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Incidence and risk factors for healthcare-associated infection among pediatric patients in a teaching hospital: a prospective study in southeast Ethiopia

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4 1 **Incidence and risk factors for healthcare-associated infection**
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6 2 **among pediatric patients in a teaching hospital: a**
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8 3 **prospective study in southeast Ethiopia**
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19 Abstract

20 **Objectives:** Healthcare-associated infections are harmful and costly and can result in
21 substantial morbidity and mortality for hospitalized children. In Ethiopia, data about the
22 occurrence of healthcare-associated infections among hospitalized pediatric patients are lacking.
23 Therefore, the study aims to determine the incidence and risk factors of healthcare-associated
24 infections among admitted pediatric in Ethiopia.

25 **Design:** A prospective study

26 **Setting:** A teaching hospital in southeast Ethiopia

27 **Participants:** 448 hospitalized pediatric patients admitted between November 1, 2018 and
28 June 30, 2019.

29 **Primary and secondary outcome measures:** Incidence and risk factors of healthcare-
30 associated infections.

31 **Results:** A total of 448 pediatric patients were followed for 3,227 patient days. The median age
32 of the patients was 8 months (interquartile range (IQR): 2-26 months). The incidence rate of
33 healthcare-associated infection was 17.7 per 1000 pediatric days of follow up while the overall
34 cumulative incidence was 12.7% (95% CI: 9.8-15.8) over eight months. Children who stayed
35 greater than 6 days (median day) [adjusted RR: 2.58, 95%CI (1.52-4.38), p-value< 0.001] and
36 children with underlying disease conditions of severe acute malnutrition [adjusted RR: 2.83, 95%
37 CI (1.61-4.97), p-value< 0.001] had higher risk of developing hospital-acquired infection.

38 **Conclusions:** The present study has revealed that healthcare-associated infections affected 13
39 in 100 admitted pediatric patients – which is a significant burden in the morbidity rate among
40 pediatric patients. Length of stay in the hospital and the presence of underlying diseases increase
41 the risk of developing a healthcare-associated infection. Avoiding unnecessary length of stay
42 could save lives and minimize the occurrence of healthcare-acquired infections.

43 **Keywords:** Nosocomial infection, Healthcare-acquired infection, Pediatric patients, Ethiopia

Strengths and limitations of this study

- To the best of our knowledge, this is the first prospective study to examine the incidence and risk factors of healthcare-associated infection among pediatric patients in Ethiopia
- Pediatric and neonates inpatients were recruited and followed-up
- The full burden of healthcare-associated infections could not be captured in this specific study as our study, was limited to in-hospital assessment only and leaving outpatients who may potentially develop an infection after discharge.

For peer review only

54 Introduction

55 There is a “perfect storm” on healthcare-associated infections (HAIs) among hospitalized
56 patients at any point in time throughout the globe. HAI is defined as an infection occurring in a
57 patient during the process of care in a hospital or other healthcare facility that is not manifested
58 or incubating at the time of admission¹. Currently, it is a growing public health problem that
59 concerns both the medical and the general community, and a rising issue for patient safety and
60 quality of care at every level²⁻⁸. About 80% of the patients with HAIs are died, directly or
61 indirectly connected to HAIs⁹. Available evidence also showed that financial burden, increased
62 resistance of microorganisms to antimicrobials, prolonged hospital stay, and sometimes deaths
63 are caused by HAIs^{10, 11, 12}.

64 Worldwide, it is estimated that hundreds of millions of patients every year, in both developed
65 and developing countries, are affected by HAIs⁷. In some Australian public hospitals, HAIs
66 affect one in every 74 hospitalizations¹³. In Europe, the total annual number of patients with HAI
67 in 2011–2012 was estimated at 3.2 million. The prevalence of patients with at least one HAI in
68 acute care hospitals was 6.0% (country range 2.3%–10.8%)¹⁴. Moreover, throughout Europe,
69 HAIs accounted for 16 million additional days with total costs estimated at approximately €7
70 billion^{14,15,16}. In the United States, approximately two million patients developed HAIs, and
71 nearly a hundred thousand of these patients were estimated to die annually. This ranked HAI as
72 the fifth leading cause of death in acute care hospitals and the risk of acquiring infection is 2 -20
73 times higher in some developing countries^{17,18}.

74 In some developing countries, the magnitude of HAIs remains underestimated and uncertain¹².
75 There is little information available on the epidemiology of HAI in African countries as well
76 ^{19,20}. Although data are sparse, evidence suggested that HAIs are considerably adding to the
77 available high burden of infections in some sub-Saharan African countries²¹. A systematic
78 review by Nejad et al reported the hospital-wide HAI prevalence in Africa varied between 2.5%
79 and 14.8%. This review has shown that published studies were only conducted in 10 African
80 countries – highlighted there were paucities of information available among the epidemiology of
81 HAI in many African countries¹⁹. In addition to this, a recent review by Irek et al (2018)
82 indicated that there was a scarcity of studies on HAIs in Africa – of the 35 eligible articles

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3 83 retrieved, more than half (n = 21, 60%) were from East Africa only ²⁰. In lieu of the paucity of
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5 84 data, most of the HAI literature just focused on adults, and data on HAIs among the pediatric
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7 85 population in sub-Saharan Africa are hardly available ^{15,19,22}. For example, a systematic review
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9 86 conducted by the World Health Organization (WHO) in the year 2010, identified no reports on
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11 87 pediatric nosocomial bacteremia in African countries between 1995 and 2008 ¹⁵.

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13 88 In Ethiopia, HAIs can result in substantial morbidity for hospitalized children; however, little is
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15 89 known about the incidence and prevalence of HAIs in the neonatal and pediatric populations.
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17 90 Also, previously conducted studies by far focused only on adults, and many of these were limited
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19 91 to surgical site infections ²³⁻²⁸, with an estimated prevalence of 10.9% ²⁴ to 66.5% ²⁷. And the
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21 92 overall incidence rate of 35.8 per 100 patients²⁶. Furthermore, the urinary tract and bloodstream
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23 93 infections were found to be the commonest forms of HAIs in Ethiopia ²⁹⁻³³.

24
25 94 To the best of our knowledge, there is no single currently available published report on the
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27 95 incidence and risk factors of HAIs among pediatric patients in Ethiopia. Therefore, this study
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29 96 was designed to determine the incidence and risk factors of HAIs among pediatric patients in
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31 97 Goba Referral Hospital, Southeast Ethiopia.

99 **Methods**

100 **Study design and setting**

101 A hospital-based prospective follow up study was conducted from November 1, 2018, to June
102 30, 2019, at Mada Walabu University Goba Referral Hospital, Southeast Ethiopia. Goba
103 Referral Hospital is the only referral and teaching hospital in the Bale zone, serving over
104 1,787,575 million people. Goba Referral Hospital is located 445 km far from the capital city
105 (Addis Ababa) of Ethiopia. According to the 2018 annual report of Goba Referral Hospital, the
106 average outpatient flow is over 96,661 and the annual admission is over 7,886 patients, of which
107 1,335 were admitted in the pediatrics ward and NICU. The hospital has a total of 127 inpatients
108 beds – of which 30 and 15 were in pediatrics and NICU, respectively.

109 **Study population and eligibility criteria**

110 All patients (age less than 18 years) admitted to the pediatric ward and neonatal intensive care
111 unit (NICU) were enrolled and those who at least stayed for 48 hours were eligible for the study.
112 Pediatric showed signs of infection and/or asymptomatic within the first 48 hours were excluded
113 from the study.

114 **Data collection procedures**

115 Data were collected using a structured questionnaire and checklist after written consent from the
116 parents/guardians was sought. Data were collected during the entire hospital stay of pediatric
117 patients. Accordingly, socio-demographic and clinical data were collected. Following this, a
118 detailed history from each patient was collected from available reports and the medical record
119 folders. Data were collected by trained general physicians and one pediatrician. The Center for
120 Diseases Control and Prevention (CDC)/ National Health Care Safety Network (CDC/NHSN)
121 Surveillance Definition for hospital-acquired infections were used³⁴. First, all patients were
122 followed for the first 48 hours and pediatrics who have developed any form of infection within
123 48 hours of admission were excluded from the study. All the rest of the pediatric patients were
124 followed until discharge for the occurrence of HAIs. HAIs were confirmed by senior physician
125 specialists working in the respective NICU and pediatrics ward. In this study, the use of any

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3 126 antimicrobials was recorded and information on different medical devices collected at the time of
4
5 127 hospital admission and before the diagnosis of HAIs, respectively (**S1 File**).

8 128 **Study variables**

10 129 The outcome variable of the study was the occurrence of healthcare-associated infections
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12 130 (HAIs). Presence of HAIs were confirmed when the patients met the criteria for signs and
13
14 131 symptoms determined by the Center for Disease Control and Prevention³⁴, wherein, the
15
16 132 independent variables included: socio-demographic characteristics (age of the child, sex, place of
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18 133 residence, and previous hospitalization), and clinical and other related variables (duration of
19
20 134 hospitalization, insertion of a urinary catheter, received anti-microbial, American Society of
21
22 135 Anesthesiology (ASA) classification, presence of central vascular catheter, presence of
23
24 136 peripheral vascular catheter, presence of peripheral intravenous line, intubation, surgery after
25
26 137 admission, underline disease, mechanical ventilator, and HIV status).

27 138 **Data processing and analysis**

30 139 Data were entered into Epi-data version 3.1 and exported to STATA version 14 statistical
31
32 140 software for further analysis. Descriptive statistics were computed to present the frequency
33
34 141 distribution of important variables. The incidence rate of HAIs was reported per 1000 patient
35
36 142 days. And cumulative incidence (incidence proportion) was calculated; it is the probability of
37
38 143 developing HAIs over a stated period. A Generalized Linear Model (GLM) was used to identify
39
40 144 the risk factors. An adjusted risk ratio (ARR) with a 95% confidence interval (CI) was used to
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42 145 determine the strength of association. A p-value < 0.05 was used to declare statistical
43
44 146 significance. Multicollinearity diagnosis was performed between categorical variables by looking
45
46 147 at values of variance inflation factor (VIF). The final model fitness was assessed by using the
47
48 148 Hosmer-Lemeshow goodness of fit test.

49 149 **Operational definition**

52 150 **Healthcare-Associated Infection (HAI)** - localized or systemic condition that results from an
53
54 151 adverse reaction to the presence of an infectious agent or its toxin and occurring 48 hours or
55
56 152 longer after hospital admission that was not incubating at the time of admission.

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3 153 **Severe Anemia** - haemoglobin <50 g/L (for patients older than 28 days) or haemoglobin <90 g/L
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5 154 (for neonates)

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8 156 **Late-Onset Neonatal Sepsis** - sepsis reported after 72 hrs. of admission.

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11 12 158 **Patient and public involvement**

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14 159 This research was done without patient involvement. Patients were not invited to comment on
15
16 160 the study design and were not consulted to develop patient relevant outcomes or interpret the
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18 161 results. Patients were not invited to contribute to the writing or editing of this document for
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20 162 readability or accuracy.

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166 **Results**

167 **Socio-demographic characteristics of the study participants**

168 A total of 487 pediatrics were enrolled in this study. However, 39 pediatric patients showed
169 signs of infection and/or asymptomatic within the first 48 hours and were excluded from the
170 study. The rest 448 pediatric patients were followed for the occurrence of HAIs until hospital
171 discharge, referred to other healthcare facilities or death. Of the total patients included in the
172 study, 201 (44.9%) were from the neonatal intensive care unit (NICU) and the remaining were
173 from the pediatric ward. Two hundred fourthly eight (55.4%) of the study participants were male
174 with an overall male-to-female ratio of 1.24: 1. The median age of the participants was 8 months
175 (interquartile range (IQR): 2-26 months). Three hundred and ninety (71.2%) of the study
176 participants were from rural areas. The median hospital stay of the patients was 6 days (IQR: 3-9
177 days) (**Table 1**).

178 **Clinical characteristics of patients**

179 In this study, 46 (10.3%) of the participants had a history of the previous hospitalization within
180 the last 30 days. An underlying disease condition, which is severe acute malnutrition (SAM) was
181 reported by 54 (12.1%) participants. Severe anemia was reported by 41 (9.2%) respondents.
182 Overall, one hundred and seventy-one (38.2%) patients received antimicrobial at the time of the
183 study (**Table 1**).

