Diabetes and Burns: Retrospective Cohort Study

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Burn injuries are often associated with multisystemic complications, even in otherwise healthy individuals. It is therefore intuitive that for the diabetic patient, the underlying pathophysiologic alterations in vascular supply, peripheral neuropathy, and immune function could have a profoundly devastating impact on patient outcome. The effects of diabetes on morbidity and mortality of the burn-injured patient have not been examined in great detail. The purpose of this retrospective study was to compare clinical outcomes between diabetic and nondiabetic burn patients. We reviewed the charts of 181 diabetic (DM) and 190 nondiabetic (nDM) patients admitted with burns between January 1996 and May 2000, matched by sex and date of admission. Burn cause and size, time to presentation, clinical course, and outcomes were evaluated. Because age was a factor, the analysis was done by three age groups: younger than 18 years, 18 to 65 years, and older than 65 years. Of patients 18 to 65 years, 51% (98/191) were diabetic, whereas 84% (81/96) of those older than 65 and only 4% (3/85) of patients younger than 18 were diabetic. Because of the disproportion in numbers of diabetics compared with nondiabetics in the younger than 18 and older than 65 years-old groups, these patients will not be discussed. Diabetics were more likely to incur scald injury from tub or shower water rather than hot fluid spills (33% DM vs 15% nDM; $P \leq 0.01$), and have a delayed presentation (45 vs 23%; $P = 0.00001$). There was no difference in total burn size in all groups. Diabetics in the 18 to 65 years group had a higher rate of full-thickness burns (51 vs 31%; $P = 0.025$), skin grafts (50 vs 28%; $P = 0.01$) and burn-related procedures (57 vs 32%; $P = 0.001$), infections (65 vs 51%; $P = 0.05$), and longer lengths of stay (23 vs 12 days; $P = 0.0001$). Although there was no statistically significant difference in incidence of specific infections, the rates of cellulitis, wound infection, urinary tract infection, line infection, and osteomyelitis, were consistently higher in the diabetic population. Partial graft slough was 6% in diabetics 18 to 65 years with a 3% regraft rate, whereas nondiabetics had a 1% regraft rate. Comparing diabetics with controlled vs uncontrolled glucose levels, diabetics with uncontrolled glucose had higher rates of infection (72 vs 55%; $P \leq 0.025$), all burn-related procedures (68 vs 45%; $P \leq 0.025$), and longer ICU stays (24 vs 10 days; $P = 0.048$). Mortality rate was 2% for diabetics and for nondiabetics. In summary, presence of diabetes in the burn patient was associated with a worse outcome. A predilection for burn injuries in the diabetic was noted in the older adult population. Deeper burns, delayed presentation, higher rates of infection, graft failure and operations, and longer lengths of stay translate into an increased cost to society both economically and in lives. This data would suggest a need for better burn education for diabetics and health care professionals, recognizing the elderly population as a "high-risk" group. We believe that targeted prevention measures and treatment strategies, emphasizing earlier and more aggressive intervention for this population, may have a favorable effect on morbidity and mortality. (J Burn Care Rehabil 2002;23:157–166)

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Between 1991 and 1993 burns resulted in an average of 51,000 hospital discharges per year in the United States, with an estimated annual incidence of 1,129,000.[1] Fire/burn injury killed 10,365 people from 1996 to 1998, 3.7% of all deaths from unintentional injury.[2] New York State had 4.7% (667 people) of these deaths, where it was the fifth leading cause of death by unintentional injury.[2] Burns cross all age, sex, race, and economic lines, affecting every part of society. They are an all-too-common, oft-times preventable injury with great potential for morbidity and mortality.

Burn injury can lead to numerous complications. The burn itself is a breach of the skin barrier, the body's primary mechanism of defense against infection. Infection is the major source of mortality for burn patients,[3] evolving from the wound, the lungs, the gastrointestinal and genitourinary tracts, or the myriad of lines and tubes necessary for patient care. Massive fluid shifts also result in cardiovascular instability and metabolic derangements. Inhalation injury and airway edema can cause respiratory complications, and a hypermetabolic state produces pronounced protein loss and increased nutritional needs. These patients often must undergo operative treatment, possibly even multiple procedures, all of which are superimposed on any previous medical conditions and the psychological trauma of the injury. It is in the midst of this physiologic milieu that the body must heal its wounds and restore function to its injured parts.

As might be expected, the hospital course for the burn patient can be long and complicated as well as costly. In Pennsylvania in 1994, 3,173 patients were admitted for burns for a total of 27,704 hospital days and a total cost of $93.8 million dollars.[4] These figures do not account for the costs of lost wages, lost workdays, lost function, or lost life. It is therefore certainly in the public interest to learn how to best prevent and treat these injuries, and to look for factors which may impede successful outcomes.

Diabetes, like burn injury, also affects multiple systems. Diabetics have a predilection for atherosclerotic occlusion in large vessels—particularly the tibial and peroneal arteries[5,6]—facilitating development of ischemic extremities. Hyperglycemia causes increased blood viscosity, further compromising distal blood flow.[5] Peripheral neuropathy results in decreased motor and sensory function. Finally, the diabetic patient's immune system is impaired secondary to derangements in polymorphonuclear leukocyte, macrophage, and lymphocyte function.[5–9]

The result of this pathology is that diabetics often exhibit wound repair failures. Their decreased sensation leads to an increased likelihood of incidental trauma with delayed recognition of injury. Poor blood supply slows the ingress of oxygen and already-impaired inflammatory cells into wounded areas, thereby hampering the wound healing process and providing an anaerobic environment for opportunistic bacteria. Couple the above with a baseline of immunosuppression, and it is not surprising that the course of the diabetic wound is often protracted and rarely simple.

