International Journal for Multidisciplinary Research (IJFMR)
E-ISSN: 2582-2160 ● Website: www.ijfmr.com ● Email: editor@ijfmr.com

Diabetic Foot Ulcer: A Clinical Study

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Abstract

Diabetic foot ulcer is one of the common presentations of diabetic foot. The diabetic foot may be defined as a group of syndromes in which neuropathy, ischemia and infection lead to tissue breakdown, resulting in morbidity and possible amputation (World Health Organization, 1995) According to the diabetes atlas 2013 published by the International Diabetes Federation, the number of people with diabetes in India currently is 65.1 million, which is expected to rise to 142.7 million by 2035.

Diabetic foot ulcers remain a major health care problem. They are common, result in considerable suffering, frequently recur, and are associated with high mortality, as well as considerable health care costs. While national and international guidance exists, the evidence base for much of routine clinical care is thin. It follows that many aspects of the structure and delivery of care are susceptible to the beliefs and opinion of individuals. It is probable that this contributes to the geographic variation in outcome that has been documented in a number of countries. This article considers these issues in depth and emphasizes the urgent need to improve the design and conduct of clinical trials in this field, as well as to undertake systematic comparison of the results of routine care in different health economies. There is strong suggestive evidence to indicate that appropriate changes in the relevant care pathways can result in a prompt improvement in clinical outcomes.

Foot disease affects nearly 6% of people with diabetes and includes infection, ulceration, or destruction of tissues of the foot. It can impair patients' quality of life and affect social participation and livelihood. Between 0.03% and 1.5% of patients with diabetic foot require an amputation. Most ulcers can be prevented with good foot care and screening for risk factors for a foot at risk of complications..

The major challenges relating to diabetes foot are:-

1. Foot ulceration is common, affecting up to 25% of patients with diabetes during their lifetime.
2. Over 85% of lower limb amputations are preceded by foot ulcers and Diabetes remains a major cause of non-traumatic amputation across the world with rates being as much as 15 times higher than in the non-diabetic population.
3. Prevention is the first step towards solving diabetic foot problems. Although it was estimated that an ankle is lost to diabetes somewhere in the world every 30 seconds, a more important fact is that up to 85% of all amputations in diabetes should be preventable.
4. Strategies aimed at preventing foot ulcers are cost-effective and can even be cost-saving if

1. increase education and effort are focused on those patients with recognized risk factors for the development of foot problem.

5. Diabetes is now the most common cause of Charcot neuro-arthropathy in Western countries, another condition that should be generally preventable.

Key words: Diabetes mellitus, foot ulcer, cellulitis, gangrene, debridement

Aim and Objective: The objective of the present study was to evaluate the various presentations of diabetic foot ulcer like, resistant deep infections, ulcer with cellulitis, severe ischemia leading on to gangrene and to study percentage of surgical intervention like debridement, minor/major amputation.

INTRODUCTION:

Diabetic foot ulcer is one of the common presentations of diabetic foot. The diabetic foot may be defined as a group of syndromes in which neuropathy, ischemia and infection lead to tissue breakdown, resulting in morbidity and possible amputation (World Health Organization, 1995) .Previous studies have indicated that diabetic patients have up to a 25% lifetime risk of developing a foot ulcer. The annual incidence of diabetic foot ulcers is ~ 3% and the reported incidence in U. S. and U. K. studies ranges as high as 10%. According to epidemiological studies, the number of patients with DM increased from about 30 million cases in 1985, 177 million in 2000, 285 million in 2010, and estimated if the situation continues, more than 360 million people by 2030 will have DM. According to Wilman et al, diabetic foot ulceration is a worldwide health problem approximately 15% of the 10 million diabetic patients in USA will develop foot ulcer at some time in their life time. The foot ulcer in this population is extremely debilitating and dramatically increases the risk of lower extremity amputation.

Diabetes Mellitus, particularly type 2 diabetes mellitus is caused by genetic and environmental factors. It is a group of genetically heterogeneous metabolic disorder that causes glucose intolerance, involving impaired insulin secretion and insulin action. The prevalence of Diabetes is increasing rapidly worldwide and the World Health Organization has predicted that by 2030 the number of adults with diabetes would have almost be doubled worldwide

According to the Diabetes Atlas 2013 published by the International Diabetes Federation, the number of people with diabetes in India currently is 65.1 million, which is expected to rise to 142.7 million by 2035.

Foot problems are a major cause of morbidity in people with diabetes. Neuropathy, vascular insufficiency, foot deformities and trauma predispose people with diabetes to foot ulcers. If not treated appropriately, foot ulcers can take many weeks to heal and/or progress to severe infection and amputation. Poorly managed foot ulcers cause increase morbidity and mortality, and also cause a large financial burden on the health system. There are recognized evidence-based best practices in prevention, treatment, and management of diabetes foot ulcers that, if implemented, not only improve patient outcomes but also reduce cost.

Patients with DM are prone to multiple complications such as diabetic foot ulcer (DFU). DFU is a common complication of DM that has shown an increasing trend over previous decades. In total, it is estimated that 15% of patients with diabetes will suffer from DFU during, their lifetime [8]. Although accurate figures are difficult to obtain for the prevalence of DFU, the prevalence of this complication ranges from 4%-27%. To date, DFU is considered as a major source of morbidity and a leading cause of hospitalization in patients with diabetes. It is estimated that approximately 20% of hospital admissions among patients with DM are the result of DFU. Indeed, DFU can lead to infection, gangrene, amputation, and even death if necessary care is not provided. On the other hand, once DFU has developed, there is an increased risk of ulcer progression that may ultimately lead to amputation.

Overall, the rate of lower limb amputation in patients with DM is 15 times higher than patients without diabetes. It is estimated that approximately 50%-70% of all lower limb amputations
are due to DFU. In addition, it is reported that every 30 s one leg is amputated due to DFU in worldwide. Furthermore, DFU is responsible for substantial emotional and physical distress as well as productivity and financial losses that lower the quality of life. The previous literature indicates that healing of a single ulcer cost approximately $$17500 (1998 United States Dollars). In cases where lower extremity amputation is required, health care is even more expensive at $30000-33500. These costs do not represent the total economic burden, because indirect costs related to losses of productivity, preventive efforts, rehabilitation, and home care should be considered. When all this is considered, 7%-20% of the total expenditure on diabetes in North America and Europe might be attributable to DFU.

Epidemiology of Diabetic foot Disease: One-third of all diabetic patients have significant peripheral neuropathy and/or peripheral vascular disease (PVD). Diabetic foot problems are the commonest reason for hospitalization of diabetic patients (about 30% of admissions) and absorb some 20% of the total health-care costs of the disease more than all other diabetic complication. In India prevalence of foot ulcers in diabetic patients in clinic population is 3%, which is much lower than reported in the western world. A possible reasoning for the low prevalence in Indians is younger age and shorter duration of diabetes. PVD has been reported to be low among Asians ranging between 3-6% as against 25-45% in Western patients.

The prevalence of PVD increases with advancing age and is 3.2% below 50 years of age and rises to 55% in those above 80 years of age. Similarly it also increases with increased duration of diabetes, 15% at 10 years and 45% after 20 years.