184 **Incidence and type of healthcare-associated infection**

185 During the study period, 448 pediatric patients were followed for a total of 3,227 patient days. A
186 total of 57 patients experienced HAI. The mean onset of HAIs in Goba referral hospital is 7.20
187 (95% CI: 6.72, 7.66) patient days. The overall incidence rate of HAIs was 17.7 per 1000
188 pediatrics days of follow up while the cumulative incidence was 12.7% (95% CI: 9.8-15.8) over
189 eight months. The mean length of stay for the infected pediatric patients was 11.5 days (95% CI:
190 9.5-13.4), while it was lower for the remaining patients at 6.5 days.

191 **Table 2** illustrates the proportion of HAIs among pediatrics in Goba referral hospital. Hospital-
192 acquired pneumonia was the most common type of HAI that was observed among pediatrics with
193 a proportion of 56.1% (95%CI: 43.9-68.4), followed by late-onset neonatal sepsis 10.5%
194 (95%CI: 3.5-19.3), and the least HAI observed was early onset of neonatal sepsis and surgical

195 site infections with an overall proportion of 1.8% each. In this study, the stratification of type of
196 HAIs by ward of admission revealed significant variability (p-value= 0.007) (**S3 File**).

197

198 **Risk factors of hospital-acquired infections**

199 **Table 3** showed the risk factors of HAIs among paediatric patients in Goba Referral Hospital.
200 HAIs were statistically associated with children's hospital duration, receiving antimicrobial
201 medications, presence of drainage tube, and presence of underlying diseases (SAM) in the
202 bivariate analysis.

203

204 In the adjusted model, the risk of HAIs was 2.58 times more likely to be higher among children
205 who stayed longer than or equal to 6 days (median day) than to those children who stayed less
206 [adjusted RR: 2.58, 95%CI (1.72-4.38)]. Patients with underlying disease conditions had 2.83
207 times higher risk of developing HAIs compared to their counterparts [adjusted RR: 2.83, 95% CI
208 (1.61-4.97)]. Socio-demographic and some clinically related confounders could not show any
209 statistically significant associations (**Table 4**).

211 Discussion

212 Healthcare-associated infections (HAIs) are a current global challenge with increased morbidity,
213 mortality and massive economic cost ³⁵⁻³⁹. Yet, there remain limited data on the occurrences of
214 HAIs in hospitalized pediatric in Sub-Saharan African, including Ethiopia. This study was
215 designed to determine the incidence and risk factors of HAIs among pediatric patients in a
216 teaching hospital, southeast Ethiopia. The overall incidence rate of HAIs was 17.75 per 1000
217 pediatrics days of follow up while the cumulative incidence was 12.7% (95% CI: 9.8-15.8) over
218 eight months. Children who stayed longer than the median day (6 days) in the hospital and
219 children with underlying disease conditions had higher risk of developing HAIs.

220 In this study, the risk of pediatrics HAIs was almost 18 per 1000 admissions. This finding is
221 lower than a related study by Ali et al (2018) from Southwest Ethiopia, which reports the
222 incidence of HAIs was 28.15 per 1000 patient days ³⁹. The difference might be associated with
223 the nature of this study which involved only pediatrics patients including those in intensive care;
224 however, a study by Ali et al includes adult study participants. Also, variation in studies could be
225 attributed to differences in geographical locations and the setting of studies (specialized
226 hospital). Our finding has also revealed that the overall cumulative incidence of HAIs was
227 12.7%; a finding which is comparable to those reported from the United States (11.9%) ³⁶, 11.2%
228 in Germany ³⁷, and (13.3%) in Poland ³⁸. Also, the present 12.7% of HAIs noted in our study
229 population fell in the ranges of 9.8-15.8% reported elsewhere ^{14, 40, 41} and the WHO pooled
230 estimated for low-income countries 10.1% ¹⁸. Conversely, other similar studies from Turkey
231 reported a much higher prevalence of HAIs ranging between 22.2 and 68.4% ^{42,43}, and in a
232 multicenter prospective study from Europe reported 18.5% ⁴⁴.

233 The present study also demonstrated that, the occurrence of HAIs was higher among male
234 participants (52.6%) than females. This result was also supported by other studies conducted
235 elsewhere ^{40, 45-47}. In the same vein, a study carried out by Luksamijarulkul et al in Thailand
236 found that an infection rate of males was almost double that of the females (24.6% and 12.9%),
237 respectively ⁴⁸.

238 The most common type of HAI observed in this study was hospital-acquired pneumonia (HAP),
239 which contributed to a proportion of 56.1% of the total HAIs. It may not be a surprise to see such

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3 240 a high proportion of HAI in the NICU and pediatrics ward since most of the patients admitted in
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5 241 intensive care are incapacitated and critical. Moreover, compared to adults, infants and neonates
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7 242 are immunologically immature, and in many cases, vulnerable ^{49,50}. The finding was similar to
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9 243 the study done in Tikur Anbessa Hospital, Ethiopia ³³. It is also true for other settings—in Iran
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11 244 43.7% ⁵¹, India 50% ⁵², Vietnam 41.9% ⁵³, Morocco 34.5% ⁵⁴, Saudi Arabia 46.7% ⁵⁵, 52.2%
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13 245 China ⁵⁶, and in a European multicenter prospective study 53% ⁴⁴. The high burden of HAP
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15 246 among hospitalized pediatrics has an important implication in terms of hospital length of stay,
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17 247 healthcare cost, and mortality. The overall mortality attributed to HAP has been as high as 30 to
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19 248 50% ⁵⁷.

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21 249 In this study, the risks of developing HAIs were three times higher among children who stayed
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23 250 longer than or equal to the median six days than their counterparts. This was correlated with the
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25 251 findings of Sarvikivi et al in Finland, who disclosed the overall hospitalization of >7 days and
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27 252 were found to be associated with an increased prevalence of HAI by 8% ⁵⁸. It is also consistent
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29 253 with several findings conducted in Ethiopia ²⁴ and studies conducted elsewhere ^{59, 60}. In our
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31 254 findings, the presence of underlying diseases such as SAM was recognized as the main risk
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33 255 factor for HAIs. This was consistent with the finding from another study in Ethiopia ²⁴
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35 256 underlying illnesses increased the susceptibility of patients, which predisposed them to infections
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37 257 secondary to the reduction of the patient's immune response that exacerbated the illnesses thru
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39 258 which in many cases had a significant factor that contributed more to the acquisition of HAIs in
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41 259 neonates and pediatric patients ^{41, 61, 62}.

42 43 44 45 46 47 48 49 50 51 52 53 54 55 56 57 58 59 60 260 **Limitations of the study**

261 Several limitations on this prospective study need to be considered. First, we did not assess the
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263 healthcare workers' infection prevention practices that would have been associated with the
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265 prevalence of HAIs. Second, the researchers did not examine the number of HAIs after the
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267 patients were discharged. Third, despite we followed patient until discharge the full burden of
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HAI could not be captured in this specific study as our study, was limited to in-hospital
assessment only and leaving outpatients who may potentially develop HAI after discharge. Since
the study was conducted in teaching referral hospital, generalization of the study findings is
limited to these facilities.

269 **Conclusions**

270 The present study revealed that HAIs had affected 13 in 100 admitted pediatric patients, which is
271 a major concern and burden in the morbidity rate of the community. And the overall incidence
272 rate of HAIs was 17.75 per 1000 pediatrics days. Prolonged hospital length of stay and the
273 presence of underlying diseases were predictors for HAIs. Avoiding unnecessary length of stay
274 could save lives and minimize the occurrence of healthcare-acquired infections.

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278 referral hospital staff, pediatric ward and NICU coordinators for their cooperation and support.

279 **Contributors**

280 BS has made substantial contributions to conception and design, acquisition of data, analysis and
281 interpretation of data. He has written the draft manuscript and provided final approval of the
282 version to be published. FS, DA, EN, GN, AK, DW, YT, DZ, and BJ has made substantial
283 contributions to design, acquisition of data and analysis, interpretation of data and revised the
284 article critically for important intellectual content and provided final approval of the version to
285 be published. All authors read and approved the final manuscript.

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289 collection, and analysis, decision to publish, or preparation of the manuscript.

290 **Competing interests**

291 The authors declare that they have no competing interests.

292 **Ethics approval**

293 Ethical clearance was obtained from the Ethical Review Committee of Madda Walabu
294 University (Ref.No: RMW 14/66/64) and a formal letter from Madda Walabu University
295 Research Community Engagement and Technology Transfer Vice President Office was

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3 296 submitted. Written consent from the parents/ legal guardians was obtained after explaining the
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5 297 objectives of the study. Identified pediatric patients having hospital-acquired infections were
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7 298 formally communicated to the physicians and nurses who were in charge of the patients for
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9 299 additional health care services. Throughout the data collection period, confidentiality and privacy
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11 300 of the patients were observed, and a unique identification code rather than their names were
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13 301 substituted.

14 302 **Data sharing statement**

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17 303 Data will be available upon request from the corresponding authors.
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References

1. Prevention of hospital-acquired infections: a practical guide. Geneva: World Health Organization; 2002.
2. Emerson CB, Eyzaguirre LM, Albrecht JS, Comer AC, Harris AD, and Furuno JP. Healthcare-Associated Infection and Hospital Readmission. *Infection control and hospital epidemiology: the official journal of the Society of Hospital Epidemiologists of America*. 2012;33(6):539-44
3. Bates DW, Larizgoitia I, Prasopa-Plaizier N, Jha AK. Global priorities for patient safety research. *BMJ* 2009; 338: b1775.
4. WHO. WHO Guidelines on Hand Hygiene in Health Care: a Summary. World Health Organization (WHO). 2009. Geneva, Switzerland,
5. Geffers C, Gastmeier P. Nosocomial infections and multidrug-resistant organisms in Germany: epidemiological data from KISS (the Hospital Infection Surveillance System). *Dtsch Arztebl Int*. 2011; 108(6):87–93.
6. Lul R. Prevention and Control of Hospital-Related Infections in Low and Middle Income Countries. *The Open Infectious Diseases Journal*. 2010; 4:125-131
7. Allegranzi B, Storr J, Dziekan G, Leotsakos A, Donaldson L & Pittet D. The First Global Patient Safety Challenge “Clean Care is Safer Care”: from launch to current progress and achievements. *Journal of Hospital Infection*. 2007; 65(s2):115–123.
8. Rosenthal VD, Maki DG, Mehta Y, Leblebicioglu H, Memish ZA, Al-Mousa HH, Balkhy H, Hu B, Alvarez-Moreno C, Medeiros EA, Apisarnthanarak A. International Nosocomial Infection Control Consortiu (INICC) report, data summary of 43 countries for 2007-2012. Device-associated module. *American journal of infection control*. 2014 Sep 1;42(9):942-56.
9. Sheng WH, Wang JT, Lin MS, Chang SC. Risk factors affecting in-hospital mortality in patients with nosocomial infections. *J Formos Med Assoc*. 2007;106(2):110—8.
10. Pittet D, Donaldson L. Clean Care is Safer Care: a worldwide priority. *Lancet* 2005; 366: 1246-7
11. Uwaezuoke S, Obu H. Nosocomial infections in neonatal intensive care facilities: cost-effective control strategies in resource-limited countries. *Nigeria Journal of Pediatrics*. 2013; 40(2): 125-132.

