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Bacteria Associated With Skin Wounds of Equines in Shargalneel, Khartoum State, Sudan

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Abstract: The results obtained in the current study have increased knowledge on bacterial infections of skin wounds in equines in Sharg Alneel, Khartoum State. The study was cross-sectional, carried out in the period from October to December, 2012 and employed with a multistage sampling strategy with two hierarchical levels of selection. It revealed 10 different species of aerobic and anaerobic bacteria including; *Staphylococcus aureus*, *Staphylococcus epidermidis*, *Staphylococcus citreus*, Streptococcus species, Pseudomonas species, *E. coli*, Clostridium species, Shigella species and Klebsiella species. Staphylococcus species were the most prevalent bacteria. However, *Staphylococcus aureus* and *Staphylococcus epidermidis* were encountered in 40.0% of the swab samples with a 95% CI ranged from 24.82 to 55.18 whilst *Staphylococcus citreus* was found in 25.0% of the swab samples with a 95% CI ranged from 11.58 to 38.42. Wound infection in equines was probably associated with age. It was more prevalent in the age group of 1 - 5 years old and it was mostly observed in the back area and the two sides of the abdomen. According to drug sensitivity patterns, *Staph aureus*, *Staph albus* and *Staph citrus* were almost sensitive to all antibiotics tested where as other microorganisms were showed different degrees of sensitivity and resistance. The largest inhibition zone (6mm) was showed by Ciprofloxacin against *Staph citrus*. Management practices and the variation in the number of tested samples might have resulted in the higher susceptibility of donkeys compared to horses, and it was interesting to note that almost the same infection rates were encountered in the two areas covered in this survey. It is recommended that saddles and harnesses used for draught animals should be improved to reduce the risks of damaging the underneath skin and as result wounds and wounds infections.
Keywords: bacteria, equine, skin wounds, Sudan

INTRODUCTION

In many parts of the world, including the Sudan, donkey (*Equusasinus*) is considered an important animal that works hard as it helps humans in their everyday lifeand plays an essential role in the economies of underdeveloped countries[13]. Donkeys are indeed of immense value being used almost daily for income generating activities[1]. They can be used mostly for a variety of works work including transport (riding, pack transport, or pulling carts) or they may be used for farm work and other jobs [13]. Pack donkeys are a real option for the future as a truly appropriate renewable power source for the tropics[14]. The economic circumstances have their role in determining the means of transport. In Nigeria, the devaluation of the Naira currency led to an increase in the prices of imported components; therefore, vehicles were difficult to maintain. As a result, many vehicles went out of service and consequently, the donkey became popular again especially in rural markets [2]. Furthermore, donkeys became a usual mean for transportation in Bethlehem as a result of the military conflict between Palestine and Israel [3]. The Sudan possesses a large and diversified animal wealth consisting of domesticated and wildlife animals [4]. Equines are mainly horses which account to 784.5 thousand and approximately 7.5 million head of donkeys. No data on mules is available. Been located in Northeast Africa, the Sudan was identified as the origin of the Nubian wild ass, where it has been domesticated and used for different purposes [5, 6] reported that despite the increase in industrialization, donkeys are still of wide use in rural and urban areas of the Sudan. They are becoming increasingly important animals given the new socio-economic situation with increased use of donkeys instead of horses in labor[7,13].

Despite their great value, donkeys are unfortunately not given veterinary enough attention although they suffer many health problems and diseases [1]. They appear resistant to many diseases, but their viability and ability to work are clearly affected and reduced [7,13]. The analysis of structured interviews using questionnaire highlighted that; ticks, wounds and harness sores are conditions encountered most frequently by donkey owners in South Africa in

addition to internal parasites [1]. Faecal samples revealed a different number of Strongyles, Strongyloides, Parascaris and Gastrodiscus egg count in different management systems[15].