Etiopathogenesis of diabetic foot lesions: The breakdown of the diabetic foot does not occur spontaneously, and there are many warning signs that may be used to predict those at risk. Dr. Elliott Joslin recognised this more than 75 years ago, when he stated that “Diabetic gangrene is not heaven-sent but is earth-born”. Ulcers invariably occur as a consequence of an interaction between environmental hazards and specific pathologies in the lower limb.

ETIOLOGY OF DFU

Recent studies have indicated multiple risk factors associated with the development of DFU. These risk factors are as follows: gender (male), duration of diabetes longer than 10 years, advanced age of patients, high Body Mass Index, and other comorbidities such as retinopathy, diabetic peripheral neuropathy, peripheral vascular disease, glycated hemoglobin level (HbA1C), foot deformity, high plantar pressure, infections, and inappropriate foot self-care habits. Although the literature has identified a number of diabetes related risk factors that contribute to lower extremity ulceration and amputation, to date most DFU has been caused by ischemic, neuropathic or combined neuroischemic abnormalities. Pure ischemic ulcers probably represent only 10% of DFU and 90% are caused by neuropathy, alone or with ischemia. In recent years, the incidence of neuroischemic problems has increased and neuro ischemic ulcers are the most common ulcers seen in most United Kingdom diabetic foot clinics now.

In total, the most common pathway to develop foot problems in patients with diabetes is peripheral sensorimotor and autonomic neuropathy that leads to high foot pressure, foot deformities, and gait instability, which increases the risks of developing ulcers. Today, numerous investigations have shown that elevated plantar pressures are associated with foot ulceration. Additionally, it has been demonstrated that foot deformities and gait instability increases plantar pressure, which can result in foot ulceration.

Diabetic Neuropathy:

More than 60% of diabetic foot ulcers are the result of underlying neuropathy. The more commonly described mechanisms of action is the polyol pathway. The hyperglycaemic state leads to an increase in action of the enzymes aldose reductase and sorbitol dehydrogenase. This results in the conversion of intracellular glucose to sorbitol and fructose. The accumulation of these sugar products results in a decrease in the synthesis of nerve cell myoinositol, required for normal neuron conduction.

Additionally, the chemical conversion of glucose results in a depletion of nicotinamide adenine dinucleotide phosphate (NADP) stores, which are necessary for the detoxification of reactive oxygen species (ROS) and for the synthesis of the vasodilator nitric oxide (NO). There is a resultant increase in oxidative stress on the nerve cell and an increase in vasoconstriction leading to ischemia, which will promote nerve cell injury and death. Hyperglycemia and oxidative stress also contribute to the abnormal glycation of nerve cell proteins and activation of protein kinase C, (PK-C) resulting in further nerve dysfunction and ischemia.

Neuropathy in diabetic patients is manifested in the **motor, autonomic, and sensory** components of the nervous system. Damage to the innervations of the intrinsic foot muscles leads to an imbalance between flexion and extension of the affected foot causing foot deformity.

Autonomic neuropathy leads to a diminution in sweat and oil gland functionality. As a result, the foot loses its natural ability to moisturize the overlying skin and becomes dry and increasingly susceptible to tears and the subsequent development of infection.

Peripheral Vascular Disease in Diabetes

Peripheral arterial disease (PAD) is a contributing factor to the development of foot ulcers in up to 50% of cases. It commonly affects the tibial and peroneal arteries of the calf.

Endothelial cell dysfunction and smooth cell abnormalities develop in peripheral arteries as a consequence of the persistent hyperglycaemic state. Moreover, **smoking, hypertension**, and **hyperlipidemia** are other factors that are common in diabetic patients and contribute to the development of PAD

Plantar callus: Callus forms under weight-bearing areas as a consequence of dry skin (autonomic dysfunction), insensitivity and repetitive moderate stress from high foot pressure. It acts as a foreign body and cause ulceration. Callus should be removed by the podiatrist or other trained health care professional.

Foot deformity

A combination of motor neuropathy, cheiroarthropathy and altered gait patterns are thought to result in the “high risk” neuropathic foot with clawing of the toes, prominent metatarsal heads, high arch and small muscle wasting.

Review of Literature

Education

It has been shown that up to 50% of DFU cases can be prevented by effective education. In fact, educating patients on foot self-management is considered the cornerstone to prevent DFU. Patient education programs need to emphasize patient responsibility for their own health and well-being. The

ultimate aim of foot care education for people with diabetes is to prevent foot ulcers and amputation. Currently, a wide range and combinations of patient
educational interventions have been evaluated for the prevention of DFU that vary from brief education to intensive education including demonstration and hands on teaching. Patients with DFU should be educated about risk factors and the importance of foot care, including the need for self-inspection, monitoring foot temperature, appropriate daily foot hygiene, use of proper footwear, and blood sugar control. However, education is better when combined with other care strategies, because previous reviews on patient education has suggested that when these methods were combined with a comprehensive approach, these methods can reduce the frequency and morbidity of the limb threatening complications caused by DFU.

Blood sugar control

In patients with DFU, glucose control is the most important metabolic factor. In fact, it is reported inadequate control of blood sugar is the primary cause of DFU. The best indicator of glucose control over a period of time is HbA1C level. This test measures the average blood
sugar concentration over a 90-d span of the average red blood cell in peripheral circulation. The higher the HbA1C level, the more glycosylation of haemoglobin in red blood cells will occur. Studies have shown that blood glucose levels > 11.1 mmol/L (equivalent to >
310 mg/mL or an HbA1C level of > 12) is associated with decreased neutrophil function, including leukocyte chemotaxis. Indeed, a greater elevation of blood glucose level has been associated with a higher potential for suppressing inflammatory responses and decreasing
host response to an infection. Pomposelli *et al* has indicated that a single blood glucose level > 220 mg/dL on the first postoperative day was a sensitive (87.5%) predictor of postoperative infection. Furthermore, the authors found that patients with blood glucose values > 220 mg/dL had infection rates that were 2.7 times higher than for patients with lower blood glucose values (31.3% *vs* 11.5%, respectively)[51]. In addition, it's indicated that a 1% mean reduction in HbA1C was associated with a 25% reduction in micro vascular complications,
including neuropathy. Investigations have found that poor glucose control accelerated the manifestation of Peripheral Arterial Disease (PAD). It has been shown that for every 1% increase in HbA1C, there is an increase of 25%-28% in the relative risk of PAD, which is a
primary cause of DFU. However, to date, no RCT has been performed to determine whether improved glucose control has benefits after a foot ulcer has developed.

Microbiome and metagenomics

Standard culture methods, which have changed little in 150 years, are limited by taking several days to complete, being falsely negative in patients receiving antibiotic therapy, and failing to identify many fastidious bacteria. Newer molecular techniques, such as 16S PCR and gene sequencing, typically identify a greater number and variety of bacteria, particularly anaerobes. Meta-genomic studies have revealed interplay among bacterial communities in various environments, including wounds, that produce specific clinical 'syndromes' or phenotypic diseases. This recent and rapidly emerging research area may provide more insights into the potential association of the skin (and gastrointestinal) microbiome with DFI.