- 1
2
3 335 12. Allegranzi B, Pittet D. Preventing infections acquired during healthcare delivery. *Lancet*
4 336 2008; 372: 1719-20
5
6 337 13. Independent Hospital Pricing Authority (AU). Activity Based Funding Admitted Patient Care
7 338 2015-16, acute admitted episodes, excluding same day.
8
9 339 14. European Centre for Disease Prevention and Control (ECDC). Point prevalence survey of
10 340 healthcare associated infections and antimicrobial use in European acute care hospitals.
11 341 Stockholm: ECDC. 2013.
12
13 342 15. Allegranzi B, Bagheri S, Combescure C, Graafmans W, Attar H, Donaldson L et al. Burden
14 343 of Endemic Health Care-Associated Infection in developing countries: Systematic review and
15 344 meta-analysis. *Lancet*. 2011; 377: 288-241.
16
17 345 16. Shelley S, Walter H, Robyn K, Christine B, Bonnie B, et al. Prevalence of
18 346 Healthcare Associated Infections in Acute Care Hospitals in Jacksonville, Florida. *Infection*
19 347 control and hospital epidemiology. 2012; 33(3):283-91
20
21 348 17. Nelson S, Stone PW, Jordan S, Pogorzelska M, Halpin H, Vanneman M, Larson E. Patient
22 349 safety climate: Variation in perceptions by infection preventionists and quality directors.
23 350 *Interdisciplinary perspectives on infectious diseases*. 2011;2011.
24
25 351 18. World health organization (WHO). Infection prevention and control in health care: time for
26 352 collaborative action. Regional Committee for the Eastern Mediterranean. EM/RC57/6. WHO.
27 353 2010.
28
29 354 19. Nejad SB, Allegranzi B, Syed SB, Ellis B, Pittet D. Health-care-associated infection in
30 355 Africa: a systematic review. *Bulletin of the World Health Organization*. 2011;89:757-65.
31
32 356 20. Irek EO, Amupitan AA, Obadare TO, Aboderin AO. A systematic review of healthcare-
33 357 associated infections in Africa: An antimicrobial resistance perspective. *African journal of*
34 358 *laboratory medicine*. 2018;7(2):1-9.
35
36 359 21. Rothe C, Schlaich C, Thompson S. Healthcare-associated infections in sub-Saharan Africa. *J*
37 360 *Hosp Infect*. 2013;85(4):257-67
38
39 361 22. Zaidi AK, Huskins WC, Thaver D, Bhutta ZA, Abbas Z, Goldmann DA. Hospital-acquired
40 362 neonatal infections in developing countries. *Lancet* 2005; 365: 1175-88
41
42 363 23. Habte-Gabr E, Gedebo M, Kronvall G. Hospital-acquired infections among surgical patients
43 364 in Tikur Anbessa hospital, Addis Ababa, Ethiopia. *American journal of infection control*.
44 365 1988 Feb 1;16(1):7-13.

- 1
2
3 366 24. Mulu W, Kibru G, Beyene G, Damtie M. Postoperative nosocomial infections and
4 antimicrobial resistance pattern of bacteria isolates among patients admitted at Felege Hiwot
5 367 Referral Hospital, Bahirdar, Ethiopia. *Ethiopian journal of health sciences*. 2012;22(1):7-18.
6 368
7
8 369 25. Gedebeu M, Habte-Gabr E, Kronvall G, Yoseph S. Hospital-acquired infections among
9 obstetric and gynaecological patients at Tikur Anbessa hospital, Addis Ababa. *J Hosp Infect*.
10 370 1988;11(1):50–9.
11 371
12
13 372 26. Endalafer N, Gebre-Selassie S, Kotiso B. Nosocomial bacterial infections in a tertiary
14 hospital in Ethiopia. *J Infect Prev*. 2011;12(1):38–43.
15 373
16
17 374 27. Feleke T, Eshetie S, Dagneu M, Endris M, Abebe W, Tiruneh M, Moges F. Multidrug-
18 resistant bacterial isolates from patients suspected of nosocomial infections at the University
19 375 of Gondar Comprehensive Specialized Hospital, Northwest Ethiopia. *BMC research notes*.
20 376 2018 Dec;11(1):602.
21 377
22
23 378 28. Amenu D, Belachew T, Araya F. Surgical site infection rate and risk factors among obstetric
24 cases of Jimma University Specialized Hospital, Southwest Ethiopia. *Ethiopian journal of*
25 379 *health sciences*. 2011;21(2):91-100.
26 380
27
28 381 29. Melaku S, Gebre-Selassie S, Damtie M, Alamrew K. Hospital acquired infections among
29 surgical, gynaecology and obstetrics patients in Felege-Hiwot referral hospital, Bahir Dar,
30 382 northwest Ethiopia. *Ethiopian medical journal*. 2012 Apr;50(2):135-44
31 383
32
33 384 30. Messele G, Woldemedhin Y, Demissie M, Mamo K, Geyid A. Common causes of
34 nosocomial infections and their susceptibility patterns in two hospitals in Addis Ababa.
35 385 *Ethiop J Health Biomed Sci* 2009; 2: 3-8.
36 386
37
38 387 31. Melaku S, Kibret M, Abera B, Gebre-Sellassie S. Antibigram of nosocomial urinary tract
39 infections in Felege Hiwot referral hospital, Ethiopia. *African health sciences*.
40 388 2012;12(2):134-9.
41 389
42
43 390 32. Walelegn W, Abera K, & Feleke M (2016). Point prevalence of hospital-acquired infections
44 in two teaching hospitals of amhara region in Ethiopia. *Drug, Healthcare and Patient*
45 391 *Safety*.8:71-76.
46 392
47
48 393 33. Mikyas D, Sileshi L. The Prevalence of Nosocomial Infections and Associated Risk Factors
49 in Pediatric Patients in Tikur Anbessa Hospital. *Ethiopian Journal of Pediatrics and Child*
50 394 *Health*. 2008; 5(5):4-16.
51 395
52
53
54
55
56
57
58
59
60

- 1
2
3 396 34. CDC/NHSN. CDC/NHSN surveillance definition of health care-associated infection and
4 397 criteria for specific types of infections in the acute care setting. *Am Journal Infect Control*.
5 398 2008; 36:309-32.
6
7
8 399 35. Joram N, de Saint Blanquat L, Stamm D, Launay E, Gras-Le Guen C. Healthcare-associated
9 400 infection prevention in pediatric intensive care units: a review. *European journal of clinical*
10 401 *microbiology & infectious diseases*. 2012 Oct 1;31(10):2481-90.
11
12 402 36. Grohskopf LA, Sinkowitz-Cochran RL, Garrett DO, Sohn AH, Levine GL, Siegel JD, Stover
13 403 BH, Jarvis WR, Networka PP. A national point-prevalence survey of pediatric intensive care
14 404 unit-acquired infections in the United States. *The Journal of pediatrics*. 2002 Apr
15 405 1;140(4):432-8.
16
17 406 37. Ott E, Saathoff S, Graf K, Schwab F, Chaberny IF. The prevalence of nosocomial and
18 407 community acquired infections in a university hospital: an observational study. *Deutsches*
19 408 *Ärzteblatt International*. 2013 Aug;110(31-32):533.
20
21 409 38. Deptuła A, Trejnowska E, Ozorowski T, Hryniewicz W. Risk factors for healthcare-
22 410 associated infection in light of two years of experience with the ECDC point prevalence
23 411 survey of healthcare-associated infection and antimicrobial use in Poland. *Journal of Hospital*
24 412 *Infection*. 2015 Aug 1;90(4):310-5.
25
26 413 39. Ali S, Birhane M, Bekele S, Kibru G, Teshager L, Yilma Y, Ahmed Y, Fentahun N, Assefa
27 414 H, Gashaw M, Gudina EK. Healthcare associated infection and its risk factors among
28 415 patients admitted to a tertiary hospital in Ethiopia: longitudinal study. *Antimicrobial*
29 416 *Resistance & Infection Control*. 2018 Dec;7(1):2.
30
31 417 40. Askarian M, Yadollahi M, Assadian O. Point prevalence and risk factors of hospital acquired
32 418 infections in a cluster of university-affiliated hospitals in Shiraz, Iran. *Journal of infection*
33 419 *and public health*. 2012 Apr 1;5(2):169-76.
34
35 420 41. Olivier C, Kunneke H, O'Connell N, Von Delft E, Wates M, Dramowski A. Healthcare-
36 421 associated infections in paediatric and neonatal wards: A point prevalence survey at four
37 422 South African hospitals. *South African Medical Journal*. 2018;108(5):418-22.
38
39 423 42. Teke TA, Tanır G, Bayhan Gİ, Öz FN, Metin Ö, Özkan Ş. Clinical and microbiological
40 424 features of resistant gram-negative bloodstream infections in children. *Journal of infection*
41 425 *and public health*. 2017 Mar 1;10(2):211-8.
42
43
44
45
46
47
48
49
50
51
52
53
54
55
56
57
58
59
60

- 1
2
3 426 43. Atici S, Soysal A, Kadayifci EK, Karaaslan A, Akkoç G, Yakut N, Demir SÖ, Girgin Fİ,
4 427 Çulha G, Altınkanat G, Öztürk N. Healthcare-associated infections in a newly opened
5 428 pediatric intensive care unit in Turkey: Results of four-year surveillance. *The Journal of*
6 429 *Infection in Developing Countries*. 2016 Mar 31;10(03):254-9.
- 7 430 44. Raymond J, Aujard Y, European Study Group. Nosocomial infections in pediatric patients a
8 431 European, multicenter prospective study. *Infection Control & Hospital Epidemiology*. 2000
9 432 Apr;21(4):260-3.
- 10 433 45. Offner PJ, Moore EE, Biffl WL. Male gender is a risk factor for major infections after
11 434 surgery. *Archives of Surgery*. 1999 Sep 1;134(9):935-40.
- 12 435 46. Wałaszek M, Kosiarska A, Gniadek A, Kołpa M, Wolak Z, Dobroś W, Siadek J. The risk
13 436 factors for hospital-acquired pneumonia in the Intensive Care Unit. *Przegl Epidemiol*.
14 437 2016;70(1):15-20.
- 15 438 47. Ahmed M, Alam SN, Khan O, Manzar S. Postoperative wound infection: a surgeon's
16 439 dilemma. *Pak J Surg*. 2007 Jan;23(1):41-7.
- 17 440 48. Luksamijarulkul P, Parikumsil P, Oomsuwan VN. Nosocomial surgical site infection among
18 441 Photharam hospital patients with surgery: Incidence, risk factors and development of risk
19 442 screening form. *J Med Assoc Thai*. 2006; 89(1): 81-9.
- 20 443 49. Brady MT. Health care-associated infections in the neonatal intensive care unit. *American*
21 444 *journal of infection control*. 2005 Jun 1;33(5):268-75.
- 22 445 50. Saiman L. Risk factors for hospital-acquired infections in the neonatal intensive care unit. In
23 446 *Seminars in perinatology*. 2002 Oct 1; 26(5):315-321.
- 24 447 51. Behzadnia S, Davoudi A, Rezai MS, Ahangarkani F. Nosocomial infections in pediatric
25 448 population and antibiotic resistance of the causative organisms in north of iran. *Iranian Red*
26 449 *Crescent Medical Journal*. 2014 Feb;16(2).
- 27 450 52. Singh S, Chaturvedi R, Garg SM, Datta R, Kumar A. Incidence of healthcare associated
28 451 infection in the surgical ICU of a tertiary care hospital. *Medical journal armed forces India*.
29 452 2013 Apr 1;69(2):124-9.
- 30 453 53. Thu TA, Hung NV, Quang NN, Archibald LK, Harun-Or-Rashid M, Sakamoto J. A point-
31 454 prevalence study on healthcare-associated infections in Vietnam: public health implications.
32 455 *Infection Control & Hospital Epidemiology*. 2011 Oct;32(10):1039-41.

- 1
2
3 456 54. Razine R, Azzouzi A, Barkat A, Khoudri I, Hassouni F, Chefchaoui AC, Abouqal R.
4 457 Prevalence of hospital-acquired infections in the university medical center of Rabat,
5 458 Morocco. *International archives of medicine*. 2012 Dec;5(1):26.
- 8 459 55. Balkhy HH, Cunningham G, Chew FK, Francis C, Al Nakhli DJ, Almuneef MA, Memish
9 460 ZA. Hospital-and community-acquired infections: a point prevalence and risk factors survey
10 461 in a tertiary care center in Saudi Arabia. *International journal of infectious diseases*. 2006 Jul
11 462 1;10(4):326-33.
- 15 463 56. Le NK, Wertheim HF, Vu PD, Khu DT, Le HT, Hoang BT, Vo VT, Lam YM, Vu DT,
16 464 Nguyen TH, Thai TQ. High prevalence of hospital-acquired infections caused by gram-
17 465 negative carbapenem resistant strains in Vietnamese pediatric ICUs: A multi-centre point
18 466 prevalence survey. *Medicine*. 2016 Jul;95(27).
- 22 467 57. American Thoracic Society, Infectious Diseases Society of America. Guidelines for the
23 468 management of adults with hospital-acquired, ventilator-associated, and healthcare-
24 469 associated pneumonia. *American journal of respiratory and critical care medicine*. 2005 Feb
25 470 15;171(4):388.
- 29 471 58. Sarvikivi E, Kärki T, Lyytikäinen O, Finnish NICU Prevalence Study Group. Repeated
30 472 prevalence surveys of healthcare-associated infections in Finnish neonatal intensive care
31 473 units. *Journal of Hospital Infection*. 2010 Oct 1;76(2):156-60.
- 34 474 59. Sangrasi AK, Leghari AA, Memon A, Talpur AK, Qureshi GA, Memon JM. Surgical site
35 475 infection rate and associated risk factors in elective general surgery at a public sector medical
36 476 university in Pakistan. *International wound journal*. 2008 Mar;5(1):74-8.
- 39 477 60. Khaleid M, Haleim A, Zein K. ET: surgical site infections and associated risk factors in
40 478 Egyptian orthopedic patients. *J Am Sci*. 2010;6(7):272-80.
- 43 479 61. Shahunja KM, Ahmed T, Faruque AS, Shahid AS, Das SK, Shahrin L, Hossain MI, Islam
44 480 MM, Chisti MJ. Experience with nosocomial infection in children under 5 treated in an urban
45 481 diarrheal treatment center in Bangladesh. *Global pediatric health*. 2016 Mar
46 482 4;3:2333794X16634267.
- 49 483 62. Dramowski A, Whitelaw A, Cotton MF. Burden, spectrum, and impact of healthcare-
50 484 associated infection at a south African children's hospital. *Journal of Hospital Infection*. 2016
51 485 Dec 1;94(4):364-72.

