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Diabetic Foot Complications in Sub-Saharan Africa: The Case of Saint-Louis in Senegal

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Abstract **Original Research Article**

Introduction: Complications of the diabetic foot represent the first cause of non-traumatic amputations. In Senegal, the number of diabetics in 2010 was estimated at 460,000 (3.4%). Only 10% of them knew they had diabetes. According to the 2016 WHO report on diabetes, the number of deaths in Senegal in 2016 due to diabetes among people aged 30 to 69 was 1,400 deaths and among people aged 70 and over 1,410 deaths. The diabetic foot is an entity that largely contributes to morbidity and mortality due to diabetes. Our work proposes to return to the various complications of the diabetic foot within the Regional Hospital of Saint-Louis. ***Patients and methods***: A retrospective and prospective study was conducted, including all diabetic patients who underwent amputations and disarticulations in connection with a diabetic foot during the years 2018 to 2021. A questionnaire was designed and used to collect the most relevant data. ***Results***: A total of 859 surgical procedures from 544 patient records were included in the study. There were 484 interventions for men and 375 for women. The patients were aged from 21 to 89 years old. There were 643 hospitalizations whose duration varied from 1 to 58 days. Three hundred and eighty operations (44%) were performed on patients who had already undergone a surgery. One hundred and thirteen patients wore prosthetic devices within 6 months after their surgery. We found that 94.8% of non-traumatic amputations and 34.2% of surgical emergencies were directly linked to diabetes and its complications. ***Conclusion:*** Most of amputations and disarticulations performed in the Regional Hospital of Saint-Louis are related to a diabetic foot. These consequences are visible in underdeveloped countries because of the difficulty of monitoring and the lack of prosthetic rehabilitation teams for patients.

Keywords: Diabetic foot, complications, amputations and disarticulations, prosthetic rehabilitation.

INTRODUCTION

In Senegal, diabetes epidemy is constantly increasing, as in Africa and all over the world. The number of diabetic people was estimated at 460,000, or 3.4% of the overall adult population in 2010. And only 10% of them knew they had diabetes. According to several studies carried out in the Saint-Louis region, there are more diabetic men than women (3.5% against 3.2%) [1-3]. According to the 2016 WHO report on diabetes, the number of deaths in Senegal in 2016 due to diabetes among people aged 30 to 69 was 1,400 deaths and among people aged 70 and over 1,410 deaths [4]. Diabetic foot complications represent the first cause of non-traumatic amputations, and such complications have some huge direct cost. The region of Saint-Louis, organized administratively into 3 departments, had more than 1 million inhabitants in 2017, this region has one of the highest prevalence, estimated at more than 10% in 2010, compared to other regions of the country. For the department of Saint-Louis, the estimated population in 2017 is 328,000 people, this department would have approximately 33,000 to 40,000 diabetics according to the most optimistic estimates (10.4% prevalence in 2010) [1-3].

A study carried out in the Saint-Louis Regional Hospital showed that between January 2009

and December 2017, 1,308 patients had surgery for complications due to diabetes [3]. This study also showed that in the General Surgery Department, 91% of non-traumatic amputations and 35% of surgical emergencies were directly related to diabetes. 778 amputations and disarticulations following diabetes were performed during this period. In the event of amputation, no specific organization is available to provide comprehensive care and support for patients (psychological support and functional rehabilitation care). These people amputated as a result of complications lose their ability to work, become dependent on their families and are obliged to wear equipment (orthotics and/or prostheses) and undergo rehabilitation. The financial, psycho-social, and societal impact is significant for the patient, their family, and the communities, especially in an already fragile socio-economic context [5]. Diabetes data and its complications are alarming in Saint-Louis [1-3]. They reflect, among other things, the weakness of screening capacities for this disease at the level of health posts and other peripheral structures, resulting in many cases from the low level of training of human resources. Indeed, many studies incriminate the lack of continuous training, and the lack of updating causing some chronic diseases [6, 7].