A wound is the disruption of the normal continuity of body structures by physical means [6]. Three types of wounds are recognized: (a) incised wounds are caused by sharp instruments and if there is associated tissue tearing the wound is so-called lacerated wound, (b) abrasions are damage of the skin surface due to friction and are characterized by superficial bruising and loss of varying thickness of superficial skin layers and underlying tissue and (c) punctured wounds are open injuries in which foreign materials and organisms are likely to be introduced deeply into the underlying tissues [16].

Skin wounds in donkeys are suitable habitats for the growth of microorganisms especially in cases of saddle sores because they accelerate the risk of infection by providing anaerobic conditions for the propagation of some microorganism [6,16]. The classic signs of equine skin wounds include pain, erythema, edema, heat and purulent discharge. Other signs that might be observed include: serous exudates, delayed healing, discoloration, foul odor and friable granulation tissue at the base of the wound which when disrupted increased the pain resulting from these wounds [6,16].

The widespread usage of antibiotics has been responsible for the development of many problems including the emergence of multidrug-resistant bacteria. *Staphylococcus aureus* is one of the bacteria that have a violent increase in resistance to antibiotics in the last decade. *Staphylococcus aureus* is a normal flora both human and animals. It often colonizes the skin and nose in healthy individuals; however, it's the causative agents of severe diseases[17]. In time, bacteria may become resistant to new drugs as well. Using current strategies of treating diseases without being sure exactly what microorganisms cause the diseases, we are inadvertently building an army of indestructible organisms that will become more resistant to every new drug that we throw at them[18]. Research yields that resistant organisms can be a source of infection from one animal to another. One study showed that when one member of a household was treated for ten days with Erythromycin, Trimethoprim-sulfamethoxazole, or Tetracycline for acne, dramatic changes in the normal skin flora of untreated members of the household were observed [18]. Methicillin-resistant *S. aureus* (MRSA) has emerged as a pressing issue in equine medicine, detection of this pathogen on farms and in equine hospitals and the potential for transmission to humans all creates concern.

It is unclear when horses first encountered M RSA, and the emergence of MRSA in the equine was so mewhat insidious. Initial reports of MRSA infection in horses were largely individual cases or, mainly associat ed with veterinary hospitals[19-21].

Despite the economic importance of the donkeys in the Sudan, it has been neglected in all development strategies and in-depth scientific researches. Moreover, donkey maladies are usually clinically treated as in horses. The present study was conducted to investigate the bacterial infections of skin wounds of working donkeys in ShargAlneel, Khartoum State.

MATERIALS AND METHODS

Study area

This study was carried out in East Nile (Sharg-Alneel) locality, the north eastern area of Khartoum state. The locality covers a total area of about 8,000 square km, equivalent to more than one-third of the size of the state, and consisting of eight local administrative units, namely: East Nile, Hajj Youssef, Wadi Soba, Alaelafoon, Um-Dawan-Ban, Al-Seilat, Wadi Abu Saleh and Abu Dileiq. The area of land utilized for agriculture is about 400 thousand acres. The population inhabiting the surveyed units is about 868,147 people. Most of these people practice farming, small business and government employees.

Sampling strategy and study design

A cross-sectional study was employed with a multistage sampling strategy with two hierarchical levels of selection during the period from October to December2012. The first and the second levels were conveniently selected. The first level was the locality while the second level was the administrative units (East Nile and Hajj Youssef).

Study population and sampling

The study population was all donkeys with clinical saddle sores and other types of wounds. Forty samples were investigated in this study. The donkeys were restrained, the skin around the lesions was disinfected using cotton wool soaked in 70% alcohol to avoid any extraneous contamination of the samples collected using sterile swabs. The samples were labeled, placed on ice packs and transported for bacteriological investigations at the laboratory of the Department of Microbiology, College of Veterinary Medicine (CVM), Sudan University of Science and Technology (SUST).

Isolation and identification procedures

Isolation and identification of the isolates were conducted in accordance to the Barrow and Feltham [22]. The swabs were cultured in nutrient broth, on nutrient agar, MacConkey agar and blood agar and incubated aerobically and anaerobically at 37oC for 24 hrs. Smears were prepared from all isolates and stained with Gram's and pure cultures were sub-cultured into agar slants incubated at 37oC for 24 hrs and stored at 4oC. The isolates were identified on the basis of their macroscopic and microscopic morphology

and biochemical characteristics (catalase, indole production, haemolysis, and acid and/or gas production in sugars).