It would seem intuitive that diabetics who incur burn injuries would have much worse courses and outcomes than nondiabetics. Although a few studies attempting to predict burn patient mortality have included diabetes as one of the variables, to the best of our knowledge, there have been no studies to date comparing the hospital course and outcome between diabetic and nondiabetic burn patients. The dearth of research in this area has led us to investigate the effect of diabetes on burn patient outcome, with our ultimate goal to improve wound healing, and effect an overall reduction in clinical complications of the diabetic patient who sustains a burn injury.

PATIENTS AND METHODS

We conducted a retrospective review of the in-hospital medical records of diabetic (DM) and nondiabetic (nDM) patients admitted to the William Randolph Hearst Burn Center at the New York Presbyterian-Weill Cornell Medical Center during the period of January 1996 to May 2000. This study was carried out with the consent of the Weill Medical College Institutional Review Board. Burn injury included burns caused by scald, flame, flash, chemical, contact, and electricity, as well as inhalation injury and patients with toxic epidermolysis necrosis syndrome. Inhalation injury was based on the discharge diagnosis, as determined by description of event, CO Hb levels, and bronchoscopy.

During this time, there were 4,543 burn admissions, 197 of which were diabetic per discharge diagnosis. Of these 197, we reviewed 181 charts. An equal number of nondiabetic patients was selected from a complete list of burn admissions to match the DM patients by sex and date of admission, thus allowing for any changes in treatment protocols which might have occurred during the period of review.

The points of comparison included demographic information, cause, extent of injury, hospital course, operative course and outcome, and discharge status. Extent of injury—defined by depth and surface area involvement—was determined by clinical judgment of the surgical team, or when grafted, by taking the recorded size of the grafted area and then calculating the percent burn surface area using the patient's height and weight as documented on admission.

In evaluating a patient's hospital course, we looked at incidence of cellulitis, sepsis, wound infection and other infections, admission to the intensive care unit, use of ventilatory support, and need for assistance from a consultant physician. Determination of infection was guided largely by a combination of discharge diagnoses, chart notes, radiographic studies, and culture results when available. Additionally for the diabetics, we determined the number of times that the patient's serum or finger blood stick glucose levels was above or below 180mg/dl- defining > 180mg/dl as uncontrolled diabetes, and also noted whether the patient's discharge diagnosis included "uncontrolled diabetes".

Operative course covered need for tangential excision and split-thickness skin graft or other burn-related operations, such as debridement, escharotomy, fasciotomy, amputation or bronchoscopy, as well as procedures not directly related to the burn injury, e.g. angioplasty or colonoscopy. Time to 100% graft take, graft failure/slough (i.e. need for regrafting), and number of grafts were also assessed. For patients who did not receive grafts, time to 100% epithelialization of the wound was determined, using outpatient clinic records where necessary.

Because of the skewed age distribution of the DM and nDM patients, they were each divided into three age groups (younger than 18 years old, 18–65 years old, and older than 65 years old) for comparison. The Wilcoxon sum rank test was used to compare continuous variables between DM and nDM groups, and the Fisher's exact test for categorical variables. Additional statistical analysis was performed using the Chi-square test and the student's t-test.

Table 1. Demographic data

	Diabetic Patients	Nondiabetic Patients
Age		
< 18 years old	3	82
18–65 yr	98	93
>65	80	15
Sex		
Male	114	121
Female	67	69
Race		
Black	53	43
White	63	54
Hispanic	38	35
Asian	20	21
Unknown	7	37
Cause		
Scald	91	101
Flame	44	44
Contact	17	18
Chemical	9	7
Flash	7	7
Electric	4	7
TENS	7	1
Inhalation	2	3
Other	2	2

TENS, toxic epidermolysis necrosis syndrome.
Figures are number of patients.

RESULTS

Demographic data are depicted in Table 1. With respect to age, there were only three patients less than 18 years old who were diabetic (3 vs 82) and only fifteen patients older than 65 who were not diabetic (15 vs 96). As the data on these groups could not be assessed statistically, the data presented, unless otherwise specified, will refer either to all patients inclusive of age, or to patients between 18 and 65 years old. It is to be noted, however, that while the age group older than 65 years represent 44.8% of the DM, it was only 7.9% of the nDM.

Scald burns were the most common cause of burn in both groups regardless of age, with flame the second most common (Table 1). Within this category DM of all ages, and specifically within the 18 to 65 years group, had significantly more scald burns from tub or shower water (32.9% DM vs 14.5% nDM; $P \leq 0.01$, and 34.8% DM vs 5.1% nDM, $P = 0.012$, respectively) than nDM. Other scalds were caused largely by spilling hot fluids.

