

## Accepted Manuscript

Title: The short musculoskeletal functional assessment (SMFA) score amongst surgical patients with reconstructive lower limb injuries in war wounded civilians

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PII: S0020-1383(14)00487-2  
DOI: <http://dx.doi.org/doi:10.1016/j.injury.2014.10.003>  
Reference: JINJ 5901

To appear in: *Injury, Int. J. Care Injured*

Received date: 21-5-2014  
Revised date: 10-9-2014  
Accepted date: 4-10-2014

Please cite this article as: Teicher C, Foote NL, Ani AMKA, Alras MS, Alqassab SI, Baron E, Ahmed K, Herard P, Fakhri RM, The short musculoskeletal functional assessment (SMFA) score amongst surgical patients with reconstructive lower limb injuries in war wounded civilians, *Injury* (2014), <http://dx.doi.org/10.1016/j.injury.2014.10.003>

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1 Title: The short musculoskeletal functional assessment (SMFA) score amongst surgical patients  
2 with reconstructive lower limb injuries in war wounded civilians

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24 Conflicts of Interest and Sources of Funding: No authors have a conflict of interest. This  
25 retrospective analysis was fully funded by MSF-France.

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26

27 Abstract

28 Background/Objectives: The MSF program in Jordan provides specialized reconstructive  
29 surgical care to war-wounded civilians in the region. The short musculoskeletal functional  
30 assessment score (SMFA) provides a method for quantitatively assessing functional status  
31 following orthopedic trauma. In June 2010 the Amman team established SMFA as the standard  
32 for measuring patients' functional status. The objective of this retrospective study is to evaluate  
33 whether the SMFA scores can be useful for patients with chronic war injuries.  
34

35 Methods: All patients with lower limb injuries requiring reconstruction were enrolled in the  
36 study. Each patient's SMFA was assessed at admission, at discharge from Amman and during  
37 follow-up in home country. In the analysis we compared patients with infected versus non-  
38 infected injuries as well as with both high and low admissions dysfunctional index (ADI).

39 Results: Among infected patients, higher ADI correlated with more surgeries and longer  
40 hospital stay. Infected patients with ADI>50 required an average of 2.7 surgeries while those  
41 with ADI<50, averaged 1.7 operations ( $p=0.0809$ ). Non-infected patients with ADI>50 required  
42 an average of 1.6 operations compared to 1.5 for those with ADI <50 ( $p= 0.4168$ ).

43 Conclusions: The ADI score in our sample appeared to be useful in two areas: 1) hospital course  
44 in patients with infection, where a high ADI score correlated with longer hospital stays and  
45 more surgeries, and 2) prognosis, which was better for non-infected patients who had high ADI  
46 scores. A scoring system that predicts functional outcome following surgical reconstruction of  
47 lower limb injuries would be enormously useful.  
48

49 Key Words: Orthopedic Trauma, SMFA, Surgery, Humanitarian medicine

50

## 50 Introduction

51 Violence in the Middle East continues to contribute to civilian morbidity and mortality  
52 with lower limb trauma common in war injuries (2) (3). These injuries affect a young active  
53 population and surgical interventions, ranging from reconstruction to amputation, are often  
54 required to preserve this functional part of the society (5) (6). Surgical reconstruction of lower  
55 limb injuries in war-wounded civilians produces a range of functional outcomes that have a  
56 major impact on the patients' future. Patient prognosis is potentially predictable using a scoring  
57 system which would help guide decision-making concerning reconstruction compared to  
58 amputation thereby assisting in mitigating the challenges surrounding such medical  
59 decisions.(7) (8).