Debridement

Debridement is the removal of necrotic and senescent tissues as well as foreign and infected materials

from a wound, which is considered as the first and the most important therapeutic step leading to wound closure and a decrease in the possibility of limb amputation in patients
with DFU. Debridement seems to decrease bacterial counts and stimulates production of local growth factors. This method also reduces pressure, evaluates the wound bed, and facilitates wound drainage. There are different kinds of debridement including surgical, enzymatic, autolytic, mechanical, and biological. Among these methods, surgical debridement has been shown to be more effective in DFU healing].

Surgical or sharp debridement involves cutting away dead and infected tissues followed by daily application of saline moistened cotton gauze. The main purpose of this type of debridement is to turn a chronic ulcer into an acute one. Surgical debridement should be repeated as often as needed if new necrotic tissue continues to form. It has been reported that regular (weekly) sharp debridement is associated with the rapid healing of ulcers than for less
frequent debridement. In a retrospective cohort study, Wilcox *et al* indicated that frequent debridement healed more wounds in a shorter time ($P < 0.001$). In fact, the more frequent the debridement, the better the healing outcome. The method of debridement depends on characteristics, preferences, and practitioner level of expertise. When surgical or sharp debridement is not indicated, then other types of debridement could be used. An older debridement type that is categorized as biological debridement is maggot debridement therapy (MDT), which is also known as maggot therapy or larval therapy. In this method, sterile and live forms of the Lucilia sericata larvae are applied to the wound to achieve debridement, disinfection, and ultimately wound healing. Indeed, larvae secrete a powerful autolytic enzyme that liquefies necrotic tissues, stimulates the healing processes, and destroys bacterial biofilms. This technique is indicated for open wounds and ulcers that contain gangrenous or necrotic tissues with or without infection. To date, paucity of RCTs show
efficacy of this method with DFU; however, some of retrospective; and prospective studies have shown MDT as a clinically effective treatment for DFU. These studies reported that MDT can significantly diminish wound odor and bacterial count, including *Methicillin-*
Resistant Staphylococcus Aurous, prevent hospital admission, and decrease the number of outpatient visits among patients with DFU. Despite the advantages of debridement, adequate
debridement must always precede the application of topical wound healing agents, dressings, or wound closure procedures, which may be expensive.

Risk factors for Ulceration

General or systemic contributions
Uncontrolled hyperglycemia
Duration of diabetes
Peripheral vascular disease
Blindness or visual loss
Chronic renal disease
Older age
Peripheral neuropathy
Structural foot deformity
Trauma and improperly fitted shoes
Callus

History of prior ulcer amputation
Prolonged elevated pressures
Limited joint mobility
Local issues

Offloading

The use of offloading techniques, commonly known as pressure modulation, is considered the most important component for the management of neuropathic ulcers in patients with diabetes. Recent studies have provided evidence indicating that proper offloading promotes
DFU healing . Although many offloading modalities are currently in use , only a few studies describe the frequency and rate of wound healing with some of the methods frequently used clinically. The choice of these methods is determined by patient physical characteristics and abilities to comply with the treatment along with the location and severity of the ulcer.

The most effective offloading technique for the treatment of neuropathic DFU is total contact casts (TCC). TCC is minimally padded and molded carefully to the shape of the foot with a heel for walking. The cast is designed to relieve pressure from the ulcer and distribute pressure over the entire surface of the foot; thus, protecting the site of the wound.

Mueller *et al* conducted an RCT that showed TCC healed a higher percentage of plantar ulcers at a faster rate when compared with the standard treatment. In addition, a histologic examination of ulcer specimens has shown that patients treated with TCC before debridement
had better healing as indicated by angiogenesis with the formation of granulation tissue than for patients treated with debridement alone as indicated by a predominance of inflammatory elements. The contributory factors to the efficacy of TCC treatment are likely to be due to pressure redistribution and offloading from the ulcer area. In addition, the patient is unable to remove the cast, which thereby forces compliance, reduces activity levels, and consequently improves wound healing. However, the frequency of side effects referred to in the literature
and minimal patient acceptance make this approach inappropriate for wide applications. Fife *et al* has shown that TCC is vastly underutilized for DFU wound care in the United States. Based on this study, only 16% of patients with DFU used TCC as their offloading modalities. The main disadvantage of TCC was the need for expertise in its application. Most centres do not have a physician or cast technician available with adequate training or experience to safely apply TCC. In addition, improper cast application can cause skin irritation and
in some cases even frank ulceration. Also, the expense of time and materials (the device should be replaced weekly), limitations on daily activities (*e.g.*, bathing), and the potential of a rigid cast to injure the insensate neuropathic foot are considered other disadvantages.

Furthermore, TCC does not allow daily assessment of the foot or wound, which is often contraindicative in cases of soft tissue or bone infections. In some cases, it is suggested to use other kinds of offloading techniques such as a removable cast walker (RCW) or
Instant TCC (iTCC). An RCW is cast-like device that is easily removable to
allow for self-inspection of the wound and application of topical therapies that require frequent administration. The application of this method allows for bathing and comfortable sleep. In addition, because RCW is removable, they can be used for infected wounds as well as for superficial ulcers. However, in a study that compared the effectiveness of TCC, RCW, and half-shoe, this method did not show equivalent healing time (mean

healing time: 33.5, 50.4, and 61.1 d, respectively), and a significantly higher proportion of people with DFU were healed after 12 wk wearing a TCC compared with the two
other widely used offloading modalities. iTCC, which involves simply wrapping a RCW with a single layer of cohesive bandage, Elastoplast or casting tape, is another offloading technique that is shown to be more effective than TCC and RCW . This technique
forces the patient to adhere to advice to immobilize the foot while allowing for ease of application and examination of the ulcer as needed.

Podiatric care

Most patients with a DFI require some form of podiatric care, along with medical, surgical, nursing, and physiotherapeutic interventions. The increasing availability of podiatrists in many countries appears to have led to major advances in diabetic foot care, although robust evidence for this is pending. Podiatric care is particularly aimed at preventing foot complications and includes debridement of callus and necrotic tissue, nail care (especially with onychomycosis), the treatment of blisters, prescribing proper footwear, and fitting orthotic devices. Once complications occur, however, the goal becomes avoiding amputation.

