Journal of Population Therapeutics & Clinical Pharmacology

RESEARCH ARTICLE
DOI: 10.53555/25cq6h98

PIN-SITE CARE WITH MEDI-HONEY™ VERSUS POVIDONE IODINE GAUZE-BASED DRESSINGS AT UNIVERSITY COLLEGE HOSPITAL, IBADAN NIGERIA: ANY DIFFERENCE IN ANTI-BACTERIAL EFFECTS?

Adeoye Allen-Tayloy[1], Aliu Olalekan Olatunji[2*], Adeola Fowotade[3], Morhasonbello Jemiludeen[4]

[1]Medical Doctor, University college Hospital, Ibadan, Nigeria
Email: deoyeallentaylor@gmail.com
[2*]Medical Doctor, University college Hospital, Ibadan, Nigeria
Email: aliu_my2004@yahoo.com
[3]Medical Doctor, University college Hospital, Ibadan, Nigeria
Email: temilabike@gmail.com
[4]Medical Doctor, University college Hospital, Ibadan, Nigeria
Email: morhasonbelloj@yahoo.com

***Corresponding Author:** Aliu Olalekan Olatunji
*Aliu_my2004@yahoo.com

ABSTRACT

Background: This research aimed at comparing the development of infections as well as the number and types of bacteria at the pin-site (area around small metallic rods used to treat fractures), comparing weekly pin site care with povidone iodine-soaked gauze versus weekly pin site care with a special type of honey (Medi-Honey™) in the Department of Orthopaedics and Trauma. To compare the incidence of pin site infection for the two intervention arms – the Medi-Honey and povidone iodine groups. Bacterial load at the pin-site five-days post-operation, the post-operative day that pin site infection was noted and grade of the pin site infection that may be observed.

Methodology: Fifty patients undergoing external fixation in the Department of Orthopaedics and Trauma, University College Hospital Ibadan, were recruited via block randomization into two intervention arms for this randomized clinical trial. A data spread sheet was filled to collect information on socio-demographic characteristics of the patients, type of pin device, part of the body, reasons for surgery, type of pin-site dressing, site of pin-to-skin interphase swab, types of bacteria, number of bacteria, the day first sign of pin-site infection was noticed as well as the number of pin-sites infected and their site. The information collated from the patients was analysed using statistical software SPSS 21.

Results: From this study Medi-Honey was found to have a reduced rate of pin site infection than povidone iodine, with a chi square value of 7.49 and a p value of 0.001, which is statistically significant.

Conclusion: The results showed that external fixator pins dressed with Medi-Honey™ had a lower infection rate and risk for infection than those dressed with povidone iodine.

Key words: External fixators, pin site care, pin site infection, leptospermum honey, povidone iodine

INTRODUCTION

External fixation is a modality of operative management in Orthopaedic Surgery that is used in the management of open fractures, stabilization of limbs after osteotomies and in the Ilizarov technique which is especially useful in deformity correction and limb lengthening[1–6].

The most common complication of external fixation is pin site infection, with incidence ranging between 11% and 96.6%. Studies have shown that infections usually occur at the interphase of the pin and the skin and then the pin track. Prevention of pin track infection is therefore essential. This has led to various methods being outlined for the control or prevention of this infection[7–13].

Pin site infection is relatively common; it was described as the most common complication following pelvic fractures treatment with external fixators in a recent systematic review and meta-analysis, with an incidence of 36%[14]. Aktugulu and colleagues also reported it as the most common complication following Ilizarov circular frame external fixation and an incidence rate of 46.6%[15]. Jansen and colleagues in 2020 also reported pin site infection as the most common complication following knee joint distraction for knee osteoarthritis, with an incidence of up to 70%[16], half pins placed in the distal femur and proximal tibia were used in this procedure to distract the knee joint. An incidence of 87.7% pin tract infection was reported from Kenya[17], Mohammed et al., used uniplanar external fixators. An incidence rate of 23.7% pin tract infection was reported from a Nigerian study[18], Ogbemudia et al… used tubular external fixators and the ilizarov frame in the patients recruited in the study.

Common microorganisms implicated from pin site infection cultures were gram positive cocci; including *Staphylococcus epidermidis* and *Staphylococcus aureus* according to Mahan et al., who also stated that 90.6 % of the pin site infections were due to *Staphylococcus epidermidis*, 37.5% due to *Staphylococcus aureus* and 9.4% due to *Escherichia coli*[31]. These microbes are common skin commensals as reported from similar works by Antoci et al., who also noted a common aetiology with 47.3% due to Staphylococcus aureus and 11.8% due to Staphylococcus epidermidis[12].

A Kenyan study by Mohammed et al., in 2017, on pin site infection after uniplanar external fixation of open fractures at Kenyatta National Hospital, reported that of the 42 bacterial culture results of the pin sites, 22 were caused by gram positive cocci, 19 by gram negative bacilli and 1 by multiple organisms[17]. None of the cultures grew gram negative cocci or gram positive bacilli[17]. They reported the commonest organism cultured as *Staphylococcus aureus*, followed closely by coagulase negative *Staphylococcus sp.*; being similar to studies done outside of Africa.