60 The Short Musculoskeletal Functional Assessment (SMFA) provides a method for  
61 quantitatively assessing functional status following orthopedic trauma via a self-evaluation tool.  
62 This self-reported health-status questionnaire is used for quantitatively assessing the functional  
63 status and treatment impact on patients affected by a broad range of musculoskeletal injuries.  
64 The SMFA was developed via the condensation of a previously designed and longer  
65 questionnaire, the musculoskeletal functional assessment (MFA). The SMFA has two parts: the  
66 Dysfunction Index, which detects elements of functional status, and the Bothersome Index,  
67 which allows patients to evaluate how bothered they are by specific functional challenges. The  
68 questionnaire aims to provide a standardized measure of the patient's physical limitations,  
69 which can serve for both individual patient management and community-based outcome,  
70 studies (1).

71 The Médecins Sans Frontières Operational Center Paris (MSF-OCP) program in Amman,  
72 Jordan is a tertiary care hospital and rehabilitation center provides specialized reconstructive  
73 surgical care to war-wounded civilians in the region (9). MSF has been performing  
74 reconstructive surgical care since August 2006 treating approximately 385 patients per year.  
75 The facility is located on the premises of the Jordanian Red Crescent Hospital (JRC). In June  
76 2010 the SMFA was adopted as the standard for measuring patients' functional status. The  
77 objective of this retrospective study is to evaluate whether the Admission Dysfunction Index  
78 (ADI), as determined by SMFA scores, is a useful prognostic tool for patients with chronic war  
79 injuries treated in the Amman facility.

80

## 81 Materials and Methods

82

### 83 Patient population

84 Most patients seen at the MSF hospital had penetrating wounds at the initial injury and  
85 had undergone previous operations. Previous operations occurred primarily in Iraq (n=81) and  
86 were conducted by a variety of different structures with patients subsequently being referred  
87 for transport to the MSF program in Amman for specialized care. For all patients, there was a  
88 significant delay between initial injury and arrival in the Amman project. All patients with lower  
89 limb injuries requiring reconstruction were retrospectively selected to be included in this  
90 analysis (n=84). Patients were excluded if non-standard surgical procedures were required or if  
91 an infection was evident before the first surgery. If a patient had a known infection,  
92 reconstructive surgery occurred only after 6 months of clinical cure from infection.

93 Procedures and conditions included were based on the Military Extremity Trauma  
94 Amputation/Limb Salvage (METALS) Study and included one or more of the following: bone  
95 graft or bone transport, corrective osteotomy, arthrodesis, local or free flap coverage, complete  
96 deficit of a major nerve and a two staged approach for infected osteomyelitis (21).  
97 The reconstruction was done according to the algorithm shown in figure 1.

98

99 Administration of the SMFA questionnaire

100 The SMFA score questionnaire is based on 46 questions (10). Patients were divided into  
101 two main groups for analysis; those who had an admission dysfunctional index (ADI) greater  
102 than or equal to 50 and those having less than 50. This distinction separates those patients who  
103 report levels four and five (high difficulty to completely disabled) for all SMFA questions (total  
104 index will be 50 or greater) from those who answered all the questions with level 3 and less so  
105 that we are comparing the patients who came with severe dysfunction with those who  
106 presented with less dysfunction.

107 A previously validated Arabic version of the SMFA was not available at that time.  
108 Translation of the document was done by an Arabic-English translator and reverse translation  
109 was done by a second independent translator. A committee of local experts fluent in both  
110 languages reviewed the final document. Illiterate patients were interviewed by a health care  
111 provider who had no previous interactions with the patient and was not familiar with their  
112 clinical status.

113 SMFA score was documented for each patient at admission, discharge and during the  
114 follow up (in their home country). A standard formula was used to measure the dysfunctional  
115 and the bothersome indices for each of these periods (10). We divided each of the admission  
116 groups (over 50 ADI and less than 50) into infected and not infected. We made this division  
117 because the presence of osteomyelitis may affect the number of surgeries, complication rate,

118 and duration of stay for each patient (16) (9). It can also affect the follow up results in their  
119 home country.

120 Patients were discharged from the outpatient component of the project in Amman once  
121 they had: 1) no clinical or serological signs or symptoms of infection, 2) radiological studies  
122 demonstrating an early bridging callus; and 3) the ability to perform four basic activities of daily  
123 living, defined as being able to independently use the toilet, stand to cook, bath, and dress (9).