There was a significant difference in the number of DM patients admitted to the hospital at least one day after injury (44.9% DM vs 23.2% nDM, $P = 0.00001$). In patients 18 to 65 years the difference was also significant (50.5% DM vs 25.8% nDM, $P = 0.001$). Although the hospital courses of the DM patients 18 to 65 years with delayed presentations were not statistically different from diabetics admitted immediately after injury, there was a trend toward higher rates of cellulitis (42.9 vs 27.1%), wound infection (12.2 vs 6.3%), and death (4.1 vs 0.0%) in these patients (Figure 1). Patients with delayed admission also had significantly smaller mean full thickness (FT) burns (1.1% ± 2.4 vs 3.4% ± 7.2% body surface area; $P = 0.039$). This represents a trend towards higher infection and mortality in patients with smaller, shallower burns.

With respect to burn body surface area (BSA), DM and nDM patients 18 to 65 years did not differ. TBSA (6.9% ± 10.2% DM vs 8.1% ± 12.5% nDM), FT BSA (2.3% ± 5.4% DM vs 2.8% ± 10.6% nDM), and partial thickness (PT) BSA (4.2% ± 8.3 DM vs 5.4% ± 5.7% nDM) were similar between groups, however, the percentage of diabetics with full thickness burns was significantly higher than that of nondiabetics (50.5 vs 31.2%, $P = 0.025$).

Diabetics 18 to 65 years had a higher rate of infection than nondiabetics (64.9 vs 50.5%; $P = 0.05$;

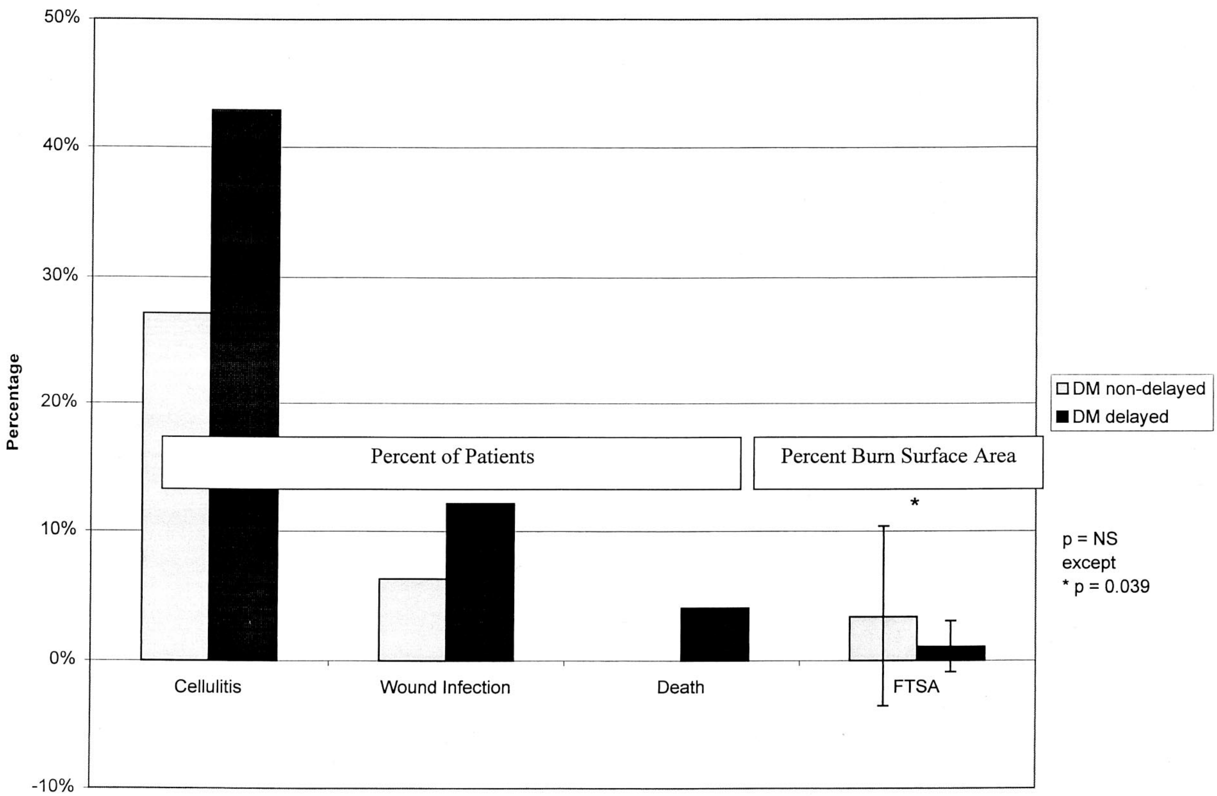

Figure 1. Diabetics (DM) who presented at least one day after injury compared with those with immediate presentation in the 18 to 65-year group. FTSA (Full Thickness Surface Area) is by percentage burn size; cellulitis, wound infection, and death are by percent of patients.

Figure 2). When categorized by type of infection, DM patients had higher rates of cellulitis (35.1 vs 28.0%), urinary tract infection (UTI, 9.3 vs 4.3%), wound infection (9.3 vs 3.2%), line infection (1.0 vs 0.0%), and osteomyelitis (1.0 vs 0.0%), but these were not individually statistically significant, due to low numbers (Figure 2). The rates of ICU admission (32.0 vs 26.9%) and days on the ventilator (19.5 ± 20.8 vs 10.8 ± 15.4 days), while again higher in DM than nDM, did not reach statistical significance. It is interesting to note that of the six DM patients placed on the ventilator, only three had suffered an inhalation injury, with two having sepsis and/or pneumonia. By contrast, all nDM patients placed on the ventilator had inhalation injury. Mortality rates between DM and nDM were virtually identical (2.1 vs 2.2%). DM 18 to 65 years demonstrated an increased need for multidisciplinary intervention by requiring more consultant assistance (23.7 vs 2.2%, $P = 0.000006$), predominantly from the general medical team.