Different studies have been done to evaluate if pin site dressings affected the rate of pin site infection[19,24,25–28]. Lee[28] stated that polyhexamethylene biguanide dressings had lower rates of pin site infection as compared to dry dressings. Ogbemudia and colleagues[18] also stated that 5% silver sulphadiazine wound dressing had a reduced rate of pin site infection than dry dressings. Some other studies have also shown that silver sulphadiazine dressing when compared to dry gauze did not show any significant difference in the rate of pin site infection in patients who had tibial external fixation. Studies have also compared chlorhexidine-impregnated patch (Biopatch®), dry gauze and half strength hydrogen peroxide which showed that none of the dressing agents was superior to the other[19]. 10% Betadine gauze when compared with paraffin ointment in adult patients did not show any significant difference in infection rates[25].

Iodine has been used as an antimicrobial agent for many decades[29].The carrier polymer povidone, a synthetic which has no antimicrobial property but enhances the action of iodine by releasing iodine into the aqueous medium from the povidone iodine complex as the iodine is consumed in its germicidal activity. This formulation has made povidone iodine safer and more tolerable as compared to earlier formulations.

It has antimicrobial activity due to its ability to inhibit vital bacterial cellular mechanism and structures. It oxidises nucleotide fatty/amino acids in bacterial cell membrane, this leads to bacteria becoming denatured[30].It has been shown to be effective against bacteria, several viruses, fungi, spores, protozoa, and amoebic cyst when compared to other antiseptic like polyhexanide, chlorhexidine, octenidine and ethanol[29].

From studies done on bacterial resistance on cross resistance, it has showed that resistance and cross resistance has not been exhibited against iodine[31–33]. Some studies have stated that this cytotoxic effect is less in human wounds due to thicker skin with a more supportive matrix in the vascular network[32,34]. Studies have been conducted in pin site care, comparing povidone iodine with other agents like sodium hypochlorite 0.05%, chlorhexidine and normal saline[33]. These have showed reduced infection rates**.** Chan et al… stated that normal saline was as efficient as povidone iodine, as the difference in pin site infection was not statistically significant.
Medi-Honey™ is a monoclonal honey produced from the pollen of the Manuka tree, it is processed like any other honey. The final process of preparation is by sterilizing with gamma radiation. This is because studies have shown that there is a minimal risk of contamination with clostridium botulinum. This is because the clostridium botulinum spores can be found in the soil, air, dust, and raw agricultural products in our environment.

In comparing the activities of Medi-Honey™ with other forms of monoclonal honey [35]; other forms of honey derived from *Eucalyptus marginata* (Jarrah honey) were more effective against *Candida sp.* when compared to Medi-Honey™ which is not distinguishable from artificial honey.
It has anti-inflammatory, immune-boosting\ and broad-spectrum antibacterial action. This is due to both physical and chemical variables. Chemical properties includes presence Glucose oxidase, catalase, ascorbic acid, flavonoids, phenolic acid, carotenoid derivatives organic acids, maillard reaction products amino acids and protein are all believed to have antioxidant capabilities[36].
Active leptospermum honey is a monofloral honey derived from the Manuka tree in Australia and New Zealand, it has demonstrated antibacterial properties that has properties that has been demonstrated in vitro and its antibacterial effects is superior to others . A study done by Mayukh Bhattacharyya concluded that antimicrobial wound dressings were as effective as oral antibiotics[37].
The aim of the study is to see which agent reduces the bacteria load at the skin-pin interface where antibiotics would not really get to act, hence the need for comparing two agents that can be used as topical antimicrobial agents.

Methodology

Study type and sample size:

This study is a randomized controlled study. It involved two intervention arms; one arm had pin site care with povidone-iodine-soaked gauze (PI) and the other arm had pin site care with Medi-Honey™(MH). The study ran over a period of ten months from September 2020 to July 2021.

All patients were recruited from the Department of Orthopaedic and Trauma unit through the surgical outpatient and the emergency unit of the University College Hospital, Ibadan. Full ethical approval was obtained from the University of Ibadan/University College Hospital (UI/UCH) Health Ethical Review Committee and the ethical principles of confidentiality, beneficence, non-maleficence, and voluntariness was ensured. The UI/UCH ethics committee assigned number UI/EC/19/0602.

The estimated sample size derived from the formula is 44 participants. After adding 5 participants for a 10% attrition rate and dividing the resultant figure to the nearest ten, and divided equally between the two intervention arms, we got an estimated sample size of 25 participants per intervention arm and 50 participants for the whole study.
This study was delimited to the following participants:

Inclusion criteria:

All consenting patients undergoing external fixation procedures in the department for orthopaedic or traumatic indications

Exclusion criteria:
Patients with bleeding disorders, peripheral vascular disease, allergic to povidone iodine and honey, dementia or other cognitive disorders that might interfere with the pin sites and lastly, poorly controlled hypertension and diabetes mellitus as well as active smokers.
The incidence of pin site infection for the two intervention arms – the Medi-Honey and povidone iodine groups - was observed and compared with each other.

Bacterial load evaluation:
The bacterial load in the pin sites taken on the fifth post operation day for microscopy culture and bacterial count were noted. The pin site infections noticed on follow up were noted and graded using the Dahl Wire and Pin Site Classification and Treatment. The data obtained was evaluated to determine if there were any correlation between the bacteriological and the clinical findings.