Systemic antimicrobial therapy

Systemic antibiotic therapy is always necessary for the treatment of clinically infected wounds, but is often insufficient to cure moderate to severe DFIs. This systemic therapy must often be combined with one or more surgical procedures, pressure off-loading, appropriate wound care, and in some cases, arterial revascularization. With a few exceptions, almost all of the currently used antimicrobial classes (if not the current generations) were available 30 years ago. What has changed is our awareness of the need to reduce the spectrum and duration of antibiotherapy to try to slow the tide of antibiotic resistance. While initial antibiotic therapy for most patients must be selected empirically, it should largely be based on the assessment of infection severity and knowledge of the local microbial epidemiology. In most regions of the world, the antibiotic regimen should always cover S. aureus, but it may be broadened to include Gram-negative isolates in severe infections or if the patient has failed to respond to prior narrower-spectrum therapy. Of note, DFIs can develop rapidly, making early follow-up after starting therapy imperative. Necrotizing soft tissue infections of the diabetic foot, including gas gangrene, are uncommon and are usually caused by mixed aerobic (and sometimes anaerobic) bacteria rather than Clostridium species. Definitive antibiotic therapy should be based on culture and sensitivity results. Even if cultures yield multiple organisms, it may be sufficient to treat only the likeliest pathogens, such as S. aureus, streptococci, and Enterobacteriaceae. Skin commensals such as coagulase-negative staphylococci, corynebacteria, or Bacillus spp, and low-virulence organisms such as enterococci, can usually be ignored unless cultured from deep, aseptically collected tissue or infections involving osteosynthetic material or hardware. Like-wise, the mere presence of skin or mucosal colonization with healthcare-associated MRSA does not oblige the clinician to empirically cover this organism, even in the presence of underlying osteosynthetic material. Quantitative cultures, which were in vogue in the past, are now rarely done as they are difficult to perform, expensive, and do not add much to deciding which wounds are infected or what organisms to treat. Because most DFIs occur in the setting of peripheral arterial disease, some have raised concerns about how well various antibiotic agents penetrate the infected site, especially bone. This has led many clinicians to prescribe weeks of intravenous antibiotic

therapy. The current availability of highly bioavailable oral antibiotics, as well as the acquisition of further evidence of the efficacy of oral antibiotic regimens, has helped change this practice. When prescribed at standard doses, most beta-lactam antibiotics achieve relatively low (albeit therapeutic) tissue levels, as these are time-dependent (not concentration-dependent) drugs. Clindamycin, fluoroquinolones, linezolid, rifampicin, and to some degree, tetracyclines and co-trimoxazole, have good oral bioavail-ability and penetration in bone, synovia, biofilm, and necrotic tissue. Few data support the need for parenteral therapy, and studies are currently underway to compare outcomes of oral versus intravenous therapy for complex musculoskeletal infec-tions, including DFI. Likewise, in a retrospective analysis of more than 2000 episodes of orthopaedic infection, including DFI, we found no evidence of superiority of bactericidal agents over bacteriostatic agents. Similarly, published randomized con-trolled DFI trials have failed to show superiority of any particular antibiotic agent or route of administration. Several systematic reviews of antimicrobial treatments for DFI have concluded that there is insufficient evidence to recommend any particular antimicrobial agent or route of administration.

Topical antibiotics, antiseptic disinfectants, and peptides

Superficial, open wounds without extensive cellulitis can potentially be treated with topical antimicrobials. The few published studies of topical therapy for DFI have employed a variety of antibiotics (e.g., mupirocin, bacitracin, neomycin, chloramphenicol, polymyxin B, and gentamicin), as well as antiseptics. We found no publication reporting on the use of topical fusidic acid for DFI, an agent often misused in other types of superficial skin infection in many parts of the world. Studies of topical therapy comparing an active agent to a placebo, to another active agent, or as adjuncts to systemic antibiotic therapy, have provided mixed results. In DFI, topical agents are typically applied in mildly infected (or, inappropriately, in uninfected) wounds, making it difficult to distinguish their clinical benefits from local wound care alone. Just eradicating or reducing microorganisms in the wound is not a sufficient endpoint for efficacy, any more than their presence is sufficient to define clinical infection. There is no evidence that topical (or systemic) antimicrobial therapy hastens healing of uninfected wounds, or that it prevents clinically apparent wound infection. A pilot randomized study of treatment in 56 DFI patients found that adding a topical gentamicin-collagen sponge as an adjunct to systemic antibiotic therapy (for up to 28 days), produced a higher infection cure rate compared to systemic antibiotics alone (100% vs. 70%, respectively) at 2 weeks after the end of therapy. In another randomized trial, adding a gentamicin-collagen sponge to systemic antibiotic therapy after a minor foot amputation in 50 patients resulted in a significantly shorter (by almost 2 weeks) median stump wound healing time. The largest study of topical antimicrobial therapy in patients with a DFI (with 835 evaluable patients) found that treatment with an investigational antimicrobial peptide cream (pexiganan) produced rates of clinical cure, pathogen eradication, and wound healing similar to those in patients treated with an oral fluoroquinolone antibiotic (ofloxacin). Further studies of this agent in treating mild DFI are currently underway. Many studies have assessed topical disinfectants or antiseptics for the treatment of DFI, including compounds with silver, povidone or cadexomer iodine, or hypochlorite. The majority of these studies used ulcer healing, rather than resolution or prevention of infection, as the primary outcome. None of these agents has demonstrated superior outcomes compared to non-antiseptic dressings. Likewise, recent systematic reviews have found that various other dressings, such as foam, hydrocolloid, or alginate, offer no advantage over other dressings for ulcer healing or resolution of

infection. Thus, as was true three decades ago, dressing changes with simple gauze and saline solution alone appears to be sufficient for most patients.

Antibiotic misuse

Excessive and inappropriate uses of antibiotics have profound negative effects, firstly for the patient, but also for the health care system and society as a whole.9 Diabetic foot experts, including the authors of the most recent IDSA16 and IWGDF18 guidelines on DFI, the European Wound Management Association policy document, and the Scottish consensus statement, recommend not treating clinically uninfected ulcers with antibiotic therapy. One double-blind, placebo-controlled trial in which 39 patients with an 'uncomplicated' neuropathic diabetic foot ulcer were treated with either antibiotic therapy (oral amoxicillin– clavulanate) or placebo found no difference in the wound healing rates. Similarly, a study of patients with neuropathic (presumably uninfected) foot ulcers found no significant difference in ulcer healing for 25 patients treated with parenteral antibiotic therapy (ceftriaxone) compared to 25 controls not treated with antibiotics. A large registry study in Sweden showed that providing web-based information on appropriate ulcer care was associated with a highly significant reduction in antibiotic prescribing for these wounds, from 71% to 29%.This finding not only supports the premise that antibiotics are not necessary in the majority of ulcers (presumably those that are uninfected) treated with appropriate wound care, but also that it is possible to improve antibiotic prescribing by clinicians.

Osteomyelitis:

diagnosis and therapy DFIs generally begin when a break in the protective skin barrier allows pathogens to multiply in the soft tissues. Diabetic foot osteomyelitis usually occurs by the contiguous spread of infection from overlying soft tissue. Osteomyelitis is found in up to 15% of patients with a clinically uninfected diabetic foot ulcer; among those with a DFI, however, approximately 20% seen in the outpatient setting and two-thirds who are hospitalized have infected bone at presentation. Diagnosing osteomyelitis of the diabetic foot can be difficult, especially early in the course. Clinical findings suggesting infection include a deep chronic ulcer over a bony prominence, 'sausage toe' (red, warm, swollen) appearance, and an erythrocyte sedimentation rate >70 mm/h. The only virtually pathognomonic clinical sign is the presence of fragments of bone discharging from a wound. The probe-to-bone test is helpful in diagnosing diabetic foot osteomyelitis if it is correctly performed (with a blunt metal probe) and interpreted (with consideration of the pre-test probability of osteomyelitis). Based on several reports, the sensitivity ranges from about 60% to 87%, specificity from 85% to 91%, and positive predictive value from 87% to 90%, but the negative predictive value is only 56–62%. The criterion standard for diagnosing osteomyelitis remains a culture of bone and, when possible, histopathological examination. Recent prospective trials have shown that culture results of soft tissue or of needle puncture specimens of bone often fail to correlate with transcutaneous or operative bone specimens, and non-invasive diagnostic approaches for the microbiological assessment of toe osteomyelitis should probably be abandoned.