Our work proposes to highlight to the various complications of the diabetic foot, in terms of indications, surgical gesture and follow-up, within the Regional Hospital of Saint-Louis, through a prospective and retrospective survey carried out among the diabetic people.

PATIENTS AND METHODS

A retrospective and prospective study of all diabetic patients who underwent amputations and disarticulations at the Saint-Louis Regional Hospital, in relation to a diabetic foot during the years 2018 to 2021 was conducted. The study took place in the department of Saint-Louis, one of the 45 departments of Senegal and one of the 3 departments of the eponymous region. The population of this department was estimated in 2018 at more than 300,000 inhabitants. Initially, patients were identified through various hospital departments (General surgery, Anesthesia, Emergencies, Internal medicine). Then, medical records and archives were used to extract medical data. We also used detailed data from a computerized database containing the records of our diabetic patients, based inside the Saint-Louis Regional Hospital, and named SIMENS (National Medical Information System for Senegal in french). A questionnaire was designed and used to collect the most relevant data. This questionnaire allowed us to record parameters such as age and sex of patients, level of amputation and indications for surgery; but also, Department, health center or health post from which the patient was referred (in case of referral), inherent complications from the surgery and the overall follow-up. The data collected was processed through a database and analyzed using the SPSS software. Quantitative variables were described using means and standard deviations, and qualitative variables were described using proportions and percentages. The results are presented in tables and figures.

RESULTS

A total of 873 amputations and disarticulations were performed during the 4 years of the study. Data were incomplete in 14 cases, we finally included 859 surgical procedures from 544 patient records. According to the Wagner classification, more than 70% of the lesions were classified as grades 4 and 5 (Table I, Figures 3 and 4). The main indications for the surgical procedure were represented by mixed, ischemic and infectious gangrene (Figure 2). There were 484 surgical procedures for men and 375 for women, for a sex ratio of 1.29. The patients were aged from 21 to 89 years old, with an average of 56.34 years old. There were 643 hospitalizations out of the 859 procedures. The length of hospitalization varied from 1 to 58 days, with an average of 18.44 days. Three hundred and eighty procedures (44%) were performed on patients who had already been operated on. One hundred and thirteen patients wore prosthetic device within 6 months after their surgery. In the surgery Department of the Saint-Louis Regional Hospital in the period from January 2018 to December 2021, it appears that 94.8% of non-traumatic amputations and 34.2% of surgical emergencies are directly linked to diabetes and its complications.

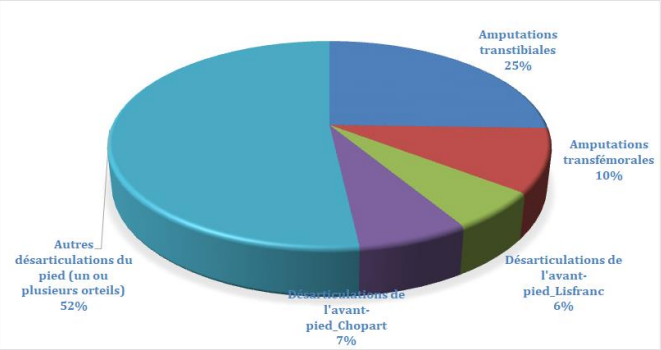

Figure 1: Types and Levels of Amputations

Table I: The Wagner Ulcer Grade Classification Scale

GRADE	DESCRIPTION	Number (percentage)
Grade 0	Pre- or post-ulcerative site	0
Grade 1	Superficial ulcer	0
Grade 2	Penetration into tendon or joint capsule	35 (4%)
Grade 3	Involvement of deeper tissues	192 (22,4%)
Grade 4	Gangrene of the forefoot	343 (40%)
Grade 5	Gangrene involving more than two-thirds of the foot	289 (33,6%)