Statistical Analysis:
Data collected was entered into a computer using Statistical Package for Social Sciences (SPSS) computer software version 21 and also analysed using SPSS. Continuous variables were presented as mean and standard deviation (±SD), while categorical variables were presented as frequency and percentages. Chi-square test (X^2) was used to compare proportions between groups. Independent t-test was used for comparison between groups as regards quantitative variables. Categorical variables were analysed with Chi square test; reported as Risk Ratios (RR) and 95% Confidence Intervals (95% CI) as appropriate for categorical data. All statistical tests were carried out at 5% significance level.

RESULTS
Fifty-five subjects were recruited and followed up subsequently. Two subjects developed adverse skin reaction to povidone iodine, three subjects were lost to follow-up (Missed one of the follow up appointments for change of wound dressings) and were excluded from the analysis. Fifty patients completed the follow up and were evaluated in the study.
A total of one hundred pins sites were evaluated for microbiology five days post operation, with a total of seven pin sites yielding growth on microscopy culture and bacterial count. A total of three hundred and twenty-eight pins' sites were evaluated over the four-week period with pin site infection in twenty-three pins. The twenty-three infected pins were found in ten patients, four patients in the Medi-Honey™ group and six patients in the povidone iodine group.

Table 1: Comparison of baseline characteristics between the groups

Variable	Arms		Total N (%)	χ^2	P-value
	Medi-honey (N=)	Povidone (N=)			
Age (years)					
<20	2(8.0)	2(8.0)	4(8.0)	5.03	0.17
20-29	1(4.0)	6(24.0)	7(14.0)		
30-39	6(24.0)	7(28.0)	13(26.0)		
≥40	16(64.0)	10(40.0)	26(52.0)		
Mean ± SD	41.64±14.15	35.96±12.02		1.53*	0.13
Gender					
Male	14(56.0)	18(72.0)	32(64.0)	1.39	0.24
Female	11(44.0)	7(28.0)	18(36.0)		
Height (cm)					
Mean ± SD	161.12±9.45	160.84±18.38	-	0.07*	0.95

Weight (kg) Mean ± SD	66.52±13.45	63.96±13.10	-	0.69*	0.50
BMI Mean ± SD	25.78±5.53 2.58±0.78	24.38±2.74 2.24±0.52	-	0.13* 0.82*	0.30 0.80

*t-test

Mean age of those in Medi-honey group was 41.64±14.15 years and 35.96±12.02 years in the povidone iodine group. There was male preponderance in Medi-honey™ group (56%) and povidone iodine group (72%); both groups were comparable in terms of height, weight and BMI (p value>0.05) as shown in table 1.

There were similarities in the pre-morbid conditions between the two groups (χ^2=1.14, p value=0.57), type of surgery (χ^2=1.10, p value=0.74), sites of surgery (χ^2=0.80, p value=0.85), number of pins (χ^2=5.12, p value=0.16), type of pin (χ^2=0.10, p value=0.75) and regions of bone pinned (p value=0.24) as shown in table 2.

Table 2: Selected characteristics between medi-honey group and povidone group

Variable	**Arms**		**Total N (%)**	**χ^2**	**P-value**
	Medi-honey (N=25)	**Povidone (N=25)**			
Pre morbid condition					
None	21(84.0)	21(84.0)	42(84.0)	1.14	0.57
Hypertension	3(12.0)	4(16.0)	7(14.0)		
Diabetes mellitus	0(0.0)	0(0.0)	1(2.0)		
Both	1(4.0)	0(0.0)			
Type of Surgery					
Mono-planar	19 (76.0)	18(72.0)	37(74.0)	1.10	0.74
External Ring fixator	6(24.0)	7(28.0)	13(26.0)		
Sites of Surgery					
Thigh	2(8.0)	3(12.0)	5(10.0)	0.80	0.85
Leg	17(68.0)	14(56.0)	31(62.0)		
Arm	2(8.0)	3(12.0)	5(10.0)		
Forearm	4(16.0)	5(20.0)	9(18.0)		
Number of pins					
2-5	10(40.0)	16(64.0)	26(52.0)	5.12	0.16
6-9	8(32.0)	7(28.0)	15(30.0)		
10-13	4(16.0)	2(8.0)	6(12.0)		
>13	3(12.0)	0(0.0)	3(6.0)		
Type of pin					
Half pins	18(72.0)	19(76.0)	37(74.0)	0.10	0.75
Tension wire	7(28.0)	6(24.0)	13(266.0)		
Regions of bone pinned					
Metaphysis	1(4.0)	0(0.0)	1(2.0)		0.24*
Diaphysis	1(4.0)	0(0.0)	1(2.0)		
Both	23(92.0)	25(100.0)	48(96.0)		

*Likelihood ratio

One infected pin site was observed in two patients in the Medi-honey™ group and one patient in the povidone-iodine group. Two patients (33.3%) each had 2 and 3 pin site infection respectively.

The only patient who had five pin site infections was in the povidone group. However, there were similarities in the proportion of pin site infection between patients in the Medi-honey™ group and povidone-iodine group (χ^2=1.67, p value=0.64) as shown in table 3.

