts of brain, D.M.
9	61	M	embolus	B.K. 1 yr. P.T.A., Endarterectomy (unsuccessful), 2 wk. P.T.A.	T.K.	Wound ↓ bronchopneumonia 2 wk. postop.	3-22	4-5	*Infection, amputated stump (L) Pneumonia, bilateral, Septicemia, <i>Pseudomonas</i> , D.M.

C.H.F. = Congestive Heart Failure
Comp. = Compensated
M.I. = Myocardial Infarction
A.S.H.D. = Arteriosclerotic Heart Disease
D.M. = Diabetes Mellitus
Pyelo. = Pyelonephritis

C.B.S. = Chronic Brain Syndrome
Wound ↓ = Wound Breakdown
P.T.A. = Prior to Admission
T.K. = Through Knee
A.K. = Above Knee
B.K. = Below Knee

44 per cent and 24 per cent, respectively. The incidence of these vascular complications is similar, with minor modifications, to that in other reported series.¹²

It should be appreciated that a great deal of overlap is present, since in excess of 50 per cent had overt evidence of three organ system involvement—a very

significant factor in patient mortality. Pulmonary disease was also present in a substantial number of patients, with poor objective documentation in approximately one-third. None of the patients with pulmonary disease was decompensated prior to surgery, however. Rare cases of frank pneumonia had satisfactorily responded to therapy preoperatively. Other un-

favorable factors, such as muscle contractures, decubitus skin ulcers, organic mental syndromes and gastrointestinal problems, were rarely encountered.

A most controversial and variable factor, having a very appreciable influence on patient morbidity and mortality, is the decision as to optimal site and time of amputation. Our experience here, as that of others cited previously, is difficult to quantitate and may never be resolved. The swing toward more conservative medical-surgical treatment, however, is replacing the more aggressive surgical high single amputations of a bygone era. This method has a lower mortality and possible morbidity, better rehabilitation potential, and thus a general increase in preservation of human economy.^{6,9} The below-knee site was most common at 44 per cent, similar to others reported. The merits of this site as outlined by Hoar and Torres¹³ will not be amplified in this report. Many of our patients received a BK amputation as a secondary procedure. The longer postoperative course is more than compensated for by the good rehabilitation potential as compared with the AK site, even though there is a slightly higher incidence of poor healing.

The staged "Symes" operation, common in our study (36 per cent), has been very uncommon in other studies for obvious reasons, namely that of poor healing (ischemia) and danger of bony nonfusion.⁴ This type of amputation (end-bearing stump with bony union), although low in morbidity and mortality and with good rehabilitation potential and short hospital stay, if there is primary healing, nevertheless has a high incidence of nonhealing, infection, and consequent reamputation at a higher site. This was confirmed in our study.

The transmetatarsal and "transtoe" amputation sites as primary procedures were not as common in our series as in others.^{5,9,14} This was probably because of the extent of the disease and the high percentage of a higher amputation within two years. Incision and drainage were uncommon as a primary procedure because of the extent of ischemic changes and consequent need for higher amputation later as others had reported previously.⁹ The extent of clinically apparent vascular disease was also a primary factor in abandoning early angiography, for the most part. Two guilotine amputations were achieved as a semi-emergent procedure, one on a patient with a *Clostridium welchii* infection who survived, and the second on a very toxic patient who died (case 3, table 3). The principles of lowest amputation for maximal mobility (rehabilitation potential) and lowest mortality must again be weighed against higher primary amputation with

higher mortality and far less rehabilitation potential.

The average length of postoperative hospital stay for all procedures was two months (range of four days to nine months), which was similar to others who report one to three months. Patients were not discharged until good healing was secured, for the most part, and the rudimentary principles of rehabilitation had been established. Needless to say, not all our patients—especially the AK amputees—were fully rehabilitated to ambulation. Our experience was similar to studies already cited by others in this regard, although at the time of this report, final evaluation data were still unavailable. It would appear, however, that over 60 per cent of knee and lower amputation patients will be ambulatory and independent in activities of daily living.

Contrary to other reports,⁴ regional and spinal anesthesia was rarely if ever used in our patients; instead, almost all were managed under general endotracheal anesthesia. It should be appreciated that general anesthesia with all its complications when liberally used on fragile patients, regardless of the extent of the procedure, is a definite factor in mortality, e.g. hypostatic-aspiration pneumonia. In spite of all the various favorable and unfavorable factors, our mortality was considerably less than that reported in comparable patients.⁴⁻⁶ Temperature gradients, oscillometry, and angiography were not objectively documented in the majority of our patients, although distal pulses below the femorals were absent in nearly half (44 per cent). The causes of death were similar to those reported by others.¹² It is of interest to note that, although our study group involved more females than males, the mortality in males was slightly higher (5:4).

All measurable risk factors are markedly similar to those of previous series reporting 22 to 25 per cent mortality rates. Hoar and Torres¹³ report a mortality of 7 per cent versus 9 per cent in our study. However, their series differs in several major aspects:

1. There were no cases of gangrene or uncontrolled sepsis above the ankle.
2. In general, the lesions involved only the toes or the heel (in our series, 38 per cent involved the entire foot and 13 per cent the leg).
3. Sepsis was usually regressing (in our patients, surgery was frequently necessary because of advancing sepsis).
4. All operations were BK amputations (in our series, 14 per cent had AK and 13 per cent TK amputations).
5. Different patient population (private, possibly

better nutritional status).

In the series of Smith,¹⁵ in which the mortality rate was 12 per cent, the patients were carefully selected; here again, all amputations were below-knee.

In most large, municipal teaching hospitals, surgery (such as amputations, bone resections) for diabetic patients is performed solely on the surgical service with medical consultation. In the current study, the staff of a medical-diabetes service served as the primary physicians and the orthopedic staff as the surgical consultants in daily attendance. The two groups of physicians worked closely together in both the preoperative and postoperative phase of care. In this series of patients, TK amputation was done primarily in those patients who were considered poor surgical risks and nonambulatory candidates. Similarly, AK amputation was done only when infection and/or vascular disease precluded surgery at a more distal level and on patients in whom severe healing problems were anticipated. If we were to eliminate all TK (13 per cent) and AK (14 per cent) operations from this study (as was done in the above studies reporting 7 and 12 per cent mortality rates), the mortality rate would have been an incredibly low 1 per cent.

The mortality rate of 9 per cent reported in the current study of 100 consecutive, unselected diabetic patients with various degrees of lower limb ischemia complicated by sepsis, cardiovascular disease and renal disease, who underwent lower limb surgery up to and including above-knee amputations, is a significant improvement in mortality from other similar series which report 22 to 25 per cent mortality rates. Furthermore, the mortality rate of 1 per cent for patients undergoing below-knee procedures is a significant improvement in mortality in comparison to previous reports. It is suggested that a "categorical" service, i.e. a service specializing in the medical-surgical man-

agement of the diabetic patient complicated by vascular disease, with a close cooperative multidisciplinary effort, contributed to the improved mortality of our group of patients.

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