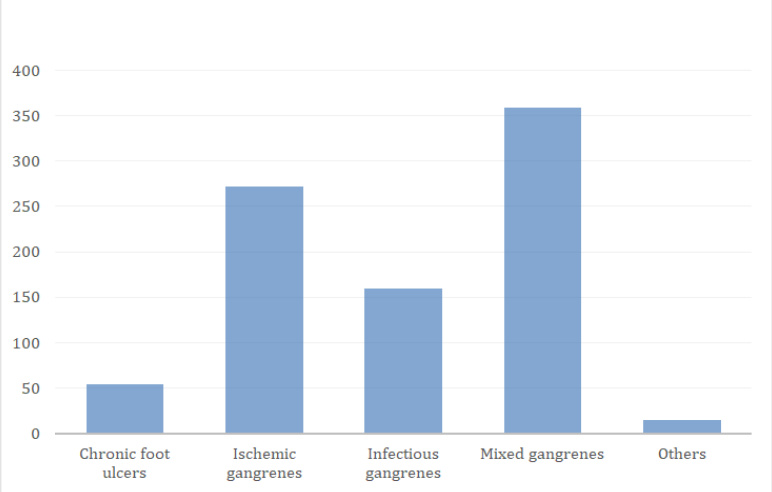

Figure 2: Indications of Amputations and Disarticulations of Diabetic Foot Complications

Table II: Distribution of the Lower Limb Surgical Procedures by Year (2018 to 2021)

Years	Number of lower limb amputations and disarticulations	Percentage
2018	298 procedures	34,7 %
2019	271 procedures	31,6 %
2020	177 procedures	20,6 %
2021	113 procedures	13,1 %

Table III: Distribution of the Lower Limb Surgical Procedures According To Patient Age

Age groups	Numbers	Percentage
20 - 29 years	8 procedures	0,9 %
30 – 39 years	44 procedures	5,1 %
40 – 49 years	191 procedures	22,2 %
50 – 59 years	274 procedures	31,9 %
60 – 69 years	219 procedures	25,5 %
70 – 79 years	87 procedures	10,1 %
80 – 89 years	36 procedures	4,2 %

Table IV: Distribution of The Lower Limb Surgical Procedures According to Duration of Surgery (Total of 643)

Duration of hospitalization (in days)	Numbers	Pourcentage
0 – 10	167 procedures	26 %
11 – 20	289 procedures	44,9 %
21 – 30	146 procedures	22,7 %
31 – 40	34 procedures	5,3 %
More than 40 days	7 procedures	1,1 %

Figure 3: Infectious Gangrene of the Foot and Distal Segment of the Leg
(Source: Department of General Surgery / Saint-Louis Regional Hospital)

Figure 4: Ischemic (Vascular) Gangrene Affecting the Entire Left Foot
(Source: Department of General Surgery / Saint-Louis Regional Hospital)

DISCUSSION

Diabetes is one of the most common chronic non-communicable diseases in the world. This pathological condition is complicated in almost 50% of cases of amputations and disarticulations of the lower extremity [7,8]. It appears that diabetes is one of the main contributing factors to lower extremity amputations, and that people with diabetes are 20 times more likely to undergo a lower extremity amputation than non-diabetics [7, 8]. We have only few data from the literature concerning the functional outcome following amputation of the lower limbs in the elderly. In the general diabetic population, significant mortality is associated with this invasive surgery, with a survival rate of 5 years which hardly exceeds 40%. The contrast between this group of diabetics and the non-diabetic population should lead us to question about the significant morbidity of this surgical procedure and limb salvage techniques in diabetics [7, 8].

In less developed countries, the epidemiology of diabetes has changed a lot in recent times. Indeed, for more than twenty years, the proportion of patients with this condition has exploded in developing regions: from 84 million in 2000 to 228 million expected in 2030. The increase of incidence and prevalence rates of this disease in sub-Saharan developing countries has been widely attributed to several factors: sedentary lifestyle, large cities growing urbanization, poor eating habits, and lack of training for healthcare personnel. In African regions, particularly the poorest, the high costs of care and the lack of training of medical and paramedical personnel constitute real obstacles to the management of diabetes complications according to international standards [9, 10].