Table 3: Proportion of pin site infection in patients between external fixator pins dressed with povidone iodine-soaked gauze versus Medi-Honey™

Variable	Arms		Total N (%)	χ^2	P-value
	Medi-honey (%)	Povidone (%)			
Number of infected pins					
1	2(50.0)	1(16.7)	3(30.0)	1.67	0.64
2	1(25.0)	2(33.3)	3(30.0)		
3	1(25.0)	2(33.3)	3(30.0)		
5	0(0.0)	1(16.7)	1(10.0)		

Out of the total 328 pins, 23 pins were infected bringing the percentage infection rates for all the pins to 7.01%. In the Medi-honey™ group, the total percentage of infected pins was 3.70% while it was 11.51% in the povidone group table 4.

Table 4: Pin sites between external fixator pins dressed with povidone iodine-soaked gauze versus Medi-Honey™

Variable	Arms		Total N (%)	χ^2	P-value
	Medi-honey (%)	Povidone (%)			
Pins					
Uninfected	182(96.30)	123(88.49)	305(92.99)	7.49	0.001
Infected	7(3.70)	16(11.51)	23(7.01)		
Total	189	139	328 (100)		

Pins dressed with Medi-honey™ had a significantly lower infection rate and risk for infection than those dressed with povidone iodine (RR=0.32, 95% CI= 0.14-0.76 (Table 5). Also, all the infected pins were both in the' metaphyseal and diaphyseal regions.

Table 5: Pin sites between external fixator pins dressed with povidone iodine-soaked gauze versus Medi-Honey™

Variable	Intervention Arm		Total N (%)	RR (95%CI)	P-value
	Infected (%)	Uninfected (%)			
Intervention Arm					
Medi-honey	7(3.70)	182(96.30)	189	0.32(0.14-0.76)	0.001
Povidone	16(11.51)	123(88.49)	139		
Total	23(7.01)	305(92.99)	328		

Further in figure 1 weekly pin site infection rates are shown. In the first week, 1 patient had 3 pin site infections. In the second week, 6 patients experienced pin site infection: 2 patients had 1 pin site infection and was in the povidone group, 3 patients (2 vs 1) in Medi-Honey™ group and povidone group respectively had 2 pin sites infection and one patient had 3 pin site infections and was in povidone group. In week 3, seven patients had pin site infections; one of the patients had five

pin site infections and was in the povidone group. In the fourth week, five patients had pin sites infection. Two patients had 1 pin site infection; one patient each had 2, 3 and 5 pin site infections respectively.

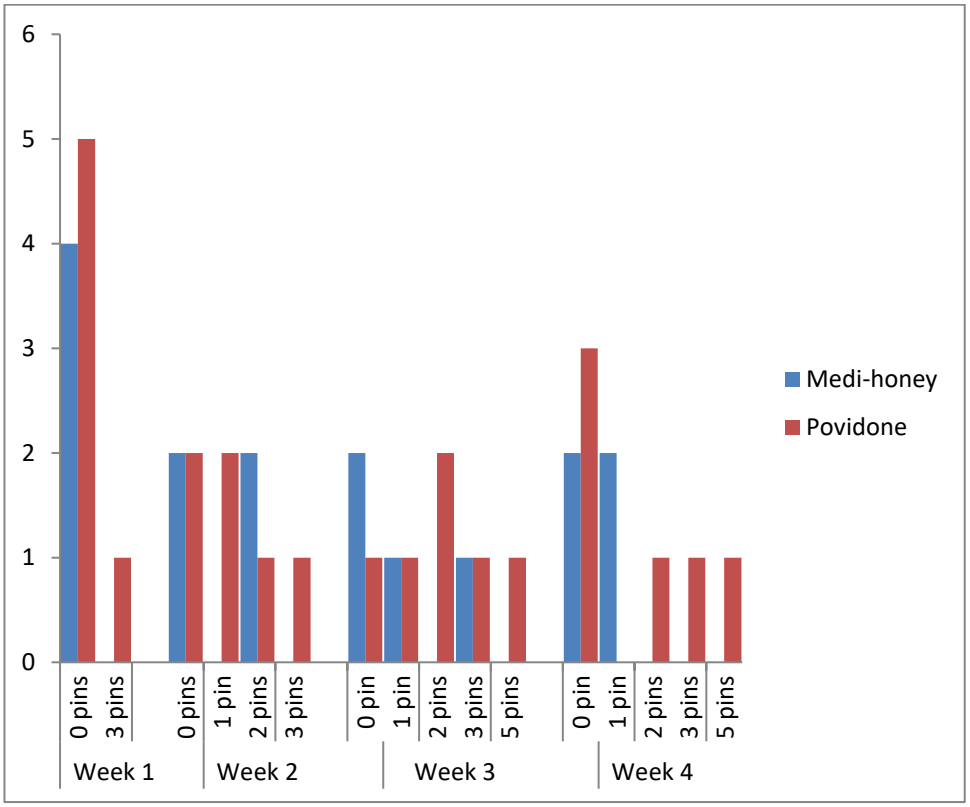

Figure 1: Weekly rate of pin site infections: shows the number of pin site infected per week with a total of twenty-three infected pin. The number of infected pins increased but did not reach the maximum infected number of pin sites as most of the patients improved as treatment was commenced as recommended by the Dahl Wire and pin site classification and treatment recommendations**.**

Microorganisms implicated from the cultures of pin site infection with povidone-iodine-soaked gauze versus Medi-Honey™ were gram positive cocci, which included 66.7% *Staphylococcus aureus* in the medi-honey group and 33.3% in the povidone group as shown on table 6. The other bacteria cultured was staphylococcus epidermidis.