The rates of tangential excision and split-thickness skin graft (49.5% DM vs 28.0% nDM, $P = 0.01$) and burn-related operations in general (56.7% DM vs 32.3% nDM, $P = 0.001$) were significantly higher in DM 18 to 65 years, as was their length of stay (LOS; 23.2 ±26.5 vs 12.2 ± 12.4 days, $P = 0.0001$). Although LOS for grafted patients was similar between DM and nDM, DM patients who were not grafted had significantly longer LOS than nDM who were not grafted (12.9 ± 11.4 vs 7.3 ± 5.1 days, $P = 0.001$). While DM patients also showed a trend of higher rate of regrafting (3.1 vs 1.0%), longer time until graft take (10.5 ± 23.6 vs 7.8 ± 8.8 days), and more operations not directly related to the burn injury (5.2 vs 1.1%), these were not statistically significant. Figure 3 summarizes the significant differences in hospital course between DM and nDM 18 to 65 years.

Burn severity (size and depth of injury) and inhalation injury are variables known to play a significant role in influencing patient outcome. As our interest is specifically in understanding the effects of diabetes alone on burn outcome, we undertook a separate analysis comparing burn patients of matched size (TBSA < 10%), similar depth (having only PT burns) and excluding patients with inhalation injury. From

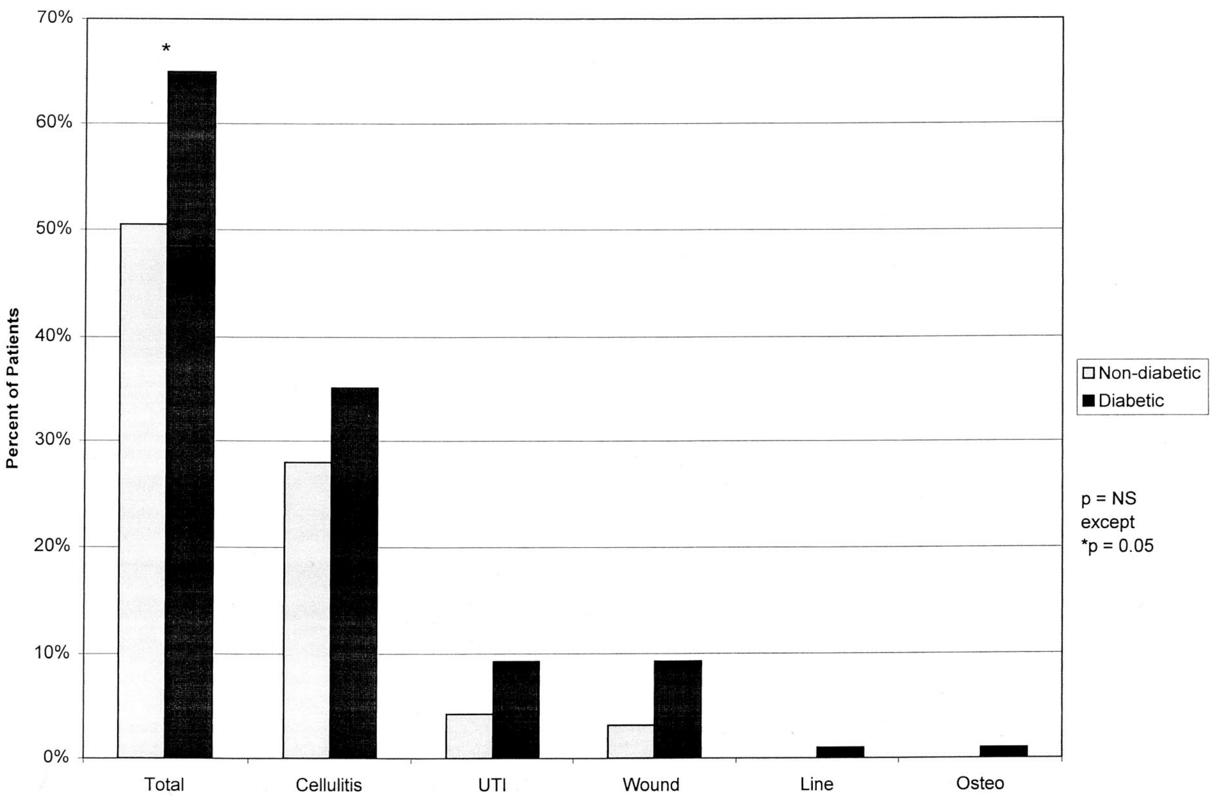

Figure 2. Rates of different infections: nondiabetics vs diabetics ages 18 to 65 years old. *UTI*, urinary tract infection.

this analysis, we found diabetics to be significantly more likely to have delayed presentation, to undergo operation, and to require consultant assistance, as well as having longer LOS. Diabetics also trended towards longer times until presenting to the burn center (4.7 ± 16.9 vs 0.5 ± 1.1 days), greater likelihood of having been treated initially outside of the burn center (28.9 vs 14.3%), higher rates of all infection (44.7 vs 30.4%), cellulitis (31.6 vs 25.0%), wound infection (5.3 vs 1.8%), UTI (53.8 vs 1.8%), ICU admission (18.4 vs 14.3%), and days in the ICU (8.6 ± 1.7 vs 3.3 ± 1.7 days), although these did not reach statistical significance (Figs. 4, 5).