124 After discharge to their home country all patients remained in follow up care by the MSF  
125 network of doctors. Patients were followed for union status, recurrence of infection and the  
126 follow up SMFA questionnaires. Bone union was reported if the patient had 1) radiologic  
127 evidence with bridging of the fracture by bone, callus, or trabecula, including three/four  
128 cortices and 2) clinical evidence with absence of pain or tenderness on palpation (11). Infection  
129 recurrence was defined as any two of 1) signs of inflammation with or without discharging  
130 wound, 2) C-reactive protein 10 mg/L or greater and 3) radiological imaging revealing  
131 sequestrum formation. Differences between the admission index and the final dysfunctional  
132 SMFA index were calculated for each patient.

133

134

135 Data Analyses

136 Each patient's SMFA was assessed at admission, at discharge from Amman and during  
137 follow-up in home country. The last follow-up questionnaire was in April 2012. In the analysis  
138 we compared patients with infected (infections found at surgery) versus non-infected injuries  
139 as well as with both high and low ADI.

140 All the patients had a deep bone culture during their surgeries regardless of  
141 presentation. Patients with a positive deep bone culture were considered infected. Any surgical  
142 complications that developed during a patient's stay in Amman were recorded as early surgical  
143 complications. The patients with an admission dysfunctional index greater than or equal to 50  
144 were recorded as 'over fifty ADI' while those with less than 50 were recorded as 'less than fifty  
145 ADI'. Data was analyzed using Stata 12 (StataCorp, College Station, Texas, USA).

146 Ethical Considerations

147 All patients presenting to the MSF facility in Amman were treated free of charge.  
148 Although individual patient data was included in the medical files of all patients, no ethnic or  
149 identifying information was encoded in the database and all analyses were conducted  
150 anonymously. As a part of program monitoring, this analysis was exempt from MSF's Ethical  
151 Review Board review. MSF received authorization to operate in Amman from the Ministry of

152 Health in Jordan via a Memorandum of Understanding. All patients provided written informed  
153 consent before all surgical procedures.

## 154 Results

155 There were 84 total patients included in this analysis admitted between February 2010  
156 and August 2012. All patients in this cohort were civilians with previous lower limb injuries; 75  
157 (89%) patients were male and 9 (11%) were female. For all patients in the cohort, the mean  
158 age was 32 years (n= 84, SD= 1.34). There was no difference between age and ADI categories  
159 (p=0.08) (Table 1).

160 Fifty six percent of all cases had positive cultures indicating osteomyelitis at their  
161 surgery. The mean admission bothersome index of those patients who had an over 50 ADI was  
162 different compared to patients with ADI less than 50 in both infected and non-infected patients  
163 (p<0.0001).

164 Among infected patients, higher ADI correlated with more surgeries and longer hospital  
165 stay. Infected patients with ADI>50 required an average of 2.7 surgeries than those with  
166 ADI<50, who averaged 1.7 operations (p=0.0809). Non-infected patients with ADI>50 required  
167 an average of 1.6 operations compared to 1.5 for those with ADI <50 (p= 0.4168).

168 For non-infected patients, the patients with over 50 ADI required an average of 1.6  
169 operations before transfer to their home country while those with a less than 50 ADI required  
170 an average of 1.5 operations/patient (p=0.4168). There was no difference in infected patients  
171 (p=0.0645) between the patients arriving with over 50 ADI requiring a longer period to achieve  
172 discharge conditions and the patients who came with less than 50 ADI. (Table 2).

173 Nonunion rate was higher in over 50 ADI both in infected and non-infected patients  
174 while recurrence of infection was seen only in infected patients. There was no difference  
175 between the over 50 and less than 50 ADI (p=0.7672) (Table 3).