Table 6: Comparison of organisms cultured from the pin sites dressed with povidone-iodine-soaked gauze versus Medi-Honey™

Variable	Intervention Arm		Total N (%)	χ^2	P-value
	Medi-honey (%)	Povidone (%)			
Type of Bacteria cultured					
Staph aureus	3(60.0)	2(40.0)	5(71.4)	-	1.0*
Staph epidermis	1(50.0)	1(50.0)	2(28.6)		

*Fisher' exact

Table 7 also shows no significant association between bacteria count and the kind of dressing care the patients had (χ^2=3.00, p value=0.22).

Table 7: Comparison of bacterial load obtained from pin sites dressed with povidone-iodine-soaked gauze versus Medi-Honey™

Variable	Arms		Total N (%)	χ^2	P-value
	Medi-honey (%)	Povidone (%)			
BACTERIA COUNT(CFU/mL)					
58	1(33.3)	0(0.0)	1 (16.7)	6.00	0.31
64	0(0.0)	1(33.3	1(16.7)		
72	0(0.0)	1(33.3)	1(16.7)		
94	1(33.3)	0(0.0)	1(16.7)		
112	1(33.3)	0(0.0)	1(16.7)		
126	0(0.0)	1(33.3)	1(16.7)		

There is no association between the bacteriological parameters and the clinical outcome. Four pin site swabs for M.C.S yielded a growth of Staphylococcus aureus and Staphylococcus epidermidis, showing that four pins that the pin site M.C.S yielded bacterial growth did not develop pin site infection. 3 pin sites swab for M.C.S also culture yielded growth later became infected. This shows that the likelihood of positive culture did not translate to clinical manifestation of pin site infection as shown in table 8.

Table 8: Association between bacteriological parameters and clinical outcomes

Variable	Bacteriological parameter		Total N (%)	χ^2	P-value
	Staph aureus (%)	Staph epidermidis (%)			
NUMBER OF INFECTED PINS					
0	2(40.0)	2(100.0)	4(57.1)		
1	1(20.0)	0(0.0)	1(4.3)	2.10	0.55
2	1(20.0)	0(0.0)	1(4.3)		0.42*
5	1(20.0)	0(0.0)	1(4.3)		

*Likelihood ratio

DISCUSSION

This study compared the pin site colonization (culture results and bacterial counts) rates between external fixator pin sites dressed with povidone iodine versus medi-Honey™. The mean age of the participants in the povidone iodine group and medi-Honey™ were 41years and 35 years respectively. The difference in the mean age was not statistically significant. This finding is at a variance with a similar study by Gulati et.al that compared the healing of chronic wounds with honey dressing vs povidone iodine dressing in adult subjects with chronic wounds[38,39]. The authors submitted that mean age was 42.27 years in the honey group and 42.95 years in the povidone iodine group; this suggesting an older population.

Majority of the patients in the present study were males. The male preponderance was expected as males are more involved in outdoor activities than females. Males also constitute an active and adventurous group that are more likely to be involved in accidents[40]. More males in the study can also be attributed to a greater exposure of male individuals to risk factors for trauma injuries such as accidents with motor vehicles and violence[41]. In addition, the number of men with access to

automobiles is higher than the number of women and more men work away from home than women, thus being more exposed to risky conditions[41]. Findings from the current study showed no significant differences in the baseline characteristics of patients in Medi-Honey™ group and those in povidone group. This was expected since the study was a randomized controlled trial and according to literature, the main goal of randomized trials is to ascertain that each individual has an equal probability to be assigned to one or the other treatment[42]. This is confirmed in the study as the participants had similar characteristics in both arms of the study at baseline. Furthermore, characteristics such as pre-morbid condition, type of surgery, sites of surgery, number of pins and type of pins were also similar in both arms of the study at baseline.

Pin site infection remains a challenge to many orthopedic surgeons. However, there have not been adequate comparative studies to provide good evidence for effective pin site care. The present study therefore compared the infection rate of external fixator pin sites using povidone iodine and medi-honey. The results showed that external fixator pins dressed with medi-honey had a lower infection rate and risk for infection than those dressed with povidone iodine and it was statistically significant. This may be due hygroscopic nature of honey which may absorb excess fluid from the pin site, as this is one of the properties of honey[37] which may have kept the pin site dry, as compared to povidone iodine. The overall incidence of pin tract infection was quite low at 7.01%. This is higher than a similar study done by Lazarides and colleagues who reported an incidence of 2.45% and the study involved 244 pin sites in 19 patients[48]. The incidence was also lower than that quoted by Parameswaran et al… of 11.2%. His study involved 285 patients in a level one trauma centre[9]. The incidence of pin tract infection reported in this study could be due to the fact that patients were closely monitored, they were giving specific instructions on what to do during follow up which would include; keeping the limb away from water and keeping the external fixators rigid. Majority of the patents had mono planar external fixators and were not bearing weight on the limbs which also translated to reduced activity in the affected limbs. However, the values were not as low as Lazirades et al[38]…, this may be attributed to the home environment that may have played a part. Kazmers and co-authors observed that excessive patient activity leads to increased pin irritation and infection and the authors also noted that traumatized skin is less resistant to infection[20]. Skin tension around a pin site has also been suggested to be associated with greater infection rates[22].