487 **Table 1: Demographic and clinical characteristics of patients who participated in the study**
 488 **in Goba Referral Hospital, southeast Ethiopia 2019 (n=448)**

Variables	Category	Frequency	Percent
Age (months)	≤ 1	103	23.0
	2-5	77	17.2
	6-12	105	23.4
	13-24	51	11.4
	25-49	37	8.3
	> 49	75	16.7
Sex	Male	248	55.4
	Female	200	44.6
Ward	NICU	201	44.9
	Pediatrics	247	55.1
Resident	Urban	129	28.8
	Rural	319	71.2
Previous Hospitalization ^a	Yes	46	10.3
	No	402	89.7
Mechanical Ventilation	Yes	76	17.0
	No	372	83.0
Presence of Peripheral Intravenous Line	Yes	430	96.0
	No	18	4.0
Presence of Peripheral Vascular Catheters	Yes	9	2.0
	No	439	98.0
With Drainage	Yes	53	11.8
	No	395	88.2
Underlying Diseases ^b	Yes	54	12.1
	No	394	87.9
Surgery After Admission	Yes	47	10.5
	No	401	89.5
Patient Received Antimicrobials	Yes	171	38.2
	No	221	49.3
	Unknown	56	12.5
Severe Anemia	Yes	41	9.2
	No	375	83.7
	Unknown	32	7.1
HIV status	Positive	2	0.4
	Negative	393	87.7
	Not tested	53	11.8
American Society of Anesthesiology (ASA) Classification	Normally health patient	72	16.1
	Patient with mild systemic diseases	235	52.5
	Severe systemic disease that is not	100	22.3

	incapacitating		
	Incapacitating systemic diseases that is a constant threat to life	36	8.0
	Unknown	5	1.1

489 ^a History of the previous hospitalization for either the same as the current reason of admission or
 490 other ailments within the last 30 days

491 ^b Severe acute malnutrition (SAM)

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493 **Table 2: Proportion of healthcare-acquired infections among pediatric patients in Goba**
 494 **Referral Hospital, Ethiopia (n=57)**

Hospital-acquired infections	Number	Proportion	95% CI
Pneumonia/ Lower Respiratory Tract Infections/ ^a	32	56.1	43.9-68.4
Late-Onset Neonatal Sepsis	6	10.5	3.5-19.3
Intravenous Line (IV) Site Infections	5	8.8	1.8-15.8
Urinary Tract Infections	4	7.0	1.8-14.0
Systemic Infections	4	7.0	1.8-14.0
Skin/Soft Tissue Infections	2	3.5	0.0-8.8
Measles	2	3.5	0.0-8.8
Early Onset Neonatal Sepsis	1	1.8	0.0-5.3
Surgical Site Infections	1	1.8	0.0-7.0

495 ^a including ventilator-associated pneumonia in pediatrics patients

496

498 **Table 3: Factors associated with hospital-acquired infections among patients in Goba**
 499 **Referral Hospital, southeast Ethiopia 2019 (n=448)**

Variables	Category	Presence of HAIs		Crude RR	p-value
		Yes (57)	No (391)		
Sex	Male	30	218	0.88(0.55-1.45)	0.65
	Female	27	173	1	
Age (months)	1-12	33	252	0.78(0.48-1.28)	0.33
	>12	24	139	1	
Residence	Urban	12	117	0.65(0.36-1.20)	0.17
	Rural	45	274	1	
Hospital Duration	≤ 6	17	220	1	0.00
	> 6	40	171	2.64(1.54-4.51)*	
Admission Unit	NICU	27	174	1.10(0.68-1.79)	0.68
	Pediatrics	30	217	1	
Patient Received Antimicrobials	Yes	17	154	1	0.48
	No	27	194	1.22(0.69-2.17)	
	Unknown	13	43	2.33(1.21-4.50)*	
Previous Hospitalization	Yes	7	39	1.22(0.58-2.53)	0.59
	No	50	352	1	
Mechanical Ventilation	Yes	12	64	1.30(0.68-2.71)	0.38
	No	45	327	1	
Presence of Urinary Catheters	Yes	2	7	1.77(0.50-6.17)	0.38
	No	55	384	1	
With Drainage Tube	Yes	14	39	2.42(1.42-4.12)*	0.00
	No	43	352	1	
Underlying Diseases ##	Yes	13	41	2.15(1.24-3.73)*	0.00
	No	44	350	1	
Surgery After Admission	Yes	4	43	0.64(0.24-1.69)	0.36
	No	53	348	1	

500 ## Severe acute malnutrition (SAM); RR: Risk Ratio; * p-value< 0.05 (Crude)

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3 **502 Table 4: Multivariable logistic regression analysis on factors associated with hospital-**
4 **503 acquired infections among patients in Goba Referral Hospital, southeast Ethiopia 2019**
5 **504 (n=448)***

Variables	Category	Patient with HAIs (n=57)	adjusted RR	P-value
Hospital Duration	≤ 6	17	2.58(1.52-4.38)**	< 0.001
	> 6	40	1	
Patient Received Antimicrobials	Yes	17	1	0.430
	No	27	1.25(0.71-2.19)	
	Unknown	13	1.93(0.84-4.42)	
Drainage Tube Inserted	Yes	14	1.77(0.88-3.54)	0.107
	No	43	1	
Underlying Diseases##	Yes	13	2.83(1.61-4.97)**	< 0.001
	No	44	1	

24 505 *Hosmer and Lemeshow Test (p=0.166); RR: Risk Ratio; ** p-value < 0.05 (adjusted)

25 506 ## Severe acute malnutrition (SAM)

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510 **Additional Files**

511 **S1 File: English version of the survey questionnaire**

512 **S2 File: Different types of HAIs cross-tabulation with number of cases in the NICU and the**
513 **pediatric ward**

514

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Data collection tool

1. Patient ID/CODE _____
2. Ward _____ Bed number _____ MRN _____
3. Age _____
4. Sex _____
5. Residence A. Urban _____ B. Rural _____
6. Reason for admission/Dx at the time of admission _____

7. Complete admission diagnoses _____
8. Date of admission _____
9. Patient health condition at the time of admission

10. Is there any other localized infection? Yes No
11. If yes, type of treatment given _____
12. Previous hospitalization Yes No
13. If yes for question 14:
 - a. Place (including ward) _____
 - b. Time (month/year) _____
 - c. Duration _____
14. Previous antibiotic use for the current illness A. Yes _____ B. No _____
15. If yes for question 15, specify _____
16. If yes for question 15, for how many days? _____ days
17. Being on mechanical ventilator? A. Yes _____ B. No _____
18. Presence of intravenous line? A. Yes _____ B. No _____
19. Presence of urinary catheters? A. Yes _____ B. No _____
If yes, for how long _____
20. Indication for catheterization _____

1
2
3 21. Drainage inserted ? A. Yes _____ B. No _____

4
5 If yes, for how long _____

6
7 22. Indication for drainage _____

8
9 23. Presence of invasive medical devices? A. Yes _____ B. No _____

10
11 24. If yes for questions 20,21,22,26 (more than one answer is possible)

12 A. Endotracheal tube? A. Yes _____ B. No _____

13 B. NGT A. Yes _____ B. No _____

14 C. Chest tube A. Yes _____ B. No _____

15
16 25. Central vascular catheter A. Yes _____ B. No _____

17
18 26. Peripheral vascular catheter A. Yes _____ B. No _____

19
20 27. Peripheral intravenous line A. Yes _____ B. No _____

21
22 28. Urinary catheter A. Yes _____ B. No _____

23
24 29. Intubation A. Yes _____ B. No _____

25
26 30. Underlying diseases? A. Yes _____ B. No _____

27
28 31. If yes, underlying diseases (more than one answer is possible)

29 i. Diabetes mellitus vi. Cardiac disorders

30 ii. Chronic renal failure vii. Severe malnutrition

31 iii. Hypertension viii. TB

32 iv. Chronic liver disease ix. Cancer

33 v. HIV/AIDS x. Others (specify)

34
35 32. Surgery since admission A. Yes _____ B. No _____

36
37 33. Surgical procedure done? A. Yes _____ B. No _____

38
39 If yes for question 36,

40
41 A. Type of surgery A. Elective _____ B. Emergency _____

42
43 B. Type of the procedure _____

44
45 C. Date _____ Time _____

46
47 D. Duration of the surgery _____ hours

48
49 E. Type of surgical wound A. Clean B. Clean contaminated C. Contaminated D.

50
51 Dirty

52
53 34. Antibiotic prophylaxis given? A. Yes _____ B. No _____

54
55 If yes for Q36, specify/name of antibiotic _____

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3 If yes for Q36, how many doses? _____
4

5 35. Duration of stay hospital stay in days _____
6

7 36. Severe anaemia [haemoglobin <50 g/L (for patients older than 28 days) or haemoglobin
8 <90 g/L (for neonates)]
9

10 A. Yes _____ B. No _____ C. Unknown/not tested _____
11

12 37. Immune deficiency A. Yes _____ B. No _____ C. Unknown/not tested _____
13

14 38. Nutritional status WAZ score (Weight-for-age Z score) A. >-3 B. -3 to 4 C.<-4
15

16 39. Available hand washing material in ward A. Yes _____ B. No _____
17

18 40. Presence of medical waste container at room A. Yes _____ B. No _____
19

20 41. Available hand washing material in ward A. Yes _____ B. No _____
21

22 42. McCabe score

23 A. Non-Fatal diseases

24 B. Ultimately fatal diseases

25 C. Rapidly fatal diseases

26 D. Unknown
27
28

29 43. American Society of Anesthesiology (ASA) classification
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31 a. Normally health patient

32 b. Patient with mild systemic diseases

33 c. Patient with severe systemic disease that is not incapacitating

34 d. Patient with incapacitating systemic diseases that is a constant threat to life
35
36

37 e. Unknown
38

39 44. HIV status A. Reactive B. Non-reactive C. Unknown
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41 45. Presence of HAIs based on CDC definition:
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47 46. Type of HAIs:
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53 Name of data collectors : _____ Signature _____ date _____
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55 Name of supervisor _____ Signature _____ date _____
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Table 3 : Cross tabulation between types of HAIs by ward in Goba referral hospital, 2019.