Radiological assessment of osteomyelitis

As in the past, imaging tests should generally begin with plain X-rays. We now know that inter-observer reproducibility is poor, especially among inexperienced clinicians, and early osteomyelitis may be missed because it takes several weeks for bone lesions to become radiologically detectable. When plain X-rays are inconclusive, or when more detail of bone or soft tissue abnormalities is required, magnetic resonance imaging (MRI) is superior to the standard radionuclide studies (which have lower

specificities). Meta-analyses of the performance of three-phase bone scintigraphy for detecting DFI using only planar imaging, or combined with single photon emission computed tomography (SPECT), report sensitivity of approximately 90%, but specificity of only approximately 50%. Newer hybrid imaging techniques (SPECT/CT, positron emission tomography (PET)/CT, and PET/ MRI) look to be useful, and improved radiopharmaceuticals are on the horizon.

Treatment of osteomyelitis

The past decade has provided much new information on how to treat diabetic foot osteomyelitis. One study of 50 patients with chronic toe osteomyelitis reported that patients who underwent wide surgical resection had a significantly lower relapse rate than those who underwent less aggressive surgery. Contrary to the teaching of 30 years ago, there are now reports of hundreds of cases of diabetic foot osteomyelitis treated without surgery, with remission rates of 60% to 70%; one recent randomized controlled trial showed similar cure rates for medical and for primarily surgical therapy. Thus, when the patient or the medical team prefers to avoid surgery, a trial of exclusively antibiotic therapy may be reasonable. Regarding the duration of antibiotic therapy, a systematic review of the treatment of osteomyelitis in patients with and without diabetes found that there was no evidence that antibiotic therapy for more than 4–6 weeks improves outcomes compared with this duration. More recently, a small randomized controlled study found that 6 weeks compared with 12 weeks of antibiotic treatment of diabetic foot osteomyelitis produced similar results

Advanced dressing

A major breakthrough for DFU management over the last decades was the demonstration of novel dressings. Ideally, dressings should confer moisture balance, protease sequestration, growth factor stimulation, antimicrobial activity, oxygen permeability, and the capacity to promote autolytic debridement that facilitates the production of granulation tissues and the re-epithelialization process. In addition, it should have a prolonged time of action, high

efficiency, and improved sustained drug release in the case of medicated therapies. Hence, no single dressing fulfills all the requirements of a diabetic patient with a foot ulcer. The choice of dressing is largely determined by the causes of DFU, wound location, depth, amount of scar or slough, exudates, condition of wound margins, presence of infection and pain, need for adhesiveness, and conformability of the dressing. Wound dressing can be categorized as passive, active, or interactive. Passive dressings are used as protective functions and for acute wounds because they absorb reasonable amounts of exudates and ensure good protection. Active and interactive dressings are capable of modifying the physiology of a wound by stimulating cellular activity and growth factors release. In addition, they are normally used for chronic wounds because they adapt to wounds easily and maintain a moist environment

that can stimulate the healing process. The main categories of dressings used for DFU are as follows: films, hydrogels, hydrocolloids, alginates, foams, and silver-impregnated.

Today, all dressings are commonly used in clinical practice, while the efficacy of these products has been a challenge for researchers and clinicians, and there are controversial results regarding their use. However, dressings are used based on DFU characteristics hydrogels have been found to be the most popular choice of dressing for all DFU types. Some studies dealing with the incorporation of these products show great potential in the treatment of DFU.

Surgery

Surgery undoubtedly plays an important role in the treatment of many types of DFI, but until recently

there has been limited evidence regarding what constitutes optimal surgical treatment. The major aims of surgery in DFIs are to evacuate pus, remove necrotic tissue, and minimize the risk of further spread. Bad outcomes are often related to a delayed diagnosis, leading to extensive destruction of the soft tissue. Despite a strong emphasis in recent guidelines and consensus documents on the importance of prompt surgical intervention in many DFIs, it is frequently delayed, sometimes leading to amputation. More conservative surgery for the treatment of DFIs is now possible because we better understand the compart-mental anatomy of the foot and the ways in which infection spreads. Furthermore, it is clear that there are more types of foot infection than just 'abscesses' and 'diabetic gangrene'. We now also appreciate that combining needed ablative foot surgery with prompt revascularization can improve the rate of limb salvage. And, finally, new wound therapies have improved the postoperative care for these patients. Any foot compartment affected by infection should be opened quickly to reduce the compartmental pressure. Contrary to previously held beliefs, fascial planes do not constrain the spread of infection. Although unproven, MRI may play a role in planning the surgical approach. Unfortunately, there is no classification that defines either the point at which surgery is absolutely necessary, or when it is likely to produce a better outcome than further medical therapy. It is now clear, however, that in most cases 'conservative' surgery (i.e., resection of just the affected bone, without amputation) or antibiotic therapy alone can treat osteomyelitis successfully. The optimal timing of surgery for DFI is not well defined, but prompt surgery, including revascularization when necessary, may reduce the need for above-ankle amputations. The rate of success, including avoiding lower extremity amputation, in DFIs, depends on the approach taken by the treating surgeon, which often reflects his or her experience and skills. When amputation is performed, both the vertical level of the limb/foot and the horizontal anatomical involvement help determine wound healing. In a recent study of diabetic foot osteomyelitis cases that were treated surgically, those involving the first metatarsal joint were less likely to heal than those in other locations, such as the lesser toes. For patients with wet gangrene or sepsis, a two-stage amputation (initial guillotine with later revision) may lead to better primary stump healing than a one-stage procedure. Contrary to previous beliefs, soft tissue coverage by skin grafting or flaps is possible if needed, even in ischemic areas.

Negative-pressure wound therapy

We now have wound healing devices that were not even dreamed of 30 years ago. Negative-pressure wound therapy (NPWT), introduced about 20 years ago, is now widely used for accelerating wound healing. There are, however, few published data on the usefulness of this method for treating infected soft tissue or bone.109 A systematic review identified four randomized trials of NPWT for diabetic foot wounds.110 While all, including a multicenter study that enrolled 342 patients, found that wounds treated with NPWT healed more rapidly than those receiving conventional dressings, the quality of each of the studies was weak and there was heterogeneity in the outcomes studied and patients selected. A more recent meta-analysis of four randomized trials in diabetic foot ulcers concluded that NPWT results in more effective and faster wound healing and may reduce potential infective complications. A Cochrane review identified two large trials that reported superior ulcer healing results with NPWT compared to moist dressing alone, but three other smaller trials did not confirm this finding. None of these trials dealt with infection. NPWT can be combined with simultaneous wound irrigation or the instillation of antiseptics or antibiotics to reduce the 'wound bed bioburden,' but the effectiveness of these methods for curing or preventing infection is as yet unclear. One case– control study including 82 diabetic patients demonstrated a significantly shorter length of hospital stay and a reduced number of

surgical visits in patients treated with negative pressure therapy with antimicrobial installation compared to negative pressure therapy without installation.More trials are needed to better understand what role this instillation technique may have in treating DFI.