In the current study, it was also found out that the infected pins were both in the metaphyseal and diaphyseal regions. This is at variance with the results of Azer and colleagues, who found out that most of the infected pins in their studies, were in the metaphyseal region rather than diaphyseal region and the results were statistically significant[43]. This could be due to the fact that more pins were placed in the diaphysis as compared to the metaphysis in this study.

The present study has also shown that microorganisms implicated from the cultures of pin site infection with povidone-iodine-soaked gauze versus Medi-Honey were gram positive cocci, which included 66.7% *Staphylococcus aureus* in the Medi-honey™ group and 33.3% in the povidone group. This finding is comparable with other studies done by Antoci et al and Mahan et al…, who reported that *Staphylococcus aureus* was the commonest organism responsible for pin tract infection[12,23]. *Staphylococci* are recognised as the most frequent cause of biofilm-associated infection; their exceptional status among biofilm-associated pathogens is due to the fact that staphylococci are frequent commensal bacteria on human skin and mucus. They are thus among the most likely germs to infect any medical device that penetrates these surfaces, such as those being inserted during surgery[44]. The microbial count in this study however was not significant (less than the 100000 as above 100000 is termed as significant) as stated by the medical microbiologist.

Organisms cultured from the pin sites dressed with povidone-iodine-soaked gauze versus Medi-Honey™ in the present study revealed no significant association noted between the type of bacteria cultured and type of dressing care. This means that there is some evidence that Medi-Honey™ is as useful as povidone-iodine in decreasing pin site colonization. Further evidence to support the use of medi-honey as wound dressing comes from laboratory studies that have clearly demonstrated that

honey has bioactivities that would be beneficial in wound care. In work with cultures of leukocytes, honey has been shown to stimulate cytokine production by monocytes[45]. Stimulation by honey of other aspects of the immune response, the proliferation of B and T lymphocytes and the activity of phagocytes, has been shown[46]. Additional to this work with cells in culture, it has been demonstrated that honey stimulates the production of antibodies in mice in response to antigens from Escherichia coli[47]**.** These findings imply that the effectiveness of honey in preventing and clearing infection in wounds that is so widely seen as evidenced by clinical data may be attributable to an increase in the body's own immunity as well as honey's antibacterial action. One of the patients that defaulted by missing one of the weekly clinic reviews still had the pin sites on the left leg with no pin site infection. This may be due to the fact that the tibia has a subcutaneous medial border (where the pins were inserted), this may suggest that Medi-Honey dressing may still be effective after one week. This study also explored association between the bacteriological and clinical outcomes. Findings revealed no significant association between bacteriological parameters and clinical outcomes. This may be due to the fact the bacteria cultured in the microscopy culture and bacterial count were insignificant as the values obtained could be termed as contamination and not colonization as stated by the medical microbiologist.

CONCLUSION

The results showed that external fixator pins dressed with Medi-honey™ had a lower infection rate and risk for infection than those dressed with povidone iodine and it was statistically significant. The overall incidence of pin tract infection was quite low at 7.01%. Microorganisms implicated from the cultures of pin site infection with povidone-iodine-soaked gauze versus Medi-Honey™ were gram positive cocci, which included 66.7% *Staphylococcus aureus* in the Medi-Honey™ group and 33.3% in the povidone group. Findings from this study have also shown no significant association between bacteriological parameters and clinical outcomes.

References

1. Pape HC, Tornetta P, Tarkin I, Tzioupis C, Sabeson V, Olson SA. Timing of fracture fixation in multitrauma patients: the role of early total care and damage control surgery. *J Am Acad Orthop Surg*. 2009;17(9):541-549. doi:10.5435/00124635-200909000-00001
2. Marin LE, McBroom DB, Caban G. Percutaneous reduction and external fixation for foot and ankle fractures. *Clin Podiatr Med Surg*. 2008;25(4):721-732, x. doi:10.1016/j.cpm.2008.05.002
3. Pfahler M, Krodel A, Tritschler A, Zenta S. Role of internal and external fixation in ankle fusion. *Arch Orthop Trauma Surg*. 1996;115(3-4):146-148. doi:10.1007/BF00434542
4. Handelsman JE, Weinberg J, Razi A, Mulley DA. The role of AO external fixation in proximal femoral osteotomies in the pediatric neuromuscular population. *J Pediatr Orthop Part B*. 2004;13(5):303-307. doi:10.1097/01202412-200409000-00004
5. Bini A, Surace MF, Pilato G. Complex articular fractures of the distal radius: the role of closed reduction and external fixation. *J Hand Surg Eur Vol*. 2008;33(3):305-310. doi:10.1177/1753193408087092
6. Osman W, Alaya Z, Kaziz H, et al. Treatment of high-energy pilon fractures using the ILIZAROV treatment. *Pan Afr Med J*. 2017;27. doi:10.11604/pamj.2017.27.199.11066
7. Thakur AJ, Patankar J. Open tibial fractures. Treatment by uniplanar external fixation and early bone grafting. *J Bone Joint Surg Br*. 1991;73(3):448-451. doi:10.1302/0301-620X.73B3.1670447
8. Ahlborg HG, Josefsson PO. Pin-tract complications in external fixation of fractures of the distal radius. *Acta Orthop Scand*. 1999;70(2):116-118. doi:10.3109/17453679909011246
9. Parameswaran AD, Roberts CS, Seligson D, Voor M. Pin tract infection with contemporary external fixation: how much of a problem? *J Orthop Trauma*. 2003;17(7):503-507. doi:10.1097/00005131-200308000-00005