Type of HAIs	Name of ward type		Total	Chi-Square Tests, df, p-value
	NICU	Pediatrics		
Pneumonia/ Lower Respiratory Tract Infections	10	22	32	$X^2(21.20)$, df=8, p-value=0.007
Late-Onset Neonatal Sepsis	6	0	6	
Intravenous Line (IV) Site Infections	4	1	5	
Urinary Tract Infections	1	3	4	
Systemic Infections	4	0	4	
Skin/Soft Tissue Infections	1	1	2	
Measles	0	2	2	
Early Onset Neonatal Sepsis	1	0	1	
Surgical Site Infections	0	1	1	
Total	27	30	57	

STROBE 2007 (v4) checklist of items to be included in reports of observational studies in epidemiology*
Checklist for cohort, case-control, and cross-sectional studies (combined)

Section/Topic	Item #	Recommendation	Reported on page #
Title and abstract	1	(a) Indicate the study's design with a commonly used term in the title or the abstract	1
		(b) Provide in the abstract an informative and balanced summary of what was done and what was found	2
Introduction			
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	4-5
Objectives	3	State specific objectives, including any pre-specified hypotheses	5
Methods			
Study design	4	Present key elements of study design early in the paper	6
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	6
Participants	6	(a) <i>Cohort study</i> —Give the eligibility criteria, and the sources and methods of selection of participants. Describe methods of follow-up <i>Case-control study</i> —Give the eligibility criteria, and the sources and methods of case ascertainment and control selection. Give the rationale for the choice of cases and controls <i>Cross-sectional study</i> —Give the eligibility criteria, and the sources and methods of selection of participants	6
		(b) <i>Cohort study</i> —For matched studies, give matching criteria and number of exposed and unexposed <i>Case-control study</i> —For matched studies, give matching criteria and the number of controls per case	NA
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	7
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	7
Bias	9	Describe any efforts to address potential sources of bias	7
Study size	10	Explain how the study size was arrived at	NA
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	7
Statistical methods	12	(a) Describe all statistical methods, including those used to control for confounding	7
		(b) Describe any methods used to examine subgroups and interactions	NA
		(c) Explain how missing data were addressed	NA
		(d) <i>Cohort study</i> —If applicable, explain how loss to follow-up was addressed <i>Case-control study</i> —If applicable, explain how matching of cases and controls was addressed	NA

		<i>Cross-sectional study</i> —If applicable, describe analytical methods taking account of sampling strategy	
		(e) Describe any sensitivity analyses	NA
Results			
Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed	9
		(b) Give reasons for non-participation at each stage	9
		(c) Consider use of a flow diagram	NA
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	9
		(b) Indicate number of participants with missing data for each variable of interest	NA
		(c) <i>Cohort study</i> —Summarise follow-up time (eg, average and total amount)	NA
Outcome data	15*	<i>Cohort study</i> —Report numbers of outcome events or summary measures over time	NA
		<i>Case-control study</i> —Report numbers in each exposure category, or summary measures of exposure	NA
		<i>Cross-sectional study</i> —Report numbers of outcome events or summary measures	9-10
Main results	16	(a) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included	9-10
		(b) Report category boundaries when continuous variables were categorized	NA
		(c) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	9
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	NA
Discussion			
Key results	18	Summarise key results with reference to study objectives	11
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias	12
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	11-12
Generalisability	21	Discuss the generalisability (external validity) of the study results	12
Other information			
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	13

*Give information separately for cases and controls in case-control studies and, if applicable, for exposed and unexposed groups in cohort and cross-sectional studies.

Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at <http://www.plosmedicine.org/>, Annals of Internal Medicine at <http://www.annals.org/>, and Epidemiology at <http://www.epidem.com/>). Information on the STROBE Initiative is available at www.strobe-statement.org.

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Incidence and risk factors for hospital-acquired infection among pediatric patients in a teaching hospital: a prospective study in southeast Ethiopia

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4 1 **Incidence and risk factors for hospital-acquired infection**
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6 2 **among pediatric patients in a teaching hospital: a**
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8 3 **prospective study in southeast Ethiopia**
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17 Abstract

18 **Objectives:** Epidemiological data on the incidence of hospital-acquired infections (HAIs) are
19 necessary because without a valid and precise baseline, the problem remains unnoticed and
20 interventions are not designed nor implemented. In Ethiopia, data about the occurrence of
21 hospital-acquired infections among hospitalized pediatric patients are lacking. We aimed to
22 determine the incidence and risk factors of hospital-acquired infections among pediatric patients
23 in Ethiopia.

24 **Design:** A prospective cohort study

25 **Setting:** A teaching hospital in southeast Ethiopia

26 **Participants:** 448 hospitalized pediatric patients admitted between November 1, 2018 and
27 June 30, 2019.

28 **Primary and secondary outcome measures:** Incidence and risk factors of hospital-
29 acquired infections.

30 **Results:** A total of 448 pediatric patients were followed for 3,227 patient days. The median age
31 of the patients was 8 months (interquartile range (IQR): 2-26 months). The incidence rate of
32 hospital-acquired infections was 17.7 per 1000 pediatric days of follow up while the overall
33 cumulative incidence was 12.7% (95% CI: 9.8-15.8) over eight months. Children who stayed
34 greater than 6 days (median day) [adjusted RR: 2.58, 95%CI (1.52-4.38)] and children with
35 underlying disease conditions of severe acute malnutrition [adjusted RR: 2.83, 95% CI (1.61-
36 4.97)] had a higher risk of developing a hospital-acquired infection.

37 **Conclusions:** The overall cumulative incidence of hospital-acquired infections was about 13
38 per 100 admitted children. Length of stay in the hospital and underlying severe acute malnutrition
39 were found to be important factors associated with increased risk of hospital-acquired infections.

40 **Keywords:** Nosocomial infection, Hospital-acquired infection, Pediatric patients, Ethiopia

42 **Strengths and limitations of this study**

- 43 • To the best of our knowledge, this is the first prospective study to examine the incidence
44 and risk factors of hospital-acquired infection among pediatric patients in Ethiopia.
- 45 • We did not use laboratory culture to isolate organisms as a guide in addition to the
46 clinical criteria to confirm the results of HAIs, which could affect our results.
- 47 • In this study, we focused on a small number of risk factors for hospital-acquired
48 infections; some important variables were not included.

50 Introduction

51 There is a “perfect storm” on hospital-acquired infections (HAIs) among hospitalized patients at
52 any point in time throughout the globe. HAI is defined as an infection occurring in a patient
53 during the process of care in a hospital or other healthcare facility that is not manifested or
54 incubating at the time of admission¹. Currently, it is a growing public health problem that
55 concerns both the medical and the general community, and a rising issue for patient safety and
56 quality of care at every level²⁻⁸. A study by Sheng et al. reported that 80% of hospitalized
57 patient’s deaths were linked to nosocomial infection (NI)⁹. Available evidence also showed that
58 financial burden, increased resistance of microorganisms to antimicrobials, prolonged hospital
59 stay, and sometimes deaths are caused by HAIs^{10, 11, 12}.

60 Worldwide, it is estimated that hundreds of millions of patients every year, in both developed
61 and developing countries, are affected by HAIs⁷. In some Australian public hospitals, HAIs
62 affect one in every 74 hospitalizations¹³. In Europe, the total annual number of patients with HAI
63 in 2011–2012 was estimated at 3.2 million. The prevalence of patients with at least one HAI in
64 acute care hospitals was 6.0% (country range 2.3%–10.8%)¹⁴. Moreover, throughout Europe,
65 HAIs accounted for 16 million additional days with total costs estimated at approximately €7
66 billion^{14,15,16}. In the United States, approximately two million patients developed HAIs, and
67 nearly a hundred thousand of these patients were estimated to die annually. This ranked HAI as
68 the fifth leading cause of death in acute care hospitals and the risk of acquiring infection is 2 -20
69 times higher in some developing countries^{17,18}.

70 In some developing countries, the magnitude of HAIs remains underestimated and uncertain¹².
71 There is little information available on the epidemiology of HAI in African countries^{19,20}.
72 Although data are sparse, evidence suggested that HAIs are considerably adding to the available
73 high burden of infections in some sub-Saharan African countries²¹. A systematic review by
74 Nejad et al reported that hospital-wide HAI prevalence in Africa varied between 2.5% and
75 14.8%. This review has shown that published studies were only conducted in 10 African
76 countries – emphasize there were paucities of information available among the epidemiology of
77 HAI in many African countries¹⁹. In addition to this, a recent review by Irek et al (2018)
78 indicated that there was a scarcity of studies on HAIs in Africa – of the 35 eligible articles

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3 79 retrieved, more than half (n = 21, 60%) were from East Africa only ²⁰. And most of the HAI
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5 80 literature just focused on adults, and data on HAIs among the pediatric population in sub-
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7 81 Saharan Africa are hardly available ^{15,19,22}. For example, a systematic review conducted by the
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9 82 World Health Organization (WHO) in the year 2010, identified no reports on pediatric
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11 83 nosocomial bacteremia in African countries between 1995 and 2008 ¹⁵.

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13 84 In Ethiopia, HAIs can result in substantial morbidity for hospitalized children; however, little is
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15 85 known about the incidence and prevalence of HAIs in the neonatal and pediatric populations.
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17 86 Also, previously conducted studies by far focused only on adults, and many of these were limited
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19 87 to surgical site infections ²³⁻²⁸, with an estimated prevalence of 10.9% ²⁴ to 66.5% ²⁷. The overall
20
21 88 cumulative incidence was 35.8 per 100 patients²⁶. Furthermore, the urinary tract and bloodstream
22
23 89 infections were found to be the commonest forms of HAIs in Ethiopia ²⁹⁻³³. Surgery since
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25 90 admission^{23,26}, underlying medical conditions^{23,25}, patients' with catheter ^{23,25,26}, the patient put
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27 91 on mechanical ventilation²⁶, immune-deficient patients ^{23,25}, patient age ^{26,32,33}, hospital type ³²,
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29 92 the type of ward and prolonged hospitalization³³ were found to be important factors associated
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31 93 with increased risk of HAIs in Ethiopia.

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33 94 To the best of our knowledge, there is no single currently available published report on the
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35 95 incidence and risk factors of HAIs among pediatric patients in Ethiopia. Epidemiological data on
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37 96 the incidence of HAI are necessary because without a valid and precise baseline, the problem
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39 97 remains unnoticed and interventions are not designed nor implemented, and neither can their
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41 98 impact be assessed. Therefore, this study was designed to determine the incidence and risk
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43 99 factors of HAIs among pediatric patients in Goba Referral Hospital, Southeast Ethiopia. The
44
45 100 current study helps policymakers to improve their decision making and input for healthcare
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47 101 professionals for the improvement of patient care.

103 **Methods**

104 **Study design and setting**

105 A hospital-based prospective follow up study was conducted from November 1, 2018, to June
106 30, 2019, at Mada Walabu University Goba Referral Hospital, Southeast Ethiopia. Goba
107 Referral Hospital is the only referral and teaching hospital in the Bale zone, serving over
108 1,787,575 million people. Goba Referral Hospital is located 445 km far from the capital city
109 (Addis Ababa) of Ethiopia. According to the 2018 annual report of Goba Referral Hospital, the
110 average outpatient flow is over 96,661 and the annual admission is over 7,886 patients, of which
111 1,335 were admitted in the pediatrics ward and Neonatal Intensive Care Unit (NICU). The
112 hospital has a total of 127 inpatients beds – of which 30 and 15 are in the pediatric ward and
113 NICU, respectively.

114 **Study population and eligibility criteria**

115 All patients (age less than 18 years) admitted to the pediatric ward and neonatal intensive care
116 unit (NICU) were enrolled and those who at least stayed for 48 hours were eligible for the study.
117 Enrolled patients showed signs of infection and/or symptoms of infection within the first 48
118 hours were excluded from the study.

119 **Data collection procedures**

120 First, consent was sought from each child's parents/guardians before commencing any study
121 procedures. On admission, all children were evaluated clinically to exclude community-acquired
122 infections by a pediatrician. Afterward, socio-demographic and clinical data were collected by a
123 structured questioner using an individual patient chart investigation approach-accordingly-a
124 detailed clinical history of patients were taken and recorded. Patients presenting with no new
125 signs or symptoms of infection after the first 48 hours of admission were included and followed
126 prospectively for the development of HAIs during their stay in the hospital. Data were collected
127 from enrolled patients on a daily bases: children were followed by a pediatrician daily, charts
128 were reviewed and discussions with nurses and physician caring for the patient were held. HAIs

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3 129 were confirmed by senior pediatrician specialists working in the respective NICU and pediatrics
4 130 ward.

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7 131 Data were collected by trained physicians and one pediatrician. The Center for Diseases Control
8 132 and Prevention (CDC)/ National Health Care Safety Network (CDC/NHSN) Surveillance
9 133 Definition for hospital-acquired infections were used³⁴. In this study, the use of any
10 134 antimicrobials was recorded and information on different medical devices collected at the time of
11 135 hospital admission and before the diagnosis of HAIs, respectively (**S1 File**).