Off-loading

Off-loading pressure from an ulcer is critical to getting it to heal, including those that are infected.This was, is, and will be the cornerstone of both treatment and secondary prevention. The criterion standard method for off-loading – the total contact cast – leads to ulcer healing in over 90% of cases and has been available for decades.What is new is recognizing that the key to its success is that it is non-removable, ensuring patient adherence. For patients with little or no foot deformity, prefabricated extra depth footwear with a stiff rocker bottom walking sole is usually sufficient. Cases with a moderate deformity may require custom-made shoes with custom-moulded, full-contact insoles. Off-loading can be partial and surgical, e.g., performing a flexor-tenotomy in a patient with claw toes. An elective surgical approach may be right when conservative therapy has failed to prevent severe deformity or joint instability, or in the presence of ulcerating hammer and claw toes. Clinicians should generally explain to the patient the benefit of off-loading, but a recent Cochrane analysis of patient education for preventing diabetic foot ulcers found that it may positively influence short-term results, but overall there is still insufficiently robust evidence that limited education alone is effective in achieving a significant reduction in the incidence of foot ulceration and amputation.

Adjunctive treatments

Hyperbaric oxygen therapy

The value of hyperbaric oxygen therapy (HBOT) for DFI continues to be hotly debated.8 A 2012 Cochrane systematic review concluded that HBOT significantly increased ulcer healing in the short term, but not the long term; because of the flawed trials, however, they were not confident in the results. Some studies suggest that HBOT facilitates wound healing and decreases rates of lower extremity amputation in diabetic patients with a foot ulcer or postsurgical amputation wound, but most experience is retrospective and non-comparative. There are, however, no published data directly related to the effect of HBOT on infectious aspects (either soft tissue or bone) of the diabetic foot.

Wound stimulating factors

Several studies have examined the value of granulocyte-colony stimulating factors for treating DFI or ulcers. A Cochrane review based on five randomized trials concluded that these treatments did not increase infection remission, but may reduce the need for surgical interventions, especially amputations, and the duration of hospitalization. Well-designed studies of platelet-derived growth factors and skin substitutes have not shown any specific benefit regarding resolution or prevention of infection. Likewise, a Cochrane review found no evidence of benefit for autologous platelet-rich plasma in the treatment of chronic wounds.

Stem cell therapy

In recent years there has been less research using growth factors on diabetic foot wounds and more employing stem cells. Most of the initial studies used angiogenic growth factors alone, but the limited efficacy prompted studies investigating the potential benefits of cell-based therapy. Studies on the local injection of unselected bone marrow-derived (or peripheral blood-derived) mononuclear cells in patients with severe peripheral arterial disease provided encouraging results, but the treatment did not provide complete revascularization, probably due to the limited delivery of specific angiogenic cells in the mixed cell population. Later studies found that autologous bone marrow cell transplantation in ischemic

diabetic foot ulcers increased leg perfusion and reduced the risk of amputations. Studies using umbilical cord stem cells have also reported encouraging results. One investigation of adipose tissue-derived stem cell implantation in patients with critical limb ischemia, some of whom were diabetic, demonstrated considerable angioneogenesis. Other investigators have also successfully harvested adipose tissue stem cells from the abdominal subcutaneous fat. While stem cell therapy shows encouraging results regarding angiogenesis, it currently has no proven direct effect on infection. Limb revascularization Peripheral arterial disease is present in about 50% of patients with a DFI, and it appears to be an independent risk factor for limb loss. Revascularization of the foot in diabetic patients can now be accomplished by either arterial bypass surgery or endovascular interventions, with limited evidence to support selecting one technique over the other. Available data suggest that patients with a life-expectancy of more than 2 years and extensive stenoses have superior outcomes with open surgery. However, using endo-vascular angioplasty can reach the infragenicular region, which was not possible until the most recent decade. While revascularization may be crucial for a critically ischemic limb, it probably has no directly beneficial effect on infection, other than to provide adequate perfusion to ensure the delivery of systemically administered antibiotics. Clinical pathways, guidelines, and bundle interventions As noted above, there are now several evidence-based DFI guidelines that have been shown to provide validated approaches to optimize outcomes.20 All address the critical importance of multidisciplinary teams,16 which have repeatedly been shown to help avoid adverse outcomes in both inpatients and outpatients with DFIs. The deployment of teams is, however, hampered by several logistical problems: (1) it is often difficult to bring team members together outside of a fixed meeting time; (2) the number of patients requiring evaluation often requires more time than is available for fixed team meetings; (3) members of the team often turnover; and (4) funding for team members' time or for administrative support is often lacking. A new concept to provide the advantages of a multidisciplinary team while overcoming some of the logistical problems is the use of a clinical pathway (preferably accompanied by electronic order-sets). Clinical pathways may uncover improper diagnostic or therapeutic approaches, or bottlenecks in providing optimal care. Order-sets provide a powerful tool to implement 'bundles' (multiple simultaneous interventions) and to encourage and facilitate optimal and evidence-based care. Although studies to date have been limited to before-and-after designs, teams and order-sets may help to optimize (and minimize) the use of antibiotic agents, reduce costs, and prevent unnecessary amputations.

Material and Method

The project is being conducted at PMCH, Udaipur, in all the Diabetic foot patients being admitted and treated since January 2018 till January 2020.

Method of collection of data

Detailed history taking, thorough physical examination, investigations, relevant special investigations, choosing the appropriate line of treatment.

Inclusion criteria

All patients with diabetes mellitus suffering from foot ulcers and infections of all age groups, incidental diagnosis of diabetes on admission with diabetic foot ulcer and patients with gangrenous foot, complicated by diabetes are included in the study.

Exclusion criteria

Exclusion criteria were patients with foot infections without diabetes mellitus, patients with gangrene foot of aetiology other than infection of foot complicated by diabetes, patients whose treatment could not

be completed.

Assessment of Diabetic Foot

A task force of the Foot Care Interest Group of the American Diabetes Association (ADA) released a 2008 report that specifies recommended components of foot examinations for patients with diabetes. Providers should take a history of all risk factors .