Antibiotic susceptibility test

Susceptibility to selected antibiotics was tested on nutrient agar plates by the disc diffusion method of Baur et al. [23]. Briefly, the nutrient agar plates were swabbed with overnight grown cultures of the isolates. Readymade antibiotic discs from HiMedia Laboratories, India, were aseptically placed on the swabbed plates. The plates were incubated at 28±10C for 18 hr and the clearing zone formed around the discs recorded using Hi Antibiotic Zone Scale (Himedia). The multiple antibiotic resistance (MAR) index (the number of antibiotics to which the isolate was resistant/total number of antibiotics tested) was determined for each isolate.

RESULTS

The overall prevalence of isolated bacteria

Isolation and identification of bacteria from the different swab samples revealed ten species of bacteria (Table 1). *Staphylococcus aureus* and *Staphylococcus epidermidis* were the most prevalent bacteria with a prevalence of 40.0% (95% CI, 24.82 - 55.18) followed by *Staphylococcus citreus* with a prevalence of 25.0% (95% CI, 11.58 - 38.42), *Salmonella* species and *Streptococcus* species with a prevalence of 15.0% (95% CI, 3.93 - 26.07), Pseudomonas species, E. coli, *Clostridium* species, *Shigella* species and *Klebsiella* species each with a prevalence of 5.0% (95% CI, -1.75 - 11.75), respectively.

Prevalence of isolated bacteria by risk factor

Investigated risk factors (Table 2), showed that E. coli were the most prevalent bacteria in the age group of 1 - 5 years old (23.5%), wounds on the back (17.6%), in donkeys (12.1%) and at Hilat Kuku area (16.7%). Salmonella species was equally prevalent among the age groups 1 - 5 and 6 - 10 years old (17.6%) and was most prevalent in the wounds of the back (23.5%), in donkeys (15.2%) and at Hilat Kuku area (22.2%). While Pseudomonas species was most prevalent in the age group 1 - 5 years old (17.6%), wounds at the ocular area (100%), in donkeys (15.2%) and at Hilat Kuku area (16.7%). But Shigella species was equally encountered among the age groups of 1 - 5 and 10 years old (5.90%) and was most prevalent in sternal wounds (25.0%), in donkeys (6.10%) and at Alhaj Youssef Alwehda area (22.2%). *Staph aureus* was most prevalent in the age group 6 - 10 years old (90.5%), wounds on both sides of the abdomen (100%), in horses (85.70%) and at Alhaj Youssef Alwehda area (72.7%). On the other hand, as shown in Table 3, *Staph epidermidis* was most prevalent in the age group of 1 - 5 years old (52.9%), wounds at the ocular area (100%), in donkeys (36.4%) and at Hilat Kuku area (50.0%). *Staph citreus* was most prevalent among the age group of 10 years old (50.0%), wounds of the back (35.2%), in horses (42.9%) and at Alhaj Youssef Alwehda area (40.0%). While Streptococcus species were most prevalent in the age group of 10 years old (50.0%), wounds at the ocular area (100%), in donkeys (15.2%) and at Hilat Kuku area (22.2%). Clostridium species were most prevalent in the age groups of 6 - 10 years old (9.50%), wounds at the ocular area (50.0%), in donkeys (9.09%) and at Alhaj Youssef Alwehda area (9.10%). Klebsiella species were most prevalent in the age group of 10 years old (50.0%), wounds at the sternal area (25.0%), in donkeys (6.10%) and at Alhaj Youssef Alwehda area (9.10%).