16 17 136 **Data quality control**

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19
20 137 The data collection tool was adapted from different related pieces of literature based on the
21 138 available evidence to HAIs^{1,23,26,32}. To ensure the quality of data, the tool was pre-tested before
22 139 the data collection period. The training was given for data collectors on study procedures and
23 140 with practical exercise sessions. Data collection was closely supervised by a principal
24 141 investigator and the collected data were checked for completeness, accuracy, and consistency.

25 26 142 **Operational definition**

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29 143 **Hospital-Acquired Infection (HAI)** - localized or systemic condition that results from an
30 144 adverse reaction to the presence of an infectious agent or its toxin and occurring 48 hours or
31 145 longer after hospital admission that was not incubating at the time of admission.

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33 146 **Severe Anemia** - haemoglobin <50 g/L (for patients older than 28 days) or haemoglobin <90 g/L
34 147 (for neonates)

35 36 148 37 38 39 149 **Study variables**

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42 150 The outcome variable of the study was the occurrence of hospital-acquired infections (HAIs).
43 151 The presence of HAIs was confirmed when the patients met the criteria for signs and symptoms
44 152 determined by the Center for Disease Control and Prevention³⁴, wherein, the independent
45 153 variables included: socio-demographic characteristics (age of the child, sex, place of residence,
46 154 and previous hospitalization), and clinical and other related variables (duration of hospitalization,

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3 155 insertion of a urinary catheter, presence of peripheral intravenous (IV) catheter, received anti-
4 156 microbial, American Society of Anesthesiology (ASA) classification, intubation, surgery after
5 admission, underline disease-refers to Severe acute malnutrition (SAM) presenting at the time of
6 157 admission, mechanical ventilator, and HIV status).
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10 11 159 **Data processing and analysis**

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14 160 Data were entered into Epi-data version 3.1 and exported to STATA version 14 statistical
15 software for further analysis. Descriptive statistics were computed to present the frequency
16 161 distribution of important variables. The cumulative incidence (incidence proportion) was
17 162 calculated as the number of new HAIs cases per person in the population over a defined period;
18 163 and it is the probability of developing HAIs over a stated study period (8 months). We estimated
19 164 incidence rate as the number of HAIs cases per unit of time, and the denominator is the total
20 amount of time "at-risk" without experiencing HAIs for all children who were being followed for
21 165 8 months. The incidence rate of HAIs was reported per 1000 patient days. Multivariable logistic
22 regression was used to identify factors with an increased risk of HAIs. An adjusted risk ratio
23 166 (ARR) with a 95% confidence interval (CI) was used to determine the strength of association. A
24 167 p-value < 0.05 was used to declare statistical significance. Multicollinearity diagnosis was
25 performed between categorical variables by looking at values of variance inflation factor (VIF).
26 171 The final model fitness was assessed by using the Hosmer-Lemeshow goodness of fit test.
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37 173 **Patient and public involvement**

38 174 Patients and the public were not involved in the planning, designing, and interpreting this data
39 analysis. However, consent was sought from all patients involved in this study.
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179 **Results**

180 **Socio-demographic characteristics of the study participants**

181 A total of 487 pediatrics patients were enrolled in this study. However, 39 pediatric patients
182 showed signs of infection and/or symptoms of the infection within the first 48 hours were
183 excluded from the study. The rest 448 pediatric patients were followed for the occurrence of
184 HAIs until hospital discharge, referred to other healthcare facilities or death. Of the total patients
185 included in the study, 201 (44.9%) were from the neonatal intensive care unit (NICU) and the
186 remainder were from the pediatric ward. Two hundred forty-eight (55.4%) of the study
187 participants were male with an overall male-to-female ratio of 1.24: 1. The median age of the
188 participants was 8 months (interquartile range (IQR): 2-26 months). The age distribution of study
189 participants by sex was presented in **Figure 1**. Three hundred and ninety (71.2%) of the study
190 participants were from rural areas. The median hospital stay of the patients was 6 days (IQR: 3-9
191 days). Of the study participants, 24 (5.4%) died. Therefore, the overall incidence density rate of
192 admitted pediatrics mortality was 7.44 per 1000 pediatrics days of follow up (**Table 1**).

193 **Clinical characteristics of patients**

194 In this study, 46 (10.3%) of the participants had a history of the previous hospitalization within
195 the last 30 days. Fifty-four, (12.1%) of children were diagnosed with severe acute malnutrition
196 (SAM) at the time of admission. Severe anemia was reported by 41 (9.2%) respondents. Overall,
197 one hundred and seventy-one (38.2%) patients received antimicrobial at the time of the study
198 (**Table 1**).

199 **Incidence and type of hospital-acquired infection**

200 During the study period, 448 pediatric patients were followed for a total of 3,227 patient days. A
201 total of 57 patients experienced HAI. The mean time of diagnosis of HAIs in Goba referral
202 hospital is 7.20 (95% CI: 6.72, 7.66) patient days. The overall incidence rate of HAIs was 17.7
203 per 1000 pediatrics days of follow up while the cumulative incidence was 12.7% (95% CI: 9.8-
204 15.8) over eight months. The mean length of stay for the infected pediatric patients was 11.5
205 days (95% CI: 9.5-13.4), while it was lower for the remaining patients at 6.5 days.

206 **Table 2** illustrates the proportion of HAIs among pediatrics patients in Goba referral hospital.
207 Hospital-acquired pneumonia was the most common type of HAI that was observed among

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3 208 pediatrics patients with a proportion of 56.1% (95%CI: 43.9-68.4), followed by late-onset
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5 209 neonatal sepsis 10.5% (95%CI: 3.5-19.3), and the least HAI observed was an early onset of
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7 210 neonatal sepsis and surgical site infections with an overall proportion of 1.8% each. In this study,
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9 211 the stratification of type of HAIs by ward of admission revealed significant variability (p-value=
10 212 0.007) (**Figure 2**).

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13 14 214 **Risk factors of hospital-acquired infections**

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16 215 **Table 3** showed the risk factors of HAIs among pediatric patients in Goba Referral Hospital.
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18 216 Bivariate analysis of risk ratio has indicated that hospital duration (> 6 days), the patient received
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20 217 antimicrobial medications, presence of drainage tube, and children diagnosed for SAM were
21 218 predispose for HAIs.

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23 219 In the adjusted model, the risk of HAIs was 2.58 times more likely to be higher among children
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25 220 who stayed longer than or equal to 6 days (median day) than to those children who stayed less
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27 221 [adjusted RR: 2.58, 95%CI (1.72-4.38)]. Patients with SAM conditions had a 2.83 times higher
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29 222 risk of developing HAIs compared to their counterparts [adjusted RR: 2.83, 95% CI (1.61-4.97)].
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31 223 Socio-demographic and some clinically related confounders could not show any statistically
32 224 significant associations (**Table 4**).

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34 225 In this study, we estimated the attributable risk which estimates the excess risk of disease in
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36 226 those exposed compared with those non-exposed. The excess occurrence of HAIs among
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38 227 children with underlying SAM diseases attributable to their SAM condition is 13 per 100 (**Table**
39 228 **4**).

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232 Discussion

233 Hospital-acquired infections (HAIs) are a current global challenge with increased morbidity,
234 mortality, and massive economic cost³⁵⁻³⁹. Yet, there remain limited data on the occurrences of
235 HAIs in hospitalized pediatric in Sub-Saharan African, including Ethiopia. This study was
236 designed to determine the incidence and risk factors of HAIs among pediatric patients in a
237 teaching hospital, southeast Ethiopia. The overall incidence rate of HAIs was 17.75 per 1000
238 pediatrics days of follow up while the cumulative incidence was 12.7% (95% CI: 9.8-15.8) over
239 eight months. Children who stayed longer than the median day (6 days) in the hospital and
240 children with underlying disease conditions (Severe acute malnutrition) had a higher risk of
241 developing HAIs.

242 In this study, the overall incidence rate of HAIs was 17.7 per 1000 pediatrics days of follow up.
243 This finding is lower than a related study by Ali et al (2018) from Southwest Ethiopia, which
244 reports the incidence of HAIs was 28.15 per 1000 patient days³⁹. The difference might be
245 associated with the nature of this study which involved only pediatrics patients including those in
246 intensive care; however, a study by Ali et al includes adult study participants. Also, variation in
247 studies could be attributed to differences in geographical locations and the setting of studies
248 (specialized hospital). One previous a before-and-after study conducted in a teaching hospital in
249 Indonesia involving children admitted to the pediatric intensive care unit and pediatric wards
250 reported the incidence density rate of HAI 29.1 per 1000 patient days, which is similar with our
251 finding.³⁶

252 Our finding has also revealed that the overall cumulative incidence of HAIs was 12.7%; a
253 finding which is comparable to those reported from the United States (11.9%)³⁷ studies
254 conducted in the pediatric intensive care unit, and (13.3%) in Poland³⁸. Also, the present 12.7%
255 of HAIs noted in our study population fell in the ranges of 9.8-15.8% reported elsewhere^{14, 40, 41},
256 and the WHO pooled estimated for low-income countries 10.1%¹⁸. Conversely, other similar
257 studies from Turkey reported a much higher prevalence of HAIs among children ranging
258 between 22.2 and 68.4%^{42,43}, and in a multicenter prospective study from Europe reported
259 18.5%⁴⁴ among pediatric patients.

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3 260 The present study also demonstrated that the occurrence of HAIs was higher among male
4 participants (52.6%) than females. This result was also supported by other studies conducted
5 261 elsewhere ^{40, 45-47}. In the same vein, one study carried out by Koch et al in Norway reported that
6 262 males present higher overall HAIs prevalence than females⁴⁸.
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11 264 The most common type of HAI observed in this study was hospital-acquired pneumonia (HAP),
12 265 which contributed to a proportion of 56.1% of the total HAIs. It may not be a surprise to see such
13 a high proportion of HAI in the NICU and pediatrics ward since most of the patients admitted in
14 266 intensive care are incapacitated and critical. Moreover, compared to adults, infants and neonates
15 267 are immunologically immature, and in many cases, vulnerable ^{49,50}. The finding was similar to
16 268 the study done in Tikur Anbessa Hospital, Ethiopia ³³. It is also true for other settings—in Iran
17 269 43.7% ⁵¹, India 50% ⁵², Vietnam 41.9% ⁵³, Morocco 34.5% ⁵⁴, Saudi Arabia 46.7% ⁵⁵, 52.2%
18 270 China ⁵⁶, and in a European multicenter prospective study 53% ⁴⁴. The high burden of HAP
19 271 among hospitalized pediatrics patients has an important implication in terms of hospital length of
20 272 stay, healthcare cost, and mortality. The overall mortality attributed to HAP has been as high as
21 273 30 to 50% ⁵⁷. In this study, ventilator-associated pneumonia (VAP) developed in 9.21% [7/76] of
22 274 children undergoing mechanical ventilation. Our estimate is in line with studies conducted on
23 275 children, reporting VAP occurs in 3 to 10% of ventilated pediatric ICU patients.^{36,58,59,60}
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34 277 In this study, the risks of developing HAIs were three times higher among children who stayed
35 278 longer than or equal to the median six days than their counterparts. Despite this positive
36 279 association, this is not proof that decreasing the length of stays neither increasing admission days
37 280 decreased/increase the occurrence of HAIs. Possible reversed causation may be one of the
38 281 mechanisms why this prolonged length of stay is associated with HAIs. Moreover, there is
39 282 evidence that HAIs cause a prolonged length of stay ⁶¹⁻⁶⁵. In our findings, the presence of
40 283 underlying diseases such as SAM was recognized as the main risk factor for HAIs. This was
41 284 consistent with the finding from another study in Ethiopia ²⁴ underlying illnesses increased the
42 285 susceptibility of patients, which predisposed them to infections secondary to the reduction of the
43 286 patient's immune response that exacerbated the illnesses thru which in many cases had a
44 287 significant factor that contributed more to the acquisition of HAIs in neonates and pediatric
45 288 patients ^{41, 66, 67}.
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289 **Limitations of the study**

290 Several limitations on this prospective study need to be considered. First, we did not assess the
291 healthcare workers' infection prevention practices that would have been associated with the
292 prevalence of HAIs. Second, the researchers did not examine the number of HAIs after the
293 patients were discharged. Third, despite we followed patient until discharge the full burden of
294 HAI could not be captured in this specific study as our study, was limited to in-hospital
295 assessment only and leaving outpatients who may potentially develop HAI after discharge.
296 Fourth, we focused on a small number of risk factors for hospital-acquired infections; some
297 important variables were not included. Fifth, the used analysis does not take any time-varying
298 risk into account. Finally, we did not use laboratory culture to isolate organisms as a guide in
299 addition to the clinical criteria to confirm the results of HAIs because of financial constraints,
300 laboratory facilities, and expertise. Given the lack of microbiology data, endogenous infections
301 may be misclassified as HAIs. Since the study was conducted in a teaching referral hospital, the
302 generalization of the study findings is limited to these facilities.