176 In infected patients, the patients who had an over 50 ADI had a bigger difference  
177 between the admission and follow up dysfunctional index, with more improvement in function  
178 than those with less than 50 ADI (the mean difference was 22.1 and 6.4 respectively) but  
179 without statistical significance (p=0.1162) (Table 4). In these patients, the improvement in the  
180 bothersome index was similar in both groups, being 28 for those with less than 50 ADI and 22.7  
181 for those with more than 50 ADI (Table 5).

182 In non-infected patients, the findings were similar, with the patients who had an over 50  
183 ADI showing a bigger difference between the admission and follow up dysfunctional index,

184 compared with those with less than 50 ADI (the mean difference was 33 and 0.2 respectively)  
185 with statistical significance ( $p=0.004$ ). The improvement in bothersome index showed the same  
186 pattern with a statistically significant improvement for those who were admitted with an over  
187 50 ADI ( $p=0.0046$ ).

188

## 189 Discussion

190 The short musculoskeletal functional assessment score (SMFA) provides a method for  
191 quantitatively assessing functional status following orthopedic trauma. Its validity, reliability  
192 and responsiveness as well as its limitations have been previously reported (10) (12).

193 Limitations of this data relate to the small sample size, translation of the SMFA  
194 questionnaire into Arabic and to the data tool's reliance on patient self-reporting. In the  
195 project, the tool was translated into Arabic and then back translated into English because an  
196 already existing Arabic translation could not be found.

197 We report on surgical outcomes using SMFA among civilian victims of violence in the  
198 Middle East for more than two years (9). Among infected patients, we found those with a  
199 higher admission dysfunctional index also had an increase in the number of required surgeries,  
200 complication rates and the duration of stay.

201 However, the ADI did not predict relapse and union rate. Infection recurrence and union  
202 rate did not show a statistically significant correlation with ADI during the follow up in the  
203 home country for either infected or non-infected patients. Respecting the strict rules of  
204 management of infections as well as following the basics of reconstruction in all patients may  
205 lead to this outcome regardless of condition at arrival. This is consistent with a previous study  
206 that also showed a comparable union rate in reconstruction patients regardless of the infection  
207 status at arrival (9).

208 From this data we examined the relationship between the admission dysfunctional  
209 index (ADI) and surgical outcomes for reconstruction patients. This score can act as a general  
210 health related quality of life instrument reflecting many factors that affect function and patient  
211 satisfaction (12). On the other hand, many studies showed that it was difficult to show the  
212 exact cause of high SMFA scores before and after reconstruction. It is subject to variable factors  
213 reflected by the patients and their environment (13) (14). This study revealed that the admission  
214 bothersome index for both infected and non-infected patients was related to the high  
215 admission dysfunctional index reflecting more suffering and lack of acceptance for the  
216 circumstances of daily life.



217 To allow for comparison of our results for reconstructive surgery with those of the  
218 METALS study group we included patients whose surgeries corresponded to those on the  
219 METALS list (21). We acknowledge that there is a theoretical difference between this study and  
220 other studies dealing with similar injuries due to the fact that all our patients were civilians  
221 living in the Middle East, which may result in some differences in their functional and social  
222 demands.

223 The main interest for this paper was to find whether the dysfunctional and the  
224 bothersome indexes were improved relative to the functional index at admission for those  
225 patients who underwent lower limb reconstruction. The presence of the need for  
226 reconstruction in the lower limb after major trauma is by itself a poor prognostic factor for  
227 expecting the improvement in the functional index (15). Amputation is suggested as the best  
228 alternative in many studies (7) (8) but is called into question by many others. (16) (17) (18).

229 This study showed that the improvement in the dysfunctional and bothersome indexes  
230 differs between those patients who came with over 50 ADI and those with less than 50 ADI in  
231 both infected and non-infected patients, with better improvement for those patients who came  
232 with a higher index. This result was contrary to our expectations which were that those patients  
233 with higher dysfunctional index at admission will have worse outcome.

234 In infected patients with less than 50 ADI, the bothersome index improvement was not  
235 parallel to the improvement in functional index. We believe our findings were consistent with  
236 the findings of Pontsford, et al, O'Donnell, et al, and Belin, et al, (13) (14) (19) who correlated  
237 the final outcome to the psychological acceptance of the patient rather than the real functional  
238 improvement.