10. Mostafavi HR, Tornetta P. Open fractures of the humerus treated with external fixation. *Clin Orthop*. 1997;(337):187-197. doi:10.1097/00003086-199704000-00021
11. Schalamon J, Dampf S, Singer G, et al. Evaluation of fractures in children and adolescents in a Level I Trauma Center in Austria. *J Trauma*. 2011;71(2):E19-25. doi:10.1097/TA.0b013e3181f8a903
12. Antoci V, Ono CM, Antoci V, Raney EM. Pin-tract infection during limb lengthening using external fixation. *Am J Orthop Belle Mead NJ*. 2008;37(9):E150-154.
13. Ogbemudia AO, Bafor A, Ogbemudia EJ, Edomwonyi E. Efficacy of 1 % silver sulphadiazine dressings in preventing infection of external fixation pin-tracks: a randomized study. *Strateg Trauma Limb Reconstr*. 2015;10(2):95-99. doi:10.1007/s11751-015-0226-2
14. Stewart RG, Hammer N, Kieser DC. External fixation of unstable pelvic fractures: a systematic review and meta-analysis. *ANZ J Surg*. 2019;89(9):1022-1027. doi:10.1111/ans.15027
15. Aktuglu K, Erol K, Vahabi A. Ilizarov bone transport and treatment of critical-sized tibial bone defects: a narrative review. *J Orthop Traumatol Off J Ital Soc Orthop Traumatol*. 2019;20(1):22. doi:10.1186/s10195-019-0527-1
16. Jansen MP, Mastbergen SC, van Heerwaarden RJ, et al. Knee joint distraction in regular care for treatment of knee osteoarthritis: A comparison with clinical trial data. Farouk O, ed. *PLOS ONE*. 2020;15(1):e0227975. doi:10.1371/journal.pone.0227975
17. Mohammed RM, Atinga EO, Sitati FC, Gakuya EM. Pin tract infection after uniplanar external fixation of open fractures at a national, teaching and referral hospital. *East Cent Afr J Surg*. 2017;22(1):42. doi:10.4314/ecajs.v22i1.6
18. Ogbemudia AO, Bafor A, Edomwonyi E, Enemudo R. Prevalence of Pin Tract Infection: The Role of Combined Silver Sulphadiazine and Chlorhexidine Dressing. *Niger J Clin Pract*. 2010;13(3). https://www.ajol.info/index.php/njcp/article/view/59717
19. Egol KA, Paksima N, Puopolo S, Klugman J, Hiebert R, Koval KJ. Treatment of external fixation pins about the wrist: a prospective, randomized trial. *J Bone Joint Surg Am*. 2006;88(2):349-354. doi:10.2106/JBJS.E.00011
20. Kazmers NH, Fragomen AT, Rozbruch SR. Prevention of pin site infection in external fixation: a review of the literature. *Strateg Trauma Limb Reconstr*. 2016;11(2):75-85. doi:10.1007/s11751-016-0256-4
21. Davies R, Holt N, Nayagam S. The care of pin sites with external fixation. *J Bone Joint Surg Br*. 2005;87(5):716-719. doi:10.1302/0301-620X.87B5.15623
22. Wikenheiser MA, Markel MD, Lewallen DG, Chao EY. Thermal response and torque resistance of five cortical half-pins under simulated insertion technique. *J Orthop Res Off Publ Orthop Res Soc*. 1995;13(4):615-619. doi:10.1002/jor.1100130418
23. Mahan J, Seligson D, Henry SL, Hynes P, Dobbins J. Factors in pin tract infections. *Orthopedics*. 1991;14(3):305-308.
24. Patterson MM. Multicenter pin care study. *Orthop Nurs*. 2005;24(5):349-360. doi:10.1097/00006416-200509000-00011
25. Yuenyongviwat V, Tangtrakulwanich B. Prevalence of pin-site infection: the comparison between silver sulfadiazine and dry dressing among open tibial fracture patients. *J Med Assoc Thail Chotmaihet Thangphaet*. 2011;94(5):566-569.
26. Camilo AM, Bongiovanni JC. Evaluation of effectiveness of 10% polyvinylpyrrolidone-iodine solution against infections in wire and pin holes for Ilizarov external fixators. *Sao Paulo Med J Rev Paul Med*. 2005;123(2):58-61. doi:10.1590/s1516-31802005000200005
27. Grant S, Kerr D, Wallis M, Pitchford D. Comparison of povidone-iodine solution and soft white paraffin ointment in the management of skeletal pin-sites: A pilot study. *J Orthop Nurs*. 2005;9(4):218-225. doi:10.1016/j.joon.2005.09.005
28. Lee CK, Chua YP, Saw A. Antimicrobial gauze as a dressing reduces pin site infection: a randomized controlled trial. *Clin Orthop*. 2012;470(2):610-615. doi:10.1007/s11999-011-1990-z