303 **Conclusions**

304 The present study revealed that the cumulative incidence of hospital-acquired infections (HAIs)
305 was about 13 per 100 admitted children. And the overall incidence rate of HAIs was 17.75 per
306 1000 pediatrics days. Length of stay in the hospital and patients with severe acute malnutrition
307 (SAM) conditions were associated with increased risk of hospital-acquired infections. Further
308 studies are strongly recommended to identify other important factors including isolating the
309 bacterial, fungal, and viral agents responsible for HAIs in the region.

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315 **Contributors**

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2
3 316 BS has made substantial contributions to conception and design, acquisition of data, analysis,
4 317 and interpretation of data. He has written the draft manuscript and provided final approval of the
5 318 version to be published. FS, DA, EN, GN, AK, DW, YT, DZ, and BJEQ has made substantial
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7 320 article critically for important intellectual content and provided final approval of the version to
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23 327 **Competing interests**

24 328 The authors declare that they have no competing interests.

28 329 **Ethics approval**

29 330 Ethical clearance was obtained from the Ethical Review Committee of Madda Walabu
30 331 University (Ref.No: RMW 14/66/64) and a formal letter from Madda Walabu University
31 332 Research Community Engagement and Technology Transfer Vice President Office was
32 333 submitted. Written consent from the parents/ legal guardians was obtained after explaining the
33 334 objectives of the study. Identified pediatric patients having hospital-acquired infections were
34 335 formally communicated to the physicians and nurses who were in charge of the patients for
35 336 additional health care services. Throughout the data collection period, confidentiality and privacy
36 337 of the patients were observed, and a unique identification code rather than their names were
37 338 substituted.

47 339 **Data sharing statement**

48 340 Data will be available upon request from the corresponding authors.

References

1. Prevention of hospital-acquired infections: a practical guide. Geneva: World Health Organization; 2002.
2. Emerson CB, Eyzaguirre LM, Albrecht JS, Comer AC, Harris AD, and Furuno JP. Healthcare-Associated Infection and Hospital Readmission. *Infection control and hospital epidemiology: the official journal of the Society of Hospital Epidemiologists of America*. 2012;33(6):539-44
3. Bates DW, Larizgoitia I, Prasopa-Plaizier N, Jha AK. Global priorities for patient safety research. *BMJ* 2009; 338: b1775.
4. WHO. WHO Guidelines on Hand Hygiene in Health Care: a Summary. World Health Organization (WHO). 2009. Geneva, Switzerland,
5. Geffers C, Gastmeier P. Nosocomial infections and multidrug-resistant organisms in Germany: epidemiological data from KISS (the Hospital Infection Surveillance System). *Dtsch Arztebl Int*. 2011; 108(6):87–93.
6. Lul R. Prevention and Control of Hospital-Related Infections in Low and Middle Income Countries. *The Open Infectious Diseases Journal*. 2010; 4:125-131
7. Allegranzi B, Storr J, Dziekan G, Leotsakos A, Donaldson L & Pittet D. The First Global Patient Safety Challenge “Clean Care is Safer Care”: from launch to current progress and achievements. *Journal of Hospital Infection*. 2007; 65(s2):115–123.
8. Rosenthal VD, Maki DG, Mehta Y, Leblebicioglu H, Memish ZA, Al-Mousa HH, Balkhy H, Hu B, Alvarez-Moreno C, Medeiros EA, Apisarnthanarak A. International Nosocomial Infection Control Consortiu (INICC) report, data summary of 43 countries for 2007-2012. Device-associated module. *American journal of infection control*. 2014 Sep 1;42(9):942-56.
9. Sheng WH, Wang JT, Lin MS, Chang SC. Risk factors affecting in-hospital mortality in patients with nosocomial infections. *J Formos Med Assoc*. 2007;106(2):110—8.
10. Pittet D, Donaldson L. Clean Care is Safer Care: a worldwide priority. *Lancet* 2005; 366: 1246-7
11. Uwaezuoke S, Obu H. Nosocomial infections in neonatal intensive care facilities: cost-effective control strategies in resource-limited countries. *Nigeria Journal of Pediatrics*. 2013; 40(2): 125-132.

- 1
2
3 372 12. Allegranzi B, Pittet D. Preventing infections acquired during healthcare delivery. *Lancet*
4 373 2008; 372: 1719-20
5
6 374 13. Independent Hospital Pricing Authority (AU). Activity Based Funding Admitted Patient Care
7 375 2015-16, acute admitted episodes, excluding same day.
8
9 376 14. European Centre for Disease Prevention and Control (ECDC). Point prevalence survey of
10 377 healthcare associated infections and antimicrobial use in European acute care hospitals.
11 378 Stockholm: ECDC. 2013.
12
13 379 15. Allegranzi B, Bagheri S, Combescure C, Graafmans W, Attar H, Donaldson L et al. Burden
14 380 of Endemic Health Care-Associated Infection in developing countries: Systematic review and
15 381 meta-analysis. *Lancet*. 2011; 377: 288-241.
16
17 382 16. Shelley S, Walter H, Robyn K, Christine B, Bonnie B, et al. Prevalence of
18 383 Healthcare Associated Infections in Acute Care Hospitals in Jacksonville, Florida. *Infection*
19 384 control and hospital epidemiology. 2012; 33(3):283-91
20
21 385 17. Nelson S, Stone PW, Jordan S, Pogorzelska M, Halpin H, Vanneman M, Larson E. Patient
22 386 safety climate: Variation in perceptions by infection preventionists and quality directors.
23 387 *Interdisciplinary perspectives on infectious diseases*. 2011;2011.
24
25 388 18. World health organization (WHO). Infection prevention and control in health care: time for
26 389 collaborative action. Regional Committee for the Eastern Mediterranean. EM/RC57/6. WHO.
27 390 2010.
28
29 391 19. Nejad SB, Allegranzi B, Syed SB, Ellis B, Pittet D. Health-care-associated infection in
30 392 Africa: a systematic review. *Bulletin of the World Health Organization*. 2011;89:757-65.
31
32 393 20. Irek EO, Amupitan AA, Obadare TO, Aboderin AO. A systematic review of healthcare-
33 394 associated infections in Africa: An antimicrobial resistance perspective. *African journal of*
34 395 *laboratory medicine*. 2018;7(2):1-9.
35
36 396 21. Rothe C, Schlaich C, Thompson S. Healthcare-associated infections in sub-Saharan Africa. *J*
37 397 *Hosp Infect*. 2013;85(4):257-67
38
39 398 22. Zaidi AK, Huskins WC, Thaver D, Bhutta ZA, Abbas Z, Goldmann DA. Hospital-acquired
40 399 neonatal infections in developing countries. *Lancet* 2005; 365: 1175-88
41
42 400 23. Yallem WW, Kumie A, Yehuala FM. Risk factors for hospital-acquired infections in
43 401 teaching hospitals of Amhara regional state, Ethiopia: A matched-case control study. *PloS*
44 402 *one*. 2017 Jul 18;12(7):e0181145.

- 1
2
3 403 24. Mulu W, Kibru G, Beyene G, Damtie M. Postoperative nosocomial infections and
4 antimicrobial resistance pattern of bacteria isolates among patients admitted at Felege Hiwot
5 404 Referral Hospital, Bahirdar, Ethiopia. *Ethiopian journal of health sciences*. 2012;22(1):7-18.
6 405
7 406 25. Gedebe M, Habte-Gabr E, Kronvall G, Yoseph S. Hospital-acquired infections among
8 407 obstetric and gynaecological patients at Tikur Anbessa hospital, Addis Ababa. *J Hosp Infect*.
9 408 1988;11(1):50–9.
10 409 26. Endalafer N, Gebre-Selassie S, Kotiso B. Nosocomial bacterial infections in a tertiary
11 410 hospital in Ethiopia. *J Infect Prev*. 2011;12(1):38–43.
12 411 27. Feleke T, Eshetie S, Dagne M, Endris M, Abebe W, Tiruneh M, Moges F. Multidrug-
13 412 resistant bacterial isolates from patients suspected of nosocomial infections at the University
14 413 of Gondar Comprehensive Specialized Hospital, Northwest Ethiopia. *BMC research notes*.
15 414 2018 Dec;11(1):602.
16 415 28. Amenu D, Belachew T, Araya F. Surgical site infection rate and risk factors among obstetric
17 416 cases of Jimma University Specialized Hospital, Southwest Ethiopia. *Ethiopian journal of*
18 417 *health sciences*. 2011;21(2):91-100.
19 418 29. Melaku S, Gebre-Selassie S, Damtie M, Alamrew K. Hospital acquired infections among
20 419 surgical, gynaecology and obstetrics patients in Felege-Hiwot referral hospital, Bahir Dar,
21 420 northwest Ethiopia. *Ethiopian medical journal*. 2012 Apr;50(2):135-44
22 421 30. Messele G, Woldemedhin Y, Demissie M, Mamo K, Geyid A. Common causes of
23 422 nosocomial infections and their susceptibility patterns in two hospitals in Addis Ababa.
24 423 *Ethiop J Health Biomed Sci* 2009; 2: 3-8.
25 424 31. Melaku S, Kibret M, Abera B, Gebre-Sellassie S. Antibigram of nosocomial urinary tract
26 425 infections in Felege Hiwot referral hospital, Ethiopia. *African health sciences*.
27 426 2012;12(2):134-9.
28 427 32. Walelegn W, Abera K, Feleke M (2016). Point prevalence of hospital-acquired infections in
29 428 two teaching hospitals of amhara region in Ethiopia. *Drug, Healthcare and Patient Safety*.
30 429 2016; 8:71-76.
31 430 33. Mikyas D, Sileshi L. The Prevalence of Nosocomial Infections and Associated Risk Factors
32 431 in Pediatric Patients in Tikur Anbessa Hospital. *Ethiopian Journal of Pediatrics and Child*
33 432 *Health*. 2008; 5(5):4-16.

- 1
2
3 433 34. CDC/NHSN. CDC/NHSN surveillance definition of health care-associated infection and
4 434 criteria for specific types of infections in the acute care setting. *Am Journal Infect Control*.
5 435 2008; 36:309-32.
6
7
8 436 35. Joram N, de Saint Blanquat L, Stamm D, Launay E, Gras-Le Guen C. Healthcare-associated
9 437 infection prevention in pediatric intensive care units: a review. *European journal of clinical*
10 438 *microbiology & infectious diseases*. 2012 Oct 1;31(10):2481-90.
11
12
13 439 36. Murni IK, Duke T, Kinney S, Daley AJ, Soenarto Y. Reducing hospital-acquired infections
14 440 and improving the rational use of antibiotics in a developing country: an effectiveness study.
15 441 *Arch Dis Child*. 2015;100:454–459.
16
17
18 442 37. Grohskopf LA, Sinkowitz-Cochran RL, Garrett DO, Sohn AH, Levine GL, Siegel JD, Stover
19 443 BH, Jarvis WR, Networka PP. A national point-prevalence survey of pediatric intensive care
20 444 unit-acquired infections in the United States. *The Journal of pediatrics*. 2002 Apr
21 445 1;140(4):432-8.
22
23
24 446 38. Deptuła A, Trejnowska E, Ozorowski T, Hryniewicz W. Risk factors for healthcare-
25 447 associated infection in light of two years of experience with the ECDC point prevalence
26 448 survey of healthcare-associated infection and antimicrobial use in Poland. *Journal of Hospital*
27 449 *Infection*. 2015 Aug 1;90(4):310-5.
28
29
30 450 39. Ali S, Birhane M, Bekele S, Kibru G, Teshager L, Yilma Y, Ahmed Y, Fentahun N, Assefa
31 451 H, Gashaw M, Gudina EK. Healthcare associated infection and its risk factors among
32 452 patients admitted to a tertiary hospital in Ethiopia: longitudinal study. *Antimicrobial*
33 453 *Resistance & Infection Control*. 2018 Dec;7(1):2.
34
35
36 454 40. Askarian M, Yadollahi M, Assadian O. Point prevalence and risk factors of hospital acquired
37 455 infections in a cluster of university-affiliated hospitals in Shiraz, Iran. *Journal of infection*
38 456 *and public health*. 2012 Apr 1;5(2):169-76.
39
40
41 457 41. Olivier C, Kunneke H, O'Connell N, Von Delft E, Wates M, Dramowski A. Healthcare-
42 458 associated infections in paediatric and neonatal wards: A point prevalence survey at four
43 459 South African hospitals. *South African Medical Journal*. 2018;108(5):418-22.
44
45
46 460 42. Teke TA, Tanır G, Bayhan Gİ, Öz FN, Metin Ö, Özkan Ş. Clinical and microbiological
47 461 features of resistant gram-negative bloodstream infections in children. *Journal of infection*
48 462 *and public health*. 2017 Mar 1;10(2):211-8.
49
50
51
52
53
54
55
56
57
58
59
60