Susceptibility of isolates towards antibiotics

Staph aureus and *Staph albus*, showed sensitivity towards all antibiotics tested except CX which was resisted by both species and CF which was resisted by *Staph albus*i.e showed no zones of inhibition (0.0 mm); the largest inhibition zone was shown with CP and OF as 4.2 mm diameter against Staph albus, whereas the smallest inhibition zone is shown with AMC against *Staph aureus*. *Staph citrus* and E. coli, showed sensitivity towards all antibiotics tested except CF, AS, CX, AT and AMC which were resisted by both species i.e showed no zones of inhibition (0.0 mm); the largest inhibition zone was shown with CP as 6.0 mm diameter against Staph citrus, whereas the smallest inhibition zone is shown with FC against Staph aureus. Streptococcus species showed varied degrees of resistance ranging from no zones (0.0 mm) to 3.5mm in CP. Klebsiella and Shigella species were tested against some antibiotics, the largest inhibition zones were shown with GM, CP, OF, PR and PF as 4.0 mm against Shigella species and with GM, FR and OF as 3.7 against Klebsiella species. In both species, there were no inhibition zones with CF. whereas the smallest zone was with BA (1.0 mm) against Shigella species and (0.7 mm) with AS, BA and PR against Klebsiella species. As well, Salmonella Species and Pseudomonas species tested only against some antibiotics which showed alsoa range of inhibition zones: the largest zone was shown with CIP and AK against Pseudomonas species and with AK and IPM against Salmonella Species where the smallest zones were with GEN against Shigella species and with AMC against Salmonella Species as shown in table (4).

Table-1: Bacteria Isolated from 40 Swab Samples of Equine Wounds in East Nile Locality (October – December 2012)

Bacteria	Number tested	Number of positive	Percentage of Positive	95% CI	
				Lower	Upper
E. coli	40	4	10.0	0.70 - 19.30	
Salmonella species	40	6	15.0	3.93 - 26.07	
Pseudomonas species	40	5	12.5	2.25 - 22.75	
Shigella species	40	2	5.00	-1.75 - 11.75	
Staphylococcus aureus	40	16	40.0	24.82 - 55.18	
Staphylococcus epidermidis	40	16	40.0	24.82 - 55.18	
Staphylococcus citreus	40	10	25.0	11.58 - 38.42	
Streptococcus species	40	6	15.0	3.93 - 26.07	
Clostridium species	40	3	7.50	-0.66 - 15.66	
Klebsiella species	40	2	5.00	-1.75 - 11.75	

Table 2: Prevalence of Bacterial Species Isolated in the different Age Groups, Wound Sites, Animal Species and Locations in East Nile Locality (October – December 2012).

Risk factor	No. of tested samples	Number of Positive Samples and their Percentages (%)				
		E. coli	*Salmonella* species	*Pseudomonas* species	*Shigella* species	*Staph.aureus*
Age Groups						
1 - 5	17	4 (23.5)	3 (17.6)	3 (17.6)	1 (5.90)	8 (47.10)
6 - 10	21	0 (00.0)	3 (17.6)	2 (9.50)	0 (00.0)	19 (90.5)
< 10	2	0 (00.0)	0 (00.0)	0 (00.0)	1 (50.0)	0 (00.00)
Wound Site						
Sternum	8	1 (12.5)	0 (00.0)	0 (00.0)	2 (25.0)	3 (37.50)
Back	17	3 (17.6)	4 (23.5)	1 (5.88)	0 (00.0)	11 (64.7)
Body Sides	13	0 (00.0)	2 (15.4)	2 (15.4)	0 (00.0)	13 (100)
Ocular Area	2	0 (00.0)	0 (00.0)	2 (100)	0 (00.0)	0 (00.00)
Animal Species						
Donkey	33	4 (12.1)	5 (15.2)	5 (15.2)	2 (6.10)	21 (63.6)
Horse	7	0 (00.0)	1 (14.3)	0 (00.0)	0 (00.0)	6 (85.70)
Location						
Kuku	18	3 (16.7)	4 (22.2)	3 (16.7)	0 (00.0)	11 (61.1)
Wehda	22	1 (4.50)	2 (9.10)	2 (9.10)	2 (9.10)	16 (72.7)

Table-3: Prevalence of Bacterial Species Isolated in the different Age Groups, Wound Sites, Animal Species and Locations in East Nile Locality (October – December 2012).