Factors increasing the Risk of Diabetic Foot Ulceration:

- Peripheral neuropathy: somatic or autonomic
- Peripheral vascular disease
- Past foot ulcer history (The annual risk of re-ulceration is found to be up to 50%)
- Plantar callus and elevated foot pressure
- Foot deformity, Nail abnormalities,
- Psychosocial factors (Anxiety, Depression, non-compliance)
- Other microvascular complication, especially chronic renal failure
- Diabetic Nephropathy, patients with end stage Renal Disease on dialysis subjects with renal or pancreas- renal transplants.
- Interdigital Infection in feet. Temperature difference between feet.
- Edema
- Ethnic background
- Living alone
- Poor social background
- History of Smoking

The foot should be examined for deformities. Hyperextension of the metatarsal-phalangeal joint with interphalangeal or distal phalangeal joint flexion leads to hammer toes. In examining for PAD, the dorsalis pedis and posterior tibial pulses should be palpated and characterized as present or absent.30 Claudication, loss of hair, and the presence of pale, thin, shiny, or cool skin are physical findings suggestive of potential ischemia. Measuring the Ankle Brachial Index (ABI) can be used for determining the extent of vascular disease. The ABI is obtained by measuring the systolic blood pressures in the ankles (dorsalis pedis and posterior tibial arteries) and arms (brachial artery) using a handheld Doppler and then calculating a ratio. Ratios below 0.91 are suggestive of obstruction. However, in patients with calcified, poorly compressible vessels or aorto-iliac stenosis, the results of the ABI can be complicated. If there is a strong suspicion of PAD, the patient should undergo vascular imaging / peripheral arterial angiogram. The loss of pressure sensation in the foot has been identified as a significant predictive factor for the likelihood of ulceration. A screening can be done by the diabetic foot is the 10-gauge monofilament. The monofilament is tested on various sites along the plantar aspect of the toes, the ball of the foot, and between the great and second toe. The test is considered reflective of an ulcer risk if the patient is unable to sense the monofilament when it is pressed against the foot with enough pressure to bend it. Areas of callus should not be tested.

RESULTS

Age

Of 120 cases studied, most of the diabetic patients were in the age group of 56-65 (36%) followed by 46-

55 (32%). Out of 120 patients 83% of the patient was above the age 45 years. The youngest patient was of 28years and the oldest was of 85 years.

Sex distribution

In present study out of 120 patient 85(70%) were male and 35(29%) were females. It shows male predominance. Ratio of male: female was 2.4:1.

Clinical presentation

Out of 120 cases 75 (62.5%) patients presented with ulcer, 14 cases presented with abscess and 4 cases presented with osteomyelitis and 27 (22.5%) cases presented with gangrene.

Ulcer was the most common presentation.

Site of lesion

The most common site of lesion was toes found in 23 patients (65%) followed by dorsum of foot involved in 18 patients (21%). The least was whole foot involvement and multiple ulcer found in 1% patient

History of trauma

In present study history of trauma (thorn prick, shoe bite, nail prick, wood piece prick etc. as a precipitating factor was present in 87 patients making a total of 72.5%.

Pathology

Out of 120 patients 90 (75%) patients had neuropathy, 36 (30%) had vasculopathy and in28 (24%) both neuropathy and vasculopathy was there. In 15 patients (12.5%) pathology couldn't be identified.

Duration of diabetes mellitus

In present out of 120 patients, 23 were diagnosed on date of admission and 97 patients were known diabetic. There were 56 (46.66%) patients with duration of diabetes between 3 to 10 years. In this a patient aged 85 years has history of diabetes for last 25 years.

Incidence of different causative organisms

The most common organism grown on culture of pus was *Staphylococcus aureus* in 32 (27%) patients followed by *Pseudomonas* in *21(18%),* enterococcus in 14 patients (12%), *Streptococci* in 13 (11%), *Proteus* in 9 patients(8%), *E coli* in 8(6%) patients, *Klebsiella* in 6(5%) patients. In 7 patients (6.66%) there was no growth. In 10 (8.66%) patients the growth was polymicrobial.

Treatment given to patient

In the present series conservative treatment was given to 12 patients, in 82 patients debridement was done, major amputation was done in 18 patients, disarticulation was done in 2 patients and drainage of pus was done in 6 patients. Split skin grafting was done in 27patients as a final treatment.

Lesion outcome (prognosis)

Out of 120 patients 82 (68%) patient's lesion healed by primary healing (re-epithelialisation) by means of regular dressing, 27(22.5%) patients needed skin grafting as final treatment and 18 (15%) patients needed amputation.

Duration of hospital stay

The average duration of hospital stay was 61 days with minimum days of stay of 3 days and the maximum days of stay being 120 days. Maximum number of patient was in the range of 14-35 days.

DISCUSSION

120 cases were studied from January 2021 to January 2023 at Pacific Medical College and Hospital, Udaipur. The analysis of the study is as follows. When compared with Wheel Lock et al there is not

much differences in youngest and oldest group as shown in
In the study of Mummidi et al, the youngest was 31 years and the oldest was 80 years, they studied 100 patients from Jan 2013 to June 2014.

Table 1: Comparison with age.

Age group	Wheel Lock et al 1969	Present Study
Youngest	32	28
Oldest	89	85

Table 2 presents the age group presented with diabetic foot ulcer was 56-65 years which is also the common period in Mayfield et al study.11 This study indicates that diabetic foot ulcer usually occurs in the elderly, as 86.99% of the patient presenting with diabetic foot ulcer were above 45 years of age.

Table 2: Age wise distribution.

Age (years)	Mayfield et al	Present Study
25-35	2%	1%
36-45	15%	20%
46-55	29%	32%
56-65	34%	36%
>65	20%	11%

Like Mayfield et al study, the present study had more number of male patients (85) suffering from diabetic foot
lesions than females (35).
The present study had ratio of male:female as 2.4:1 where as in Mayfield study male:female ratio was almost equal. In Mummidi et al study the male predominance was there in there study 78% patients were male. Male predominance has no clear explanation but may be due their occupational and recreational activities there is more stress on the feet.

Table 3: Sex distribution.

Sex	Mayfield et al		Present Study	
Male	32	53%	85	70.83
Female	29	47%	35	29.16

Like Apelquist et al, the most common presentation was ulcer which included 75 patients out of 120 patients. The ulcer included both the superficial and deep. The commonest presentation is ulcer followed by gangrene and abscess/osteomyelitis which is comparable with the study of Apelquist et al. Similarly in study conducted by Qari the most common presentation was ulcer and it was found in 59% of patients.

Table 4: Mode of clinical presentation.

Presentation	Apelquist et al (n = 314)		Present study (n =120)	
Ulcer	200	63%	75	62.5%
Abscess/osteomyelitis	46	14.64%	18	15%

Gangrene	68	21%	27	22.5%

In the present study out of 120 patients the most common site of involvement was toes which were found in 78 patients and this was comparable with Apelquist et al and Reiber et al study in which the most common site was also the toes. But in Apelquist et al and Reiber et al , the second most common site of involvement was plantar (metatarsal heads ,mid foot and heal) where as in the present study it was the dorsum of foot.

Table 5: Site of lesion.