One of the most important problems in the management of diabetic disease is represented by the lack of knowledge of paramedical personnel. This lack of knowledge also results in a lack of competence around the diabetic disease. These shortcomings are due in our context to a bad organization of the updating training of the paramedical personnel. The need for training has been recognized for a long time. Socrates and Plato already considered training as a lifelong affair. Permanent training has received increasing attention from the World Health Organization. It was formally recommended by the Twenty-seventh World Health Assembly in 1974 which called upon Member States to consider as a matter of urgency: A system of permanent training which consists of a set of interdependent elements putting at stake are the personnel, policy, planning, activities and equipment of institutions and programs that have agreed to unite their efforts to offer all health workers an opportunity to perfect their training throughout their career [11]. The system adopted should promote community participation and ensure the coordination and

deployment of resources from various sectors and programs, with the goal of improving the skills of all categories of health workers. Permanent training must above all meet the requirements of the health system which, in turn, must meet the needs of the population. This training must also respond to the desire of health workers to maintain and improve their professional skills.

Permanent training takes on particular importance in times of rapid change, such as those which countries are experiencing today as they strive to reorient their health systems towards primary health care - an essential condition for achieving health for all - despite the continual deterioration of the socio-economic climate. The management of health services becomes much more efficient when permanent training is provided to all categories of health personnel, and supervision of agents is integrated into the training process [12, 13]. Permanent training will make it possible to establish a link between basic training and practice; accompanied by supervisory measures, it raises the level of care and reinforces work efficiency. This comprehensive approach to learning is based on a series of guiding principles aimed at establishing a continuous training system for health workers; these principles were first formulated in 1982, on a provisional basis, before being tested to demonstrate their practical usefulness within the framework of national resources and needs. This represents a further step in WHO's efforts to work with Member countries to establish systems to coordinate the activities of health services and research and educational institutions and professional associations, and various other relevant organizations. This coordination promotes inter-institutional collaboration for creating a continuing education system that is incorporated into national health development strategies. Permanent education accessible to all categories of health personnel requires a comprehensive, intersectoral and multidisciplinary approach [14-16].

In the department of Saint-Louis, poverty is endemic as in many regions of Senegal. Over the past 10 years, this department and particularly the city of Saint-Louis and its surroundings have been confronted with the advance of the sea, the drop in income from tourism and the difficulties of access for fishermen to fishing resources. All these problems mean that the Saint-Louis region is experiencing a very fragile economic and social situation, strongly linked to climatic disturbances. Many diabetic patients are unable to buy their insulin due to lack of means. For the same reasons they cannot ensure their medical follow-up. This results in many complications of diabetes including diabetic foot, leading to mutilating surgical procedures. The effects of this poverty found in many diabetic patients are aggravated by the lack of health insurance for most patients. As a result, to ensure their treatment and follow-up, many patients are forced to rely on their families, with important consequences at the social and family level [5, 6]. Senegal's epidemiological profile is largely dominated by infectious and parasitic diseases, like most countries in sub-Saharan Africa. Nevertheless, for several years, in the African region, a rapid progression of non-communicable diseases (NCDs) has been observed, which are no longer the sole prerogative of so-called rich countries [6]. Non-communicable diseases are estimated to cause 34% of all deaths. In 2011 in the Saint-Louis region, the prevalence of chronic diseases among men was the highest in Senegal, at 15.6% for a national average of 10.4%. Among women, this prevalence was the second highest in Senegal after Dakar, with a rate of 20.3% for a national average of 18.6%. Concerning diabetes, two national programs exist, a program to fight against diabetes and another to fight against chronic non-communicable diseases. These national programs are managed at the level of the Ministry of Health and are based on the main principles published by the WHO concerning the fight against diabetes. The creation in 2013 of the Division for the Fight against Non-Communicable Diseases demonstrates a clear political will of the Ministry of Health and Social Action to take charge of Non-Communicable Diseases (NCDs) in an epidemiological context marked by strong increase in these pathologies [1, 2, 5, 6].