Risk factor	No. of tested samples	Number of Positive Samples and their Percentages (%)				
		Staph. epidermidis	*Staph. citreus*	Streptococcus species	Clostridium species	Klebsiellaspecies
Age Groups						
1 - 5	17	9 (52.9)	4 (23.5)	3 (17.6)	1 (5.9)	1 (5.90)
6 - 10	21	6 (28.6)	5 (23.8)	2 (9.50)	2 (9.5)	0 (0.00)
< 10	2	1 (50.0)	1 (50.0)	1 (50.0)	0 (0.0)	1 (50.0)
Wound Site						
Sternum	8	5 (62.5)	2 (25.0)	1 (12.5)	0 (0.00)	2 (25.0)
Back	17	8 (47.1)	6 (35.2)	1 (5.88)	0 (0.00)	0 (0.00)
Body Sides	13	1 (7.70)	2 (15.4)	2 (15.4)	2 (15.4)	0 (0.00)
Ocular Area	2	2 (100)	0 (00.0)	2 (100)	1 (50.0)	0 (0.00)
Animal Species						
Donkey	33	12 (36.4)	7 (21.2)	5 (15.2)	3 (9.09)	2 (6.10)
Horse	7	4 (57.10)	3 (42.9)	1 (14.3)	0 (00.0)	0 (0.00)
Location						
Kuku	18	9 (50.0)	6 (33.3)	4 (22.2)	1 (5.60)	0 (0.00)
Wehda	22	7 (31.8)	4 (40.0)	2 (9.10)	2 (9.10)	2 (9.10)

Table-4: Susceptibility of isolates towards antibiotics

Antibiotic	*Staph aureus*	*Staph albus*	Klebsiala species	*Staph citrus*	*E. coli*	Shigella species	Streptococcus species	Salmonella species	Pseudomonas species
GM	3.7	3.6	3.7	4.0	4.0	4.0	0.0	-	-
CP	3.3	4.2	3.3	6.0	4.0	4.0	3.5	-	-
FR	3.3	3.8	3.7	4.5	4.0	3.0	1.0	-	-
OF	3.0	4.2	3.7	5.0	4.0	4.0	2.0	-	-
CF	0.7	0.0	0.0	0.0	0.0	0.0	0.0	-	-
AS	0.3	0.3	0.7	0.0	0.0	0.0	0.0	-	-
BA	1.0	0.8	0.7	1.5	1.0	1.0	0.0	-	-
PR	1.7	1.3	0.7	3.5	3.0	4.0	0.0	-	-
CX	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-	-
AT	0.3	3.0	-	0.0	0.0	-	3.0	0.5	2.0
CIP	3.9	3.6	-	3.9	3.5	-	3.8	3.4	4.0
CAZ	1.0	1.5	-	2.5	2.5	-	2.0	1.0	1.2
PI	1.7	2.0	-	2.5	2.5	-	0.0	1.5	1.4
AK	4.0	4.0	-	3.0	3.0	-	4.0	4.0	4.0
IPM	3.0	4.0	-	4.0	4.0	-	1.0	4.0	2.8
TE	1.3	1.7	-	0.5	1.0	0.0	1.0	1.5	2.4
E	2.8	2.7	-	2.4	2.5	-	2.9	2.2	2.0
AMC	0.1	0.2	-	0.0	0.0	-	0.1	0.2	0.0
GEN	3.5	2.5	-	3.3	4.0	-	2.1	3.2	1.0
VA	2.2	1.7	-	1.3	1.5	-	1.9	2.2	0.0
LM	3.0	2.1	2.0	1.3	1.0	3.0	0.0	-	-
C	3.2	3.0	-	2.3	2.5	-	2.6	2.8	3.6
P	1.2	0.7	-	1.4	1.0	-	0.6	1.2	0.0
PF	2.0	2.8	2.3	3.3	4.0	4.0	2.0	-	-
FC	1.4	0.3	-	0.3	1.0	-	0.4	-	-