We reviewed outpatient clinic charts in an attempt to evaluate the rate of reepithelialization (hence, wound closure) of nongrafted patients. Of the 184 patients (117 nondiabetic, 67 diabetic) who did not receive grafts, 86 had charts (54 nondiabetic, 32 diabetic) with patient follow-up. Only thirteen of the diabetic patients 18 to 65 years followed-up until their wounds were fully healed, with an average time to healing of 45.2 days. In the nDM 18 to 65 years, 16 patients had complete follow-up, for an average of 33.8 days. These differences were not statistically significant, however the sequelae of an average healing time of 45.2 days in the diabetic population is of clinical significance. There were five post-discharge complications in the diabetic patients (3 patients 18 to 65 years, 2 patients older than 65 years): two patients developed cellulitis, two others developed dry gangrene (one after a vascular bypass) and one patient's wound reopened. No complications were reported in the nDM of any age.

To evaluate the effect of uncontrolled diabetes, diabetics 18 to 65 were considered uncontrolled if their glucose levels by serum or finger blood stick were higher than 180mg/dl greater than 50% of the times it was checked, or if they were coded as "uncontrolled diabetes" on discharge. Fifty patients 18 to 65 years (53%) met these criteria. A subset analysis of patients 18 to 65 years with uncontrolled diabetes demonstrated significantly higher rates of all infection combined (72.0 vs 54.5%, $P \leq 0.025$), more days in the ICU (24.2 ±23.2 vs 9.6 ± 9.0 days, $P = 0.048$), and higher rates of burn operations as a whole (68.0 vs 45.4%, $P \leq 0.025$). They also showed a tendency towards longer delays to presentation (6.4 ±20.9 vs 3.3 ± 7.6 days), larger TBSA (8.8% ± 13.0 vs 4.7% ± 5.5%), higher rates of sepsis (6.0 vs 2.3%), wound infection (12.0 vs 6.8%), UTI (10.0 vs 9.1%), pneumonia (10.0 vs 0.0%), line infection

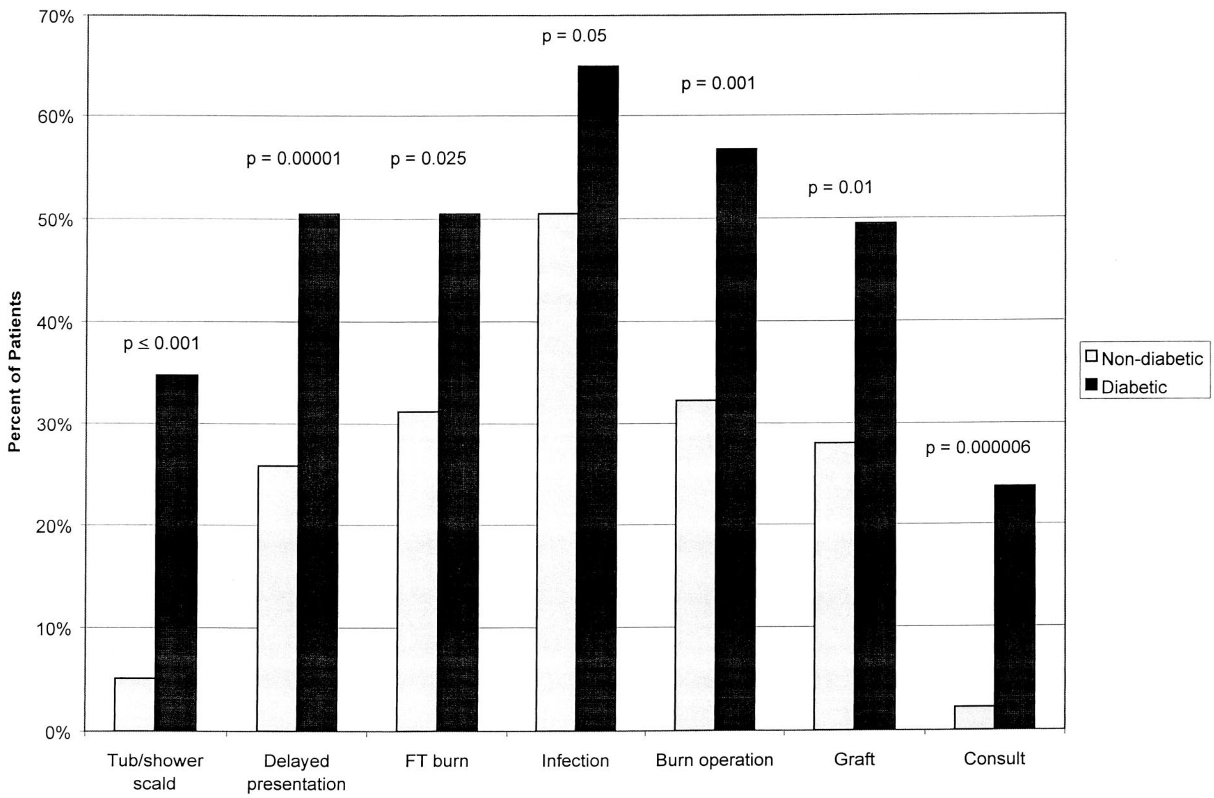

Figure 3. Summary of significant differences between nondiabetics and diabetics ages 18 to 65 years. *FT*, full-thickness.