29. Bigliardi PL, Alsagoff SAL, El-Kafrawi HY, Pyon JK, Wa CTC, Villa MA. Povidone iodine in wound healing: A review of current concepts and practices. *Int J Surg*. 2017;44:260-268. doi:10.1016/j.ijsu.2017.06.073
30. Kanagalingam J, Feliciano R, Hah JH, Labib H, Le TA, Lin JC. Practical use of povidone-iodine antiseptic in the maintenance of oral health and in the prevention and treatment of common oropharyngeal infections. *Int J Clin Pract*. 2015;69(11):1247-1256. doi:10.1111/ijcp.12707
31. Lachapelle JM, Castel O, Casado AF, et al. Antiseptics in the era of bacterial resistance: a focus on povidone iodine. *Clin Pract*. 2013;10(5):579-592. doi:10.2217/cpr.13.50
32. Niedner R. Cytotoxicity and sensitization of povidone-iodine and other frequently used anti-infective agents. *Dermatol Basel Switz*. 1997;195 Suppl 2:89-92. doi:10.1159/000246038
33. Chan CK, Saw A, Kwan MK, Karina R. Diluted povidone-iodine versus saline for dressing metal-skin interfaces in external fixation. *J Orthop Surg Hong Kong*. 2009;17(1):19-22. doi:10.1177/230949900901700105
34. Leaper DJ, Durani P. Topical antimicrobial therapy of chronic wounds healing by secondary intention using iodine products. *Int Wound J*. 2008;5(2):361-368. doi:10.1111/j.1742-481X.2007.00406.x
35. Motuma A abeshu, bekesho geleta. Medicinal Uses of Honey. *Biol Med*. 2016;8(2):279. doi:10.4172/0974-8369.1000279
36. Simon A, Sofka K, Wiszniewsky G, Blaser G, Bode U, Fleischhack G. Wound care with antibacterial honey (Medihoney) in pediatric hematology–oncology. *Support Care Cancer*. 2006;14(1):91-97. doi:10.1007/s00520-005-0874-8
37. Lazarides AL, Hamid KS, Kerzner MS. Novel Use of Active Leptospermum Honey for Ringed Fixator Pin Site Care in Diabetic Charcot Deformity Patients. *Foot Ankle Spec*. 2018;11(2):117-122. doi:10.1177/1938640017709907
38. Mandal MD, Mandal S. Honey: its medicinal property and antibacterial activity. *Asian Pac J Trop Biomed*. 2011;1(2):154-160. doi:10.1016/S2221-1691(11)60016-6
39. Gulati S, Qureshi A, Srivastava A, Kataria K, Kumar P, Ji AB. A Prospective Randomized Study to Compare the Effectiveness of Honey Dressing vs. Povidone Iodine Dressing in Chronic Wound Healing. *Indian J Surg*. 2014;76(3):193-198. doi:10.1007/s12262-012-0682-6
40. Adeyekun A, Obi-Egbedi-Ejakpovi E. Computerised tomographic patterns in patients with head injury at the university of Benin teaching hospital. *Niger J Clin Pract*. 2013;16(1):19. doi:10.4103/1119-3077.106717
41. Morgado FL, Rossi LA. Correlação entre a escala de coma de Glasgow e os achados de imagem de tomografia computadorizada em pacientes vítimas de traumatismo cranioencefálico. *Radiol Bras*. 2011;44(1):35-41. doi:10.1590/S0100-39842011000100010
42. Suresh K. An overview of randomization techniques: An unbiased assessment of outcome in clinical research. *J Hum Reprod Sci*. 2011;4(1):8-11. doi:10.4103/0974-1208.82352
43. Azer A, Mohamed HaA. Outcome of Pin Tract Care in Sudanese Patients Treated with Ilizarov. *Sci Acad Publ*. 2020;10(1):1-11. doi:10.5923/j.cmd.20201001.01
44. Cheung GYC, Rigby K, Wang R, et al. Staphylococcus epidermidis Strategies to Avoid Killing by Human Neutrophils. Gilmore MS, ed. *PLoS Pathog*. 2010;6(10):e1001133. doi:10.1371/journal.ppat.1001133
45. Tonks AJ, Cooper RA, Jones KP, Blair S, Parton J, Tonks A. Honey stimulates inflammatory cytokine production from monocytes. *Cytokine*. 2003;21(5):242-247. doi:10.1016/s1043-4666(03)00092-9
46. Abuharfeil N, Al-Oran R, Abo-Shehada M. The Effect of Bee Honey on the Proliferative Activity of Human B-and T-Lymphocytes and the Activity of Phagocytes. *Food Agric Immunol*. 1999;11(2):169-177. doi:10.1080/09540109999843

47. Al-Waili NS, Haq A. Effect of Honey on Antibody Production Against Thymus-Dependent and Thymus-Independent Antigens in Primary and Secondary Immune Responses. *J Med Food*. 2004;7(4):491-494. doi:10.1089/jmf.2004.7.491