- =was not performed

GM = Gemifloxacin (5 mcg), CP = Ciprofloxacin (5 mcg), OF = Ofloxacin (5 mcg), CF = Cefotaxime, AS = Ampicillin, GM = Gemifloxacin (5 mcg), CP = Ciprofloxacin (5 mcg), AS = Ampicillin/Sulbactam (30 mcg)., BA = Bactricin (10 mcg), CX = ceftizoxime (30 mcg), AT = Azithromycin (15 mcg), CIP = Cephalexin (30mcg), CAZ = cefazolib (30 mcg), PI = piperacillin (30 mcg), AK = Amikamicin (30 mcg), IPM = impenen (10 mcg), TE = Tiecarcillin (30 mcg), E = Erythromycin (15 mcg), AMC = Amoxacillin (30 mcg), GEN = Gentamicin (10 mcg), VA = Vancomycin (30 mcg), LM = Lincomycin, C = Cholaramphenicol (30 mcg), and P = Penicillin (10 unit).

Table-5:Antibiotic Resistance (MAR) Index of the Gram +ve and Gram –ve Bacteria Isolated from Equine Skin Wound in East Nile Locality (October – December 2012).

Isolate	No. of tested antibiotics	No. of resisted antibiotics	MAR Index
S. aureus	25	1	4.00
S. epidermidis	25	2	8.00
S.citreus	25	5	25.0
Streptococcus spp	25	7	28.0
E. coli	20	2	10.0
*Salmonella*spp	13	1	7.70
*Pseudomonas*spp	12	2	16.7
*Shigella*spp	12	5	41.7
*Klebsiella*spp	12	2	16.7

DISCUSSION

The present study was designed to investigate the bacterial associated with equine wounds at East Nile locality, Khartoum state. The study revealed 10 different species of aerobic and anaerobic bacteria namely: *Staphylococcus aureus*, *Staphylococcus epidermidis*, *Staphylococcus citreus*, Pseudomonas species, Streptococcus species, Pseudomonas species, *E. coli*, Clostridium species, Shigella species and Klebsiella species. These findings were in agreement with the findings of Mohammed [8]; Devrajani et al. [9], Fredrick and Ellie [10] and Mamman et al. [11], who isolated different species of aerobic and anaerobic bacteria from skin wounds of horses, donkeys and other domesticated animals.

Similar to the findings of Mohammed [8], Staphylococcus species were the most prevalent bacteria encountered in equine wounds. *Staphylococcus aureu*s and *Staphylococcus epidermidis* were reported in 40.0% of the swab samples with a 95% CI ranging from 24.82 to 55.18 whilst *Staphylococcus citreus* was reported in 25.0% of the swab samples with a 95% CI ranging from 11.58 to 38.42. This finding could be related to the virulence factors of the Staphylococcus species; which are capable of secreting certain enzymes and toxins that encourage colonization of wounds and spread better than other competitive bacteria. Salmonella species and Streptococcus species were isolated from 15.0% of the swab samples with a 95% CI ranging from 3.93 to 26.07. This finding did confirm the findings of Devrajani et al. [9], Fredrick and Ellie [10] and Mamman et al. [11] who reported the same prevalence of Salmonella species and Streptococcus species in skin wounds of domestic animals. A plausible explanation of this moderate percentage may be due to the fact that Salmonella species and Streptococcus species usually cause non-invasive infections and are thus less severe with a variable number of the organisms found in the lesions. Pseudomonas species, E. coli, Clostridium species, Shigella species and Klebsiella species had a low prevalence. This finding supported the findings of Mohammed [8]Devrajani et al. [9], Fredrick and Ellie [10] and Mamman et al. [11] who also reported the low prevalence of these bacteria in skin wounds of equines. This might be due to the competitive inhibition of these bacteria by other more virulent organisms (Staphylococcus spp.) or the defensive mechanisms of the animals and micro-environment of the wound inhibited their propagation.