(2.0 vs 0.0%), and osteomyelitis (2.0 vs 0.0%), as well as ICU admission (36.0 vs 27.3%). All of the diabetic patients with inhalation injury had uncontrolled glucose, with a higher rate of uncontrolled diabetics requiring ventilatory support (10.0 vs 2.3%) and spending more days on the ventilator (22 ± 21.8 vs 5 ± 0 days; Table 2). It should be noted, however, that 40% of the uncontrolled diabetics who required ventilatory support did not have inhalation injury.

DISCUSSION

Burns are a comprehensive and complicated injury. Common sense dictates that such an injury, superimposed on an equally destructive disease such as diabetes, would increase patient morbidity. Little work has been done to evaluate this relationship. Studies by Aspesos, *et al*,[10] and Hammond, *et al*,[11] showed no difference in mortality in diabetic patients 60 years or 80 years old or older respectively as compared with nondiabetics. McGill, *et al*,[12] and Germann, *et al*,[13] found that diabetes, when categorized under "comorbidities" or "gastrointestinal/urologic disorder" respectively, did not significantly affect postburn mortality, while a similar study by O'Keefe, *et al*[14] did note an increased morbidity in patients with a preexisting medical condition. McGill also noted no correlation between comorbidities and number of infections, or discharge status. Finally, an article by Fisher, *et al*,[15] advocating a new burn severity grading system, includes diabetes as one of its additional variables for determination of burn grade severity, but they note that this was based solely on clinical experience. Although these articles demonstrate that diabetes does not increase mortality in burn patients—as we have also shown—none of them address the effect of diabetes on morbidity (and therefore on lengths of hospitalization and associated health-care costs) or cause. Our results show differences between diabetic and nondiabetic patients from cause of burn through hospital course and discharge.

An examination of the numbers of diabetic patients over age 65 admitted with burn injury yielded an interesting observation. While it is expected that the incidence of diabetes in the general population increases with age (particularly in the adult older than 65 years), the actual percentage of diabetic patients admitted to our burn center in the older than 65 year-old group is disproportionately high (81/96, 84% DM). This is not representative of the general

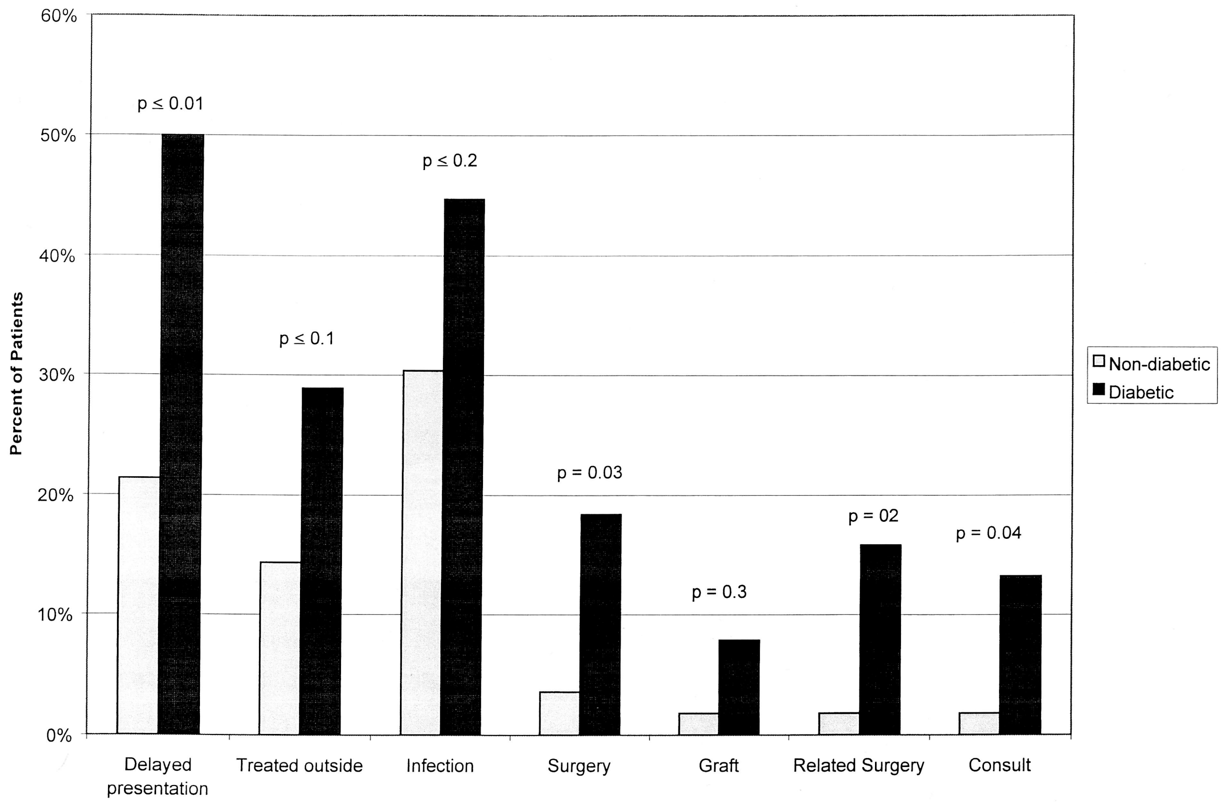

Figure 4. Comparison of nondiabetic and diabetic patients 18 to 65 years with only partial-thickness burns and no inhalation injury. TBSA is ≤ 10%.

incidence of diabetes in the U.S., and clearly identifies this group as a highly significant "at-risk" subset of the population predisposed to injury.