Site of lesion	**Apelquist et al (n = 314)**	**Reiber et al (n = 302)**	**Present study (n =120)**
Toes	51%	52%	65%
Dorsum of foot	14%	11%	21%
Plantar	28%	37%	10%
Multiple ulcer	7%	0%	1%
Lateral aspect of foot	0%	0%	0%
Dorsum and toes	0%	0%	2%
Whole foot	0%	0%	1%

In present study out of 120 patients, 87 cases were having history of trauma, it accounts for 72.5% of the present study. This is compared with Reiber et al series in which 77% of ulcer pathways include trauma. Sensory neuropathy can cause loss of variety of sensations like touch, pressure, temperature, vibration, position and pain. When the sensation of pain is lost it gives rise to an insensate foot, resulting in repetitive unrecognized trauma and abnormal distribution of pressure on the feet and hence emerge as the principal factor in causing foot ulcer.

Table 6: History of trauma.

History of trauma	**No. of patient (n = 120)**	**Percentage**
Positive	87	72.5%
Negative	33	27.5%

In present study out of 120 patients 90 patients (75%) had neuropathy which is comparable with Reiber et al in which neuropathy was there in 78% of the patients. In the present study 112(93.33%) patients had either neuropathy or vasculopathy. The majority of the patients having neuropathy/vasculopathy had history of diabetes of more than 5 years.

Table 7: Pathology.

Pathology	**Reiber et al**	**Present Study**
Neuropathy	78%	75%
Vasculopathy	35%	30%
Both		24%

No neuropathy and vasculopathy		12%

In the present study the most common organism cultures is *S. aureus* followed by *Pseudomonas* which is comparable with Gibbons et al and Wheta et at study.

Table 8: Incidence of different causative organisms.

Organism	**Gibbons et al (n =50)**	**Whet a et al (n=54)**	**Hughes et al (n =42))**	**Present study (n =120)**
S. aureus	22%	20%	25%	27%
Enterococcus	16%	15%	17%	12%
Streptococci	13%	23%	20%	11%
Proteus	11%	9%	11%	8%
E coli	7%	5%	3%	6%
Klebsiella	4%	6%	7%	5%
Pseudomonas	3%	3%	0%	18%
Bacteroids fragilis	-	2%	5%	7%

In the present series conservative treatment was given to 12 patients, in 82 patients debridement was done, major amputation was done in 18 patients, disarticulation was done in 2 patients, and drainage of pus was done in 6patients. Split skin grafting was done in 27 patients as a final treatment. Proper control of diabetes is very important in diabetic foot management, fasting and post prandial blood sugar estimation were well under control. Initially the patient were started on broad spectrum antibiotic and if required it was changed depending on the culture and sensitivity report.

Table 9: Amputation.

Study	**Number of cases**	**Amputation**	**Percentage**
Collen et al	215	83	38.6%
Oyibo et al	194	30	15.4%
Present study	120	18	15%

In the present study out 120 cases studied 68% had good prognosis which healed by re-epithelialisation which is comparable with Apelquist et al and Reiber et al study. In the present series all the patient recovered finally there was no mortality and 15% underwent amputation.

Table 10: Lesion outcome (prognosis).

Lesion outcome	**Apelquist et al**	**Reiber et al**	**Present study**
Primary healing	63%	81%	68%
Amputation	24%	14%	15%
Skin grafting	-	-	22.5%
Death	13%	5%	3%

This study consists of 120 cases of diabetic foot ulcer patients with emphasis on various presentation and surgical intervention over a period of 24 months. After analysis of the data the following are the

conclusions.

The youngest patient in present study series of 120 patients studied was 28 years, and the oldest 85 years. The highest number of patients was seen in the age group of 56-65 years. The male to female ratio was approximately 2.4:1. Surgical complications are more common in men due to their increased susceptibility to trauma, smoking, and alcoholism. Commonest presenting lesion was ulcers, followed by gangrene and abscess/osteomyelitis Commonest site of lesion was toes (including ventral and Dorsal surface) followed by dorsum of foot. Trivial trauma (prior to diabetic foot ulcer) is the initiating factor in about 72.5% of the cases.

Out of 120 patients 23 were diagnosed of diabetes mellitus on date of admission. Most of the patients had history of diabetes mellitus between 3 to 25 years. All most all the patient had infection (only in 12 patients the culture was sterile) in addition to neuropathy and ischemia. This study shows that all three are can be there in diabetic foot ulcer. Minimum duration of stay in hospital was 4 days and maximum 120 days. Most common microorganisms grown from culture taken from the lesion was *S. Aureus* followed by *Pseudomonas.*

Conservative treatment consists of control of diabetes with human actrapid / human mixtard/lente/Glargine insulin along with appropriate oral or iv antibiotics along with simple dressing was effective few cases. Wound debridement, slough excision, followed by dressing with povidine-iodine, metronidazole, collagenase, L- lysine, mupirocin, etc. dressings resulted in healing of ulcers. Split skin grafting, disarticulation, bellow knee

amputation, and above knee amputation, were the other modes of treatment. There was 3% mortality in present study.

11. Future research

Increasing antibiotic resistance has stimulated research addressing various types of non-antibiotic treatment for DFIs. Among these, photodynamic inactivation, bactericidal laser therapy, and bacteriophages appear to show promise. Using telemedicine diagnostic support in the home environment may also allow needed foot assessment as well as expert consultative advice. Recently, investigators have developed a photographic foot imaging device for use in home monitoring for the early diagnosis of foot ulcers and pre- ulcerative lesions in diabetic patients. Home monitoring of foot temperatures by infrared thermometry, with modification of activity when the temperature is elevated, has been shown to be reduce foot ulceration in patients with diabetes. Infrared thermal cameras may be useful to detect infections or to predict which patients are at risk of future foot complications, including infections. A study of 38 patients with a diabetic foot complication found that diagnosis based on the combination of photographic and temperature sensing devices was both sensitive and specific, with good intra-observer agreement. Likewise, a quantum dot- based foot mapping system (utilizing a red dot to show the presence of bacteria and a green one to show areas of accumulating inflammation) may help to visualize infection and differentiate it from sterile inflammation. Finally, given the high recurrence rates of neuropathic foot ulcers, helping patients to modify their walking pattern, perhaps with feedback-based approaches, may prove useful. Employing other forms of physical therapy and rehabili- tation may also help improve the outcomes of DFI.

12. Conclusions

DFIs are a common, complex, and costly problem that will almost certainly increase in prevalence in the

near future. Clinical research over the past three decades has markedly increased our understanding of the pathophysiology, diagnosis, and treatment of both soft tissue and bone infections. The task now is to implement available validated guidelines, to audit processes and outcomes, to educate providers and patients, and to further advance research.

Diabetes is a lifelong problem, and the incidence of diabetic foot complications increases with age and duration of the disease. Diabetic patients at risk for foot lesions must be educated about risk factors and the importance of foot care, including the need for self inspection and surveillance, monitoring foot temperatures, appropriate daily foot hygiene, use of proper footwear, good diabetes control, and prompt recognition and professional treatment of newly discovered lesions. They take a tremendous toll on the patient's physical and mental well-being as well as impose a substantial economic burden, often removing the patient from the workforce and placing a financial drain on the health care system.

The management of the surgical patient with diabetes should be based on knowledge of the path physiology of diabetes and on an assessment of its chronic complications.

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