Diabetes is on the rise in Africa and particularly in Senegal where the latest prevalence estimates are around 3.4%. According to the WHO, the number of deaths in Senegal in 2016 due to diabetes among people aged 30 to 69 was 1400 deaths; and in people aged 70 and over 1,410 deaths. Finally, diabetic foot complications, which affect 25% of diabetic patients, still represent the first cause of non-traumatic amputations and their direct cost is considerable. Our study reported 859 amputations and disarticulations over a period of 4 years within a single health structure, the Saint-Louis Regional Hospital. There were 484 interventions in men and 375 in women, for a sex ratio of 1.29 and an average of 56.34 years. These surgeries were the cause of 643 hospitalizations with an average duration of 18.44 days. These data clearly show the significant morbidity resulting from diabetic foot complications. Three hundred and eighty procedures (44%) were performed on patients who had already been operated on. This rate of re-operation appears in many works outside ours, and it testifies to the lack of follow-up of diabetic patients who have already been operated on. In our context in sub-Saharan Africa, secondary prevention and tertiary prevention are not sufficiently considered due to logistical problems as well as lack of personnel and lack of training. One hundred and thirteen patients wore prosthetic devices within 6 months of their surgery. This represents only a small proportion of our operated patients. And for good reason, the rate of fitting of lower limb amputees has often been relatively low, mainly due to the impact of

prosthetic equipment, but also because the technology of leg prostheses is rare and expensive. Other works report many difficulties encountered in the fitting of diabetic amputees, the fitting being excessively expensive and coming from very far [17, 18]. In the General Surgery Department of the Saint-Louis Regional Hospital in the period from January 2018 to December 2021, it appears that 94.8% of non-traumatic amputations and 34.2% of surgical emergencies are directly linked to diabetes and its complications.

The region of Saint-Louis represents a particular case in terms of prevalence because it far exceeds the national average, with more than 10% of the local population during the year 2010, i.e., 30,000 to 40,000 cases of diabetics, in the only department of Saint-Louis. Complications of diabetes are frequent in this department, with foot injuries. Between 2009 and 2017, these complications were responsible for an average of 2 to 3 amputations per week, in the Saint-Louis Regional Hospital [3]. It is also a notorious or even deleterious handicap on the economic activities of diabetic patients. In Saint-Louis, several issues that appear in other sub-Saharan studies may explain the high frequency of diabetic feet received and treated at the Regional Hospital. The lack of knowledge of health personnel and health structures on the management of diabetes is not uncommon. Only the regional hospital has specialized doctors in diabetes and qualified paramedical staff. The Saint-Louis district hospital does not play its role of intermediary and has only a few staff trained in the management of diabetes (doctors and nurses). As a result, patients are systematically referred by the staff of the centers, health posts and health huts directly to the regional hospital of Saint-Louis. This situation leads to a significant number of consultations resulting in a drop in the quality of care provided, and a decrease of education sessions for diabetics. At the level of the district hospital and the health centers, health posts and health huts, the personnel have only recently been trained about prevention, cares and follow-up of diabetic patients, as well as surgical complications of diabetes, and in particular the diabetic foot.

The weakness of screening capacities has often been reported. Indeed, in Saint-Louis, few health posts and health huts had blood glucose meters until recently, and most encountered supply problems for the different types of strips and reagents. The poor performance of screenings also comes from the very low information, awareness and therefore knowledge of the public on the disease and its risk factors. One of the significant factors is represented by the financial difficulties encountered in access to care for people with diabetes and their difficulties in following their treatment. Most diabetic patients come from rural or peri-urban areas; their financial means are limited and their access to information restricted. These two factors have a negative impact on their attitudes and behaviors towards the disease, on their decision-making capacities to continue their (expensive) treatment, even if their blood sugar level is falling. Finally, many of them find it difficult to accept this chronic disease, and therefore to follow the treatments prescribed by the medical staff. In the event of complications such as diabetic foot, the costs incurred such as hospitalization, rehabilitation, and equipment costs are too high for them. In addition, there has been a lack of significant advocacy with health and social authorities of the region and district in recent years, to improve the financial support of these patients and to promote identification of community and social support mechanisms.