239 Leahy's study of amputation versus reconstruction showed that for both options the  
240 final outcome was a range of dysfunctional index of 20-30 (8). In our previous study we  
241 demonstrated the same findings (9). Sanders showed that after immediate treatment of closed  
242 fractures of lower limb by intramedullary nail (simple closed fracture) there was a comparable  
243 (25) mean dysfunctional index one year after surgery, demonstrating residual deficits in  
244 functional outcome (20). Our current study showed that the final index for all the patients  
245 regardless of their index at admission also lies within the range of 20-30 (higher for infected  
246 patients with over 50 ADI).

247 In both infected and non-infected patients with lower admission dysfunctional index, we  
248 could not improve the dysfunctional index more than the baseline. However, there is an  
249 argument to be made for proceeding with reconstruction to prevent future problems. For  
250 example, a patient having an unacceptable malunion may come with a low functional index and  
251 minimal disability. Correction of this misalignment would not be expected to create an

252 immediate difference in his dysfunctional index, but may prevent further disability in the  
253 future.

254 Patients with over 50 ADI, both infected and non-infected, showed an average  
255 improvement index of 22 and 33 points in dysfunctional index and 22 and 34 in bothersome  
256 index, respectively, with a statically significant improvement in the follow up dysfunctional and  
257 bothersome indexes for non-infected patients. The non-infected patients with higher ADI had  
258 the best improvement for both indexes in the follow up evaluation.

259 A scoring system that effectively predicts functional outcome following surgical  
260 reconstruction of lower limb injuries would be useful. The ADI score in our sample appeared to  
261 be instructive in two areas. The first being that in the hospital course of patients with infection,  
262 a high ADI score demonstrated a longer hospital stays and more surgeries. The second relates  
263 to prognosis (as defined by improvement in functional and bothersome indices) which was  
264 better for non-infected patients who had high ADI scores. This data suggests some  
265 considerations for the counseling of patients in addition to opening the door to further  
266 questions regarding this cohort.

267 The presence of infection and a high admission dysfunctional index is a combination  
268 that may lead to more surgeries, more complications and longer stay, with little likelihood of  
269 significant improvement in physical or social function. This information should be discussed  
270 thoroughly with the patients and may lead to better understanding in regards to why  
271 amputation is being clinically suggested. Both the infected and non-infected patients with less  
272 than 50 admission dysfunctional index can be counseled that they likely will not have a  
273 significant functional improvement.

274 The non-infected patients with high admission dysfunctional index showed the greatest  
275 improvement in functional and bothersome indexes and we believe reconstruction is especially  
276 beneficial for this group of war trauma victims. Retrospectively the SMFA has been a useful tool  
277 to evaluate this cohort and should be considered as part of an evaluation package when looking  
278 at outcomes in war wounded reconstructive surgical patients. We believe that further research  
279 is needed to be able to correlate SMFA data with definitive clinical treatment or prognostic  
280 indicators.

281

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335 C. Andersen, CDR Michael T. Mazurek, COL James R. Ficke, CDR John J. Keeling, COL Paul  
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340 Acknowledgements:

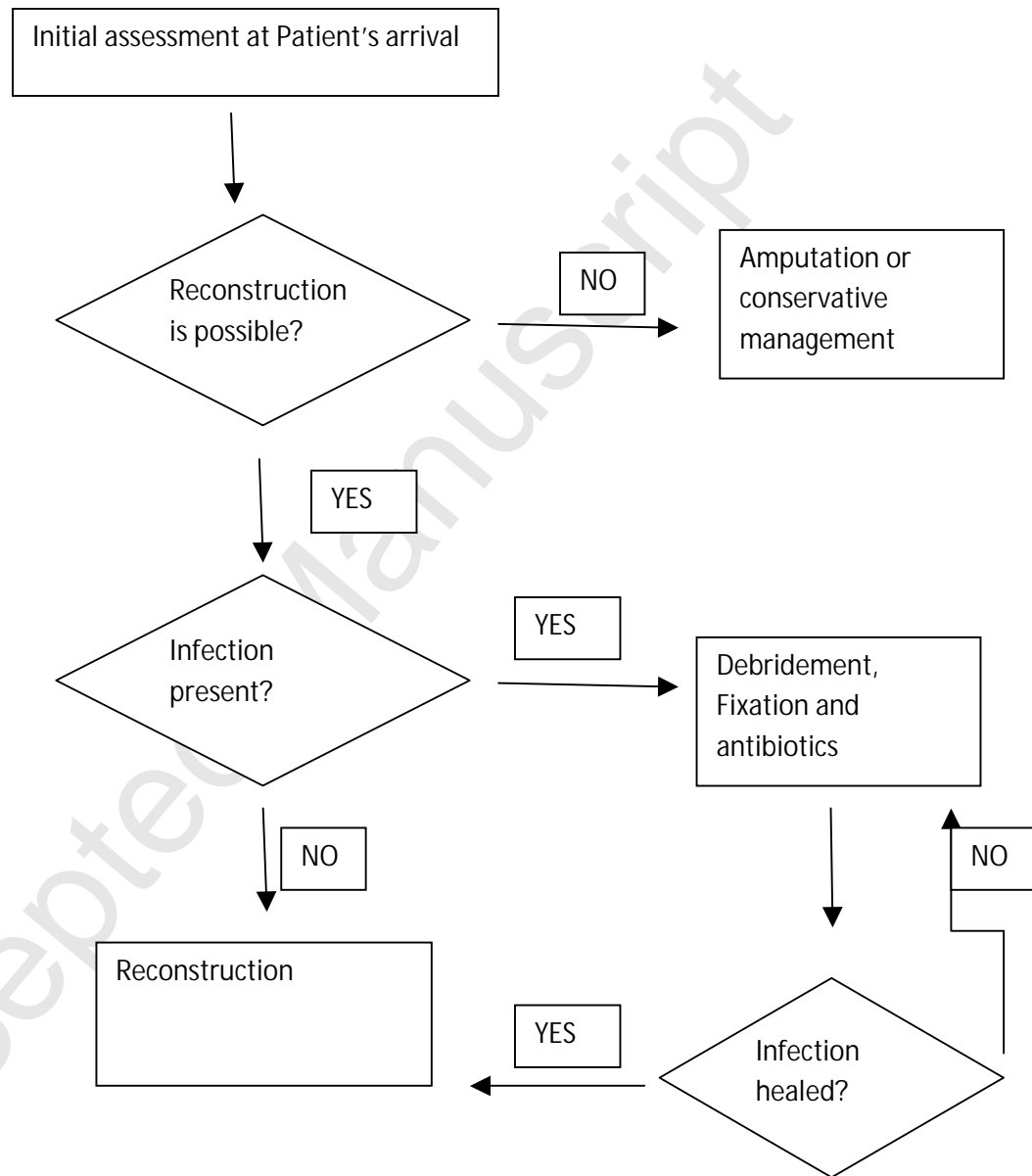
341 Médecins Sans Frontières Operational Center Paris (MSF-OCP) funded this study.  
342 Epicentre receives core funding from Médecins Sans Frontières public fundraising activities. The  
343 authors would like to acknowledge the MSF-OCP teams in Jordan and Iraq for their work in the  
344 field and would like to thank Patricia Kahn (MSF-USA) for her assistance on this manuscript.