Patients in this age group are often beset with multiple morbidities. For diabetics, their advanced age means that in addition to these other co-factors, they are also more likely to suffer from the multiple progressive complications of their diabetes. Older diabetics are at high risk for blindness, end-stage renal disease, limb amputation, coronary artery disease, and stroke.[16] These complications make them not only more prone to injury, but also less capable of withstanding it.

Although scald burns are a common cause across age groups in DM and nDM alike, DM had a higher rate of burns from tub or shower water. These injuries are more preventable than hot liquid spills, and point to the diabetic's increased susceptibility to burns secondary to peripheral neuropathy. Impaired sensation results in decreased ability to accurately assess water temperature; motor dysfunction leads to balance instability, increasing the risk of falls. Both pave the way for scald burns. This decreased sensation also explains why diabetics were more likely to have FT burns. An inability to feel heat prevents one from reacting to it, thus tending to prolong exposure. Additionally, lack of awareness of such an injury would preclude seeking treatment, thus explaining the high percentage of delayed presentation by diabetics.

While there was not a statistically significant difference in the hospital course of diabetics who presented at least one day post-injury as compared with those who presented immediately, the numbers are still worth noting. The patients who presented late had on average a smaller percentage surface area of FT wounds—a not surprising finding considering the decreased likelihood of discovery of injury. These patients with smaller wounds, however, tended towards higher rates of infection and death. Current theory states that morbidity and mortality increase with wound size and depth.[17–20] Although our numbers are too small to be conclusive, they do lend credence to the idea that delayed presentation of burn injury negatively impacts on morbidity and mortality in diabetics.

Roi *et al*[21] have shown that patients admitted to the burn unit later actually had a lower rate of mortality. This is attributed to their having survived the acute

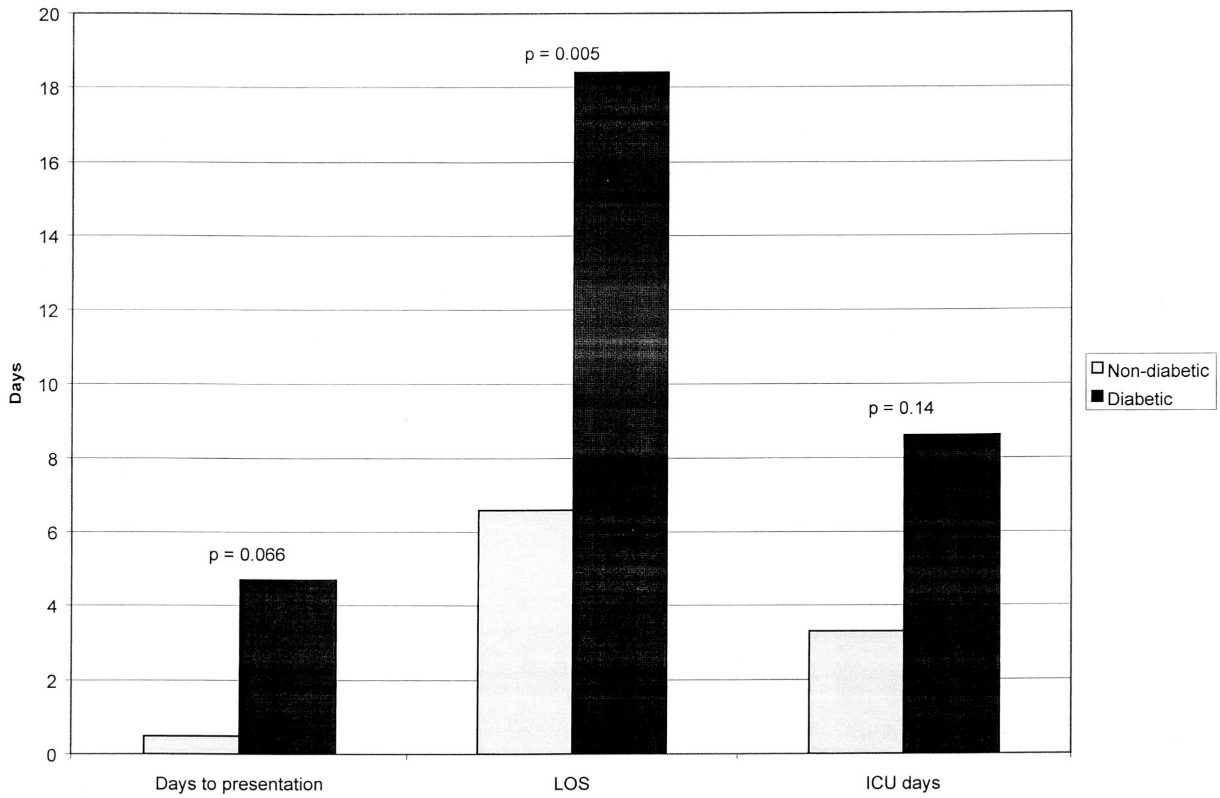

Figure 5. Days to presentation and lengths of intensive care unit and hospital stay in nondiabetic and diabetic patients 18 to 65 years with only partial-thickness burns and no inhalation injury, with TBSA ≤ 10%. *LOS*, length of stay; *ICU*, intensive care unit.