A supply system for suitable footwear should also have been implemented to reduce costs for patients with foot complications. Difficulties related to diabetic foot complications appear regarding management. In our work, it appears that the indications are mainly represented by gangrene (61.1%) and chronic skin ulcerations (19.2%). In preliminary work, it appeared that lower limb damage remained predominant (75.1%), and that diabetes was inaugural in 13.6% of these complications [3]. Concerning these difficulties related to complications and to the diabetic foot, it would be interesting to establish an integrated management of the diabetic foot from primary prevention to fitting and functional rehabilitation. This integrated care will concern both diabetics with a diabetic foot and those at risk. The last problem concerns the community actors of civil society who are insufficiently involved. There is an Association of Diabetic People in the Region of Saint-Louis with approximately 1,800 members, working in the three departments. This association, which works in close partnership with the Regional Hospital, conducts awareness campaigns for the public, supports diabetic patients in hospital and conducts research on patients who have been lost to sight. This association has few financial means and cannot respond to all problems of patients. Faced with the poor support at community level for diabetic patients on their return to their families, diabetics most often find themselves alone, this situation has an impact both on the rate of abandonment of treatment and on the rate of worsening of complications. The success of a multidisciplinary team for the management of the diabetic foot has been repeatedly demonstrated in the literature. There are many examples that explain the value of adopting an integrated approach to the issue of diabetes, with the involvement of an experienced motivated and trained team [19-21]. This is the benefit of setting up a diabetes clinic with cross-cutting cares, or a reference center for the management of diabetes. Unfortunately, such a structure does not exist in the city of Saint-Louis. Despite the important scientific advances in the field of medicine and surgery, lower limb amputations are still as frequent even though they represent a failure of surgical management. A previous work showed that between the years 2009-2017 (and the years 2018-2012), even if the amputation rate remains relatively

high, the level of amputations is increasingly distal. Indeed, we find that the relationship between amputations of the forefoot and transtibial or transfemoral amputations is increasingly important. The hypothesis that can be formulated in view of this finding would be that of earlier management, limiting the evolution of lesions towards the regions of the leg and thigh.

In 2007, Abbas and Archibald proposed a series of measures to be taken to improve the management of diabetic foot disease without mobilizing significant financial resources [22]: the implementation of sustainable training programs intended for health professionals, focusing on the management of diabetic foot complications and on training programs that will raise the awareness of both patients and healthcare personnel, improve the work environment in order to promote self-training, rationalize antibacterial prescriptions and taking into account epidemiological data, and ensure monitoring of activities around the management of diabetes within the hospital.

CONCLUSION

Diabetes is one of the most widespread chronic non-communicable diseases in the world, this condition is on the rise in sub-Saharan Africa in general and in Senegal in particular. Given the changes in lifestyle and the evolution of our environment, this chronic disease is now developing in all social groups of the population. In Senegal, diabetes is spreading with its significant share of acute and chronic complications, the most striking of which is represented by the diabetic foot. Our work shows that most of amputations and disarticulations performed in the Saint-Louis regional hospital are related to a diabetic foot. Several problems can explain these worrying figures: lack of knowledge of health personnel and health structures on the management of diabetes, poor performance of screenings, absence of a training program, refresher course and follow-up on the diabetes, difficulties related to complications of the diabetic foot, absence of a podiatry service for the care of diabetic patients, lack of an integrated approach and a multidisciplinary team around the care of diabetes. For all these reasons, major lower limb amputations have become a public health problem, which is often associated with significant economic, psychological, and social consequences for the patient and his family. These consequences are more striking and visible in underdeveloped countries because of the difficulty of monitoring and the scarcity of prosthetic rehabilitation teams for patients.

Conflicts of Interest: The authors of this work declare no conflict of interest in relation to the writing of this article.

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