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Figure One: Enrollment of Surgical Reconstruction Patients



**Table 5: Improvement in Bothersome Index by Infection Status and ADI**

Infection	ADI Group	Number of Patients	Admission bothersome index (mean, only for patients with follow-up information)
Infected patients (n=16)	ADI<50	10	43.8
	ADI $\geq$ 50	6	59.4
	Both	16	49.6
Non-infected patients (n=15)	ADI<50	9	26.2
	ADI $\geq$ 50	6	61.8
	Both	15	40.4

\* negative number indicates worse result at final

[

Follow-up bothersome index (mean)	Mean Difference	Mean Difference (95% Confidence Interval)		Test	p-value
15.8	28.0	5.5	50.4	Two sample t test for the mean of independent samples(equal variance), assuming normal distribution	0.7646
36.6	22.7	-15.2	60.7		
23.6	26.0	8.8	43.1		
34.6	-8.4	-27.5	10.7	Two sample t test for the mean of independent samples(equal variance), assuming normal distribution	0.0046
28.3	33.5	11.8	55.2		
32.0	8.4	-8.8	25.5		



**Table 4: Improvement in Dysfunctional Index by Infection Status and A.**

Infection Status	ADI Group	Number of Patients	Admission dysfunctional index (mean, only for patients with follow-up information)	Follow-up dysfunctional index (mean)
Infected patients (n=19)	ADI<50	13	31.2	24.8
	ADI≥50	6	56.6	34.6
	Both	19	39.2	27.9
Non-infected patients (n=15)	ADI<50	9	31.2	31.1
	ADI≥50	6	59.3	26.3
	Both	15	42.5	29.2

\* negative number indicates worse result at final

**DI**

Mean Difference	Mean Difference (95% Confidence Interval)		Test	p-value
6.4	-5.0	17.8	Two sample t test for the mean of independent samples(equal variance), assuming normal distribution	0.1162
22.1	1.0	43.1		
11.3	1.6	21.0		
0.2	-14.1	14.4	Two sample t test for the mean of independent samples(equal variance), assuming normal distribution	0.0043
33.0	14.9	51.2		
13.3	0.0	26.7		

**Table 3: Comparison at follow-up by Infection Status and ADI**

Infection		Infected patients (n=44)				
ADI Group		< 50 (n=29)	$\geq$ 50 (n=15)	Test	<i>p-value</i>	< 50 (n=23)
Union	Union	25 (86.2%)	12 (80.0%)	Chi-Square test (Fisher's exact test)	0.814	23 (100%)
	Mal union	2 (6.9 %)	1 (6.7%)			0 (0%)
	Non union	2 (6.9 %)	2 (13.3%)			0 (0%)
Infection recurrence		3 (10.3%)	2 (13.3%)	Two sample binominal proportion test	0.7672	0 (0%)

Non-infected patients (n=33)		
$\geq 50$ (n=10)	Test	<i>p</i> -value
9 (90%)	Chi-Square test(Fisher's exact test)	0.303
0 (0%)		
1 (10%)		
0 (0%)	N/A	N/A

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**Table 1: Comparison at admission by ADI**

ADI Group	< 50 (n=58)	≥ 50 (n=26)	<i>p</i> -value
Age (in years, mean)	30.6	35.6	0.0843
Duration of stay (in days, mean)	109.6	152.9	0.0554
Number of surgeries (mean)	1.6	2.2	0.0581
Early surgical complications*	16 (28.1%)	12	0.135
		(46.2%)	0.1061
Admission bothersome index (mean)**	32.2	60.2	<0.0001

**Table 2: Comparison at admission (by Infection Status and ADI)**

Infection	Infected patients (n=47)			Non-infected patients (n=37)		
	< 50 (n=32)	≥ 50 (n=15)	<i>p-value</i>	< 50 (n=26)	≥ 50 (n=11)	<i>p-value</i>
Age (in years, mean)	32.4	35.6	0.3893	28.4	35.6	0.1233
Duration of stay (in days, mean)	106.4	162.8	0.0645	113.4	139.4	0.2875
Number of surgeries (mean)	1.7	2.7	0.0809	1.5	1.6	0.4168
Early surgical complications*	12 (37.5%)	8 (53.3%)	0.3061	4 (16.0%)	4(36.4%)	0.1758
Admission bothersome index (mean)	39.9	61.9	0.0015	22.8	57.8	<0.0001

\*showing the number of patients WITHOUT early surgical complications, one missing value