Wound infection is probably associated with age because in present investigation more prevalence was encountered in the age group of 1 - 5 years old. This finding was parallel to that made by Mohammed [8], Pratt [12] and Mamman[11]. They reported that the age group of 1 - 5 years old, sometimes up to 7 years old, is the most susceptible age group to skin injuries and infection by *Corynebacterium pseudotuberculosis* and other bacterial isolates but adult equines of any other ages could also be affected. Conceivably, this could be attributed to the high level of activity of this age group leading to skin injuries that can be contaminated with a variety of micro-organisms.

Skin injuries and contaminating micro-organisms were mostly observed in the back area and the two sides of the abdomen. This finding agreed with Mohammed [8], and a possible elaboration to this finding could be due to the fact that the back and the two sides of the abdomen are covered with the saddle and harness for long periods during the day. The skin over these areas becomes macerated by the profuse sweating resulting from strenuous work during the warm hours of the day which leads to abrasion and damage of skin barriers. The continuous abrasive movement of poor saddles and harnesses caused wounds in these devitalized areas. The added effect of the increased warmth of these covered areas would result in deprivation of enough current of air and exacerbate the condition and provide an excellent skin wound micro-climate highly conducive for the propagation of bacteria. Management practices and the variation of the number of tested samples might have resulted in the higher susceptibility of donkeys compared to horses with almost the similar infection rates in the two investigated areas. The results obtained were in contrast to the findings of Mohammed [8], who observed no significant difference between donkeys and horses and between localities (Khartoum, Omdurman and Khartoum North).

Tiwari et al. [24] indicated that there was no single antibiotic effective against all of the bacteria isolated from wounds and antibiotic sensitivity pattern of most of the bacteria revealed resistant against one or multiple drugs. The same was observed in the present study with *Shigella*species being the most resistant bacteria and *S. aureus* the most susceptible. Gatifloxacin, sparfloxacin, amikacin, chloramphenicol and gentamicin were highly sensitive against most of the cases in the study of Tiwari et al. [24], whereas in the present study,CP, AK, CIP, and IPM showed high efficiency against almost all of the isolates.The isolated bacteria were less sensitive to erythromycin, colistin, cefotaxime, enrofloxacin, vancomycin, tetracycline, ceftriaxone, clindamycin, streptomycin, and kanamycin, and were resistant to ampicillin, amoxycillin, ampicillin/sulbactum, methicillin and norfloxacininin most of the cases[24]. Herein, CF, AS, BA, CX and AMC were the least effective or totally ineffective antibiotics. Certain reasons or factors could be behind acquiring new resistance and/or transmission of resistant strains among equines and other animalsin the Sudan.These maybe enumerated as follow: unideal storing conditions of veterinary drugs. Although, it is known that temperatures are very high in the country, drugs are kept in stores that do not have air conditions or any other cooling system all-over the year. Another factor might likely be the liberated uncontrolled selling of and tradingin drugs. An owner or a herder could buy any veterinary drug he/she wants with no restrictions. Consequently, irrational and indiscriminate (arbitrary) use of these drugs without being prescribed by a vet after reaching a final diagnosis. Moreover, since these owners, most often, are not aware of the correct route of drug administration, amount to be given (dose),and for how long a drug should be given, the final outcome might be magnifying the health problem of the animal and enhancing resistance development. Use of drugs after expiry date could should not be unconsidered.

CONCLUSIONS AND RECOMMENDATIONS

The current investigation led to the conclusion that Staphylococcus species were the most

prevalent bacteria in the equine wounds in East Nile (Sharg-Alneel) locality. It was also concluded that wound infection was associated with age and donkeys were more susceptible to wound infections than horses with similar infection rates in the two investigated areas. It was recommended that more intensive researches on equine bacterial wound infections are warranted, and saddles and harnesses used for draught animals should be improved.

The study showed that all of the isolated bacteria from equine skin wounds in this study were either having mono-drug or poly-drug resistance. Clinical wound cases could effectively be treated by CP, AK, CIP, and IPM, while on the other hand, the use of CF, AS, BA, CX and AMC is not recommended.

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