phase of the injury, resulting in a decreased risk of subsequent death. Their results, however, do not differentiate between diabetics and nondiabetics, nor do they analyze morbidity. Again, while our results are not conclusive, they certainly demonstrate the need for further investigation.

When matched for injury size (TBSA <10%), depth (having only partial-thickness burns), and absence of inhalation injury, diabetic patients demonstrated longer hospital stays, as well as higher rates of surgical intervention and consultant assistance, with trends towards higher rates of infection compared with nondiabetics. These statistics illustrate the increased complexity of the diabetic patient. A finding of prolonged LOS in diabetic patients could suggest either a more complicated hospital course than would be expected from PT burns, or a longer time to healing. Both explanations demonstrate the negative impact diabetes has on patient recovery, and emphasizes the need for ways to more adequately assess burn depth and the possible need for different treatment protocols for diabetics.

To better ascertain whether diabetics healed nongrafted wounds at different rates than nondiabetics, we reviewed the outpatient clinic charts of patients who did not receive skin grafts. Unfortunately, there was a high number of patients for whom charts were not available. In most cases, the patient simply did not keep the appointment. Those who did often stopped coming once their wounds were almost fully healed. As such, we were unable to determine the date of complete closure for a large number of patients, prohibiting statistical significance of our data. The higher numbers of complications reported for diabetics as compared with nondiabetics does attest to greater wound healing problems in the diabetic. This might be a function of slower epithelialization, or perhaps a misjudgment of the extent of tissue damage. A prospective study of patients matched by wound with time to closure and out-patient progress specifically in mind would be required to make more solid conclusions.

The findings in the comparison of controlled vs uncontrolled diabetics are of a "chicken-or-the-egg" variety. High blood glucose levels could facilitate growth and spread of infection, complicate the pa-

Table 2. Other results comparing uncontrolled and controlled diabetics, age 18 to 65 years old

	Controlled (n = 44)	Uncontrolled (n = 50)	*P* Value
Infection (%)	54.5	72.0	$P \leq 0.025$
ICU days	24.2	9.6	$P = 0.048$
Burn-related operations (%)	68.0	45.4	$P \leq 0.025$
Days to presentation	3.3	6.3	NS
Delayed presentation (%)	41.0	56.9	NS
TBSA (%)	4.7	8.8	NS
Inhalation injury (%)	0	10	NS
Sepsis (%)	2.3	5.8	NS
Wound infection (%)	6.8	12.0	NS
Pneumonia (%)	0.0	10.0	NS
Line infection (%)	0.0	2.0	NS
Osteomyelitis (%)	0.0	2.0	NS
ICU (%)	27.3	36.0	NS
Ventilator (%)	2.3	10.0	NS
Ventilator days	5	22	NS

ICU, intensive care unit; *NS*, not significant.

tient's hospital course prolonging ICU stay, and impair wound healing resulting in the need for operative intervention.[5] Conversely, fluctuations in cortisol levels and insulin requirements, which can be associated with critical illness and stress, could have brought about uncontrollable hyperglycemia.[22,23] Although cause and effect cannot be definitively determined in these cases, we have shown that uncontrolled diabetes significantly correlates with increased morbidity. As such, diabetic control should be made a priority in the care of these patients.

CONCLUSIONS

We have demonstrated that diabetes clearly has a negative effect on the burn patient's course. We now must find out exactly what the causes are and how to mitigate the effects. Perhaps diabetic wounds are more difficult to assess than nondiabetic wounds. If there were a way to assess burn depth other than by just visual means, maybe more of the seemingly "less serious" burns would be treated with more aggressive and earlier interventions, improving wound healing and preventing complications. Diabetics may require a more aggressive approach to minimize wound-associated complications. Or perhaps diabetics should be approached with a different treatment paradigm altogether, one involving hyperbaric oxygen, or topical growth factors. All of this has yet to be demonstrated and will require further examination into the history of the diabetic burn patient and the future of burn treatment.

What is also of critical importance is burn education and ultimately prevention in diabetics. Diabetic individuals suffer from a disease which predisposes them to injury, then inhibits their ability to ascertain the presence of injury and extracts a greater price for it. The results are as we have shown: their wounds are deeper, they are more likely to sustain infection, to require assistance from consultant physicians in the management of their care, to undergo operative intervention, and to stay in the hospital longer. It all adds up to an extraordinary cost to society, both in dollars and in lives. Standard warnings and burn prevention strategies may not be adequate to prevent diabetic patients from sustaining burn injuries, particularly in the older population. New approaches may need to be developed that emphasize and alert the diabetic individuals, their families, and their caregivers to the higher risk that the diabetic population is exposed to with regard to burn injury.

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