- 1
2
3 463 43. Atici S, Soysal A, Kadayifci EK, Karaaslan A, Akkoç G, Yakut N, Demir SÖ, Girgin Fİ,
4 464 Çulha G, Altınkanat G, Öztürk N. Healthcare-associated infections in a newly opened
5 465 pediatric intensive care unit in Turkey: Results of four-year surveillance. *The Journal of*
6 466 *Infection in Developing Countries*. 2016 Mar 31;10(03):254-9.
- 7
8
9 467 44. Raymond J, Aujard Y, European Study Group. Nosocomial infections in pediatric patients a
10 468 European, multicenter prospective study. *Infection Control & Hospital Epidemiology*. 2000
11 469 Apr;21(4):260-3.
- 12
13
14 470 45. Offner PJ, Moore EE, Biffl WL. Male gender is a risk factor for major infections after
15 471 surgery. *Archives of Surgery*. 1999 Sep 1;134(9):935-40.
- 16
17
18 472 46. Wałaszek M, Kosiarska A, Gniadek A, Kołpa M, Wolak Z, Dobroś W, Siadek J. The risk
19 473 factors for hospital-acquired pneumonia in the Intensive Care Unit. *Przegl Epidemiol*.
20 474 2016;70(1):15-20.
- 21
22
23 475 47. Ahmed M, Alam SN, Khan O, Manzar S. Postoperative wound infection: a surgeon's
24 476 dilemma. *Pak J Surg*. 2007 Jan;23(1):41-7.
- 25
26
27 477 48. Koch AM, Nilsen RM, Eriksen HM, Cox RJ, Harthug S. Mortality related to hospital-
28 478 associated infections in a tertiary hospital; repeated cross-sectional studies between 2004-
29 479 2011; 2015.
- 30
31
32 480 49. Brady MT. Health care-associated infections in the neonatal intensive care unit. *American*
33 481 *journal of infection control*. 2005 Jun 1;33(5):268-75.
- 34
35
36 482 50. Saiman L. Risk factors for hospital-acquired infections in the neonatal intensive care unit. In
37 483 *Seminars in perinatology*. 2002 Oct 1; 26(5):315-321.
- 38
39
40 484 51. Behzadnia S, Davoudi A, Rezai MS, Ahangarkani F. Nosocomial infections in pediatric
41 485 population and antibiotic resistance of the causative organisms in north of iran. *Iranian Red*
42 486 *Crescent Medical Journal*. 2014 Feb;16(2).
- 43
44
45 487 52. Singh S, Chaturvedi R, Garg SM, Datta R, Kumar A. Incidence of healthcare associated
46 488 infection in the surgical ICU of a tertiary care hospital. *Medical journal armed forces India*.
47 489 2013 Apr 1;69(2):124-9.
- 48
49
50 490 53. Thu TA, Hung NV, Quang NN, Archibald LK, Harun-Or-Rashid M, Sakamoto J. A point-
51 491 prevalence study on healthcare-associated infections in Vietnam: public health implications.
52 492 *Infection Control & Hospital Epidemiology*. 2011 Oct;32(10):1039-41.

- 1
2
3 493 54. Razine R, Azzouzi A, Barkat A, Khoudri I, Hassouni F, Chefchaoui AC, Abouqal R.
4 494 Prevalence of hospital-acquired infections in the university medical center of Rabat,
5 495 Morocco. *International archives of medicine*. 2012 Dec;5(1):26.
- 6
7
8 496 55. Balkhy HH, Cunningham G, Chew FK, Francis C, Al Nakhli DJ, Almuneef MA, Memish
9 497 ZA. Hospital-and community-acquired infections: a point prevalence and risk factors survey
10 498 in a tertiary care center in Saudi Arabia. *International journal of infectious diseases*. 2006 Jul
11 499 1;10(4):326-33.
- 12
13
14 500 56. Le NK, Wertheim HF, Vu PD, Khu DT, Le HT, Hoang BT, Vo VT, Lam YM, Vu DT,
15 501 Nguyen TH, Thai TQ. High prevalence of hospital-acquired infections caused by gram-
16 502 negative carbapenem resistant strains in Vietnamese pediatric ICUs: A multi-centre point
17 503 prevalence survey. *Medicine*. 2016 Jul;95(27).
- 18
19
20 504 57. American Thoracic Society, Infectious Diseases Society of America. Guidelines for the
21 505 management of adults with hospital-acquired, ventilator-associated, and healthcare-
22 506 associated pneumonia. *American journal of respiratory and critical care medicine*. 2005 Feb
23 507 15;171(4):388.
- 24
25
26 508 58. Almuneef M, Memish ZA, Balkhy HH, Alalem H, Abutaleb A. Ventilator-associated
27 509 pneumonia in a pediatric intensive care unit in Saudi Arabia: a 30-month prospective
28 510 surveillance. *Infection Control & Hospital Epidemiology*. 2004;25(9):753-8.
- 29
30
31 511 59. Elward AM, Warren DK, Fraser VJ. Ventilator-associated pneumonia in pediatric intensive
32 512 care unit patients: risk factors and outcomes. *Pediatrics*. 2002;109(5):758-64.
- 33
34
35 513 60. Foglia E, Meier MD, Elward A. Ventilator-associated pneumonia in neonatal and pediatric
36 514 intensive care unit patients. *Clinical microbiology reviews*. 2007;20(3):409-25.
- 37
38
39 515 61. Sarvikivi E, Kärki T, Lyytikäinen O, Finnish NICU Prevalence Study Group. Repeated
40 516 prevalence surveys of healthcare-associated infections in Finnish neonatal intensive care
41 517 units. *Journal of Hospital Infection*. 2010 Oct 1;76(2):156-60.
- 42
43
44 518 62. Sangrasi AK, Leghari AA, Memon A, Talpur AK, Qureshi GA, Memon JM. Surgical site
45 519 infection rate and associated risk factors in elective general surgery at a public sector medical
46 520 university in Pakistan. *International wound journal*. 2008 Mar;5(1):74-8.
- 47
48
49 521 63. Khaleid M, Haleim A, Zein K. ET: surgical site infections and associated risk factors in
50 522 Egyptian orthopedic patients. *J Am Sci*. 2010;6(7):272-80.
- 51
52
53
54
55
56
57
58
59
60

- 1
2
3 523 64. Arefian H, Hagel S, Fischer D, Scherag A, Brunkhorst FM, Maschmann J, Hartmann M.
4
5 524 Estimating extra length of stay due to healthcare-associated infections before and after
6
7 525 implementation of a hospital-wide infection control program. *PloS one*. 2019
8
9 526 17;14(5):e0217159.
- 10 527 65. Zhou Q, Fan L, Lai X, Tan L, Zhang X. Estimating extra length of stay and risk factors of
11
12 528 mortality attributable to healthcare-associated infection at a Chinese university hospital: a
13
14 529 multi-state model. *BMC Infectious Diseases*. 2019 Dec 1;19(1):975.
- 15 530 66. Shahunja KM, Ahmed T, Faruque AS, Shahid AS, Das SK, Shahrin L, Hossain MI, Islam
16
17 531 MM, Chisti MJ. Experience with nosocomial infection in children under 5 treated in an urban
18
19 532 diarrheal treatment center in Bangladesh. *Global pediatric health*. 2016 Mar
20
21 533 4;3:2333794X16634267.
- 22 534 67. Dramowski A, Whitelaw A, Cotton MF. Burden, spectrum, and impact of healthcare-
23
24 535 associated infection at a south African children's hospital. *Journal of Hospital Infection*. 2016
25
26 536 Dec 1;94(4):364-72.

538 **Table 1: Demographic and clinical characteristics of patients who participated in the study**
 539 **in Goba Referral Hospital, southeast Ethiopia 2019 (n=448)**

Variables	Category	n (%)
Patient age, Median (IQR): 8 months (2-26 months)		
Sex	Male	248 (55.4)
	Female	200 (44.6)
Ward	Neonatal Intensive Care Unit (NICU)	201 (44.9)
	Pediatrics	247 (55.1)
Resident	Urban	129 (28.8)
	Rural	319 (71.2)
Previous Hospitalization ^a	Yes	46 (10.3)
	No	402 (89.7)
Mechanical Ventilation	Yes	76 (17.0)
	No	372 (83.0)
Presence of peripheral intravenous (IV) catheter ^b	Yes	430 (96.0)
	No	18 (4.0)
Presence of Urinary Catheters	Yes	9 (2.0)
	No	439 (98.0)
Drainage Tube Inserted ^c	Yes	53 (11.8)
	No	395 (88.2)
Underlying Severe acute malnutrition (SAM) Diseases ^d	Yes	54 (12.1)
	No	394 (87.9)
Surgery After Admission	Yes	47 (10.5)
	No	401 (89.5)
Patient Received Antimicrobials ^e	Yes	171 (38.2)
	No	221 (49.3)
	Unknown	56 (12.5)
Severe Anemia	Yes	41 (9.2)
	No	375 (83.7)
	Unknown	32 (7.1)
Hospital Duration (median day)	≤ 6	237 (52.9)
	> 6	211 (47.1)
HIV status	Positive	2 (0.4)
	Negative	393 (87.7)
	Not tested	53 (11.8)
American Society of Anesthesiology (ASA) Classification	Normally health patient	72 (16.1)
	Patient with mild systemic diseases	235 (52.5)
	Severe systemic disease that is not incapacitating	100 (22.3)
	Incapacitating systemic diseases that is a constant threat to life	36 (8.0)

	Unknown	5 (1.1)
Gestational age (n=191)	< 37 weeks	83 (43.5)
	≥ 37 weeks	108 (56.5)
Birth weight (n=191) ^f	< 2500gm	46 (24.1)
	≥ 2500 gm	145 (75.9)

540 ^a History of the previous hospitalization for either the same as the current reason of admission or
541 other ailments within the last 30 days

542 ^bPeripheral intravenous (IV) catheter: A peripheral intravenous (IV) catheter is inserted into
543 small peripheral veins to provide access to administer IV fluids and medications.

544 ^cDrainage tube: insertion of a chest tube, endotracheal, and nasogastric (NG) intubation.

545 ^d Severe acute malnutrition (SAM) diagnosed at the time of hospital admission.

546 ^e The use of antimicrobials before admission either through intravenous (IV), intramuscular (IM)
547 or oral (PO) administration.

548 ^fAny neonate weighting less than 2500 gm at birth irrespective of gestational age was considered
549 low birth weight (LBW).

551 **Table 2: Proportion of hospital-acquired infections among pediatric patients in Goba**
 552 **Referral Hospital, Ethiopia (n=57)**

Hospital-acquired infections	Number	Proportion	95% CI
Pneumonia/ Lower Respiratory Tract Infections/ ^a	32	56.1	43.9-68.4
Late-Onset Neonatal Sepsis	6	10.5	3.5-19.3
Intravenous Line (IV) Site Infections	5	8.8	1.8-15.8
Urinary Tract Infections	4	7.0	1.8-14.0
Systemic Infections	4	7.0	1.8-14.0
Skin/Soft Tissue Infections	2	3.5	0.0-8.8
Measles	2	3.5	0.0-8.8
Early Onset Neonatal Sepsis	1	1.8	0.0-5.3
Surgical Site Infections	1	1.8	0.0-7.0

553 ^a including ventilator-associated pneumonia (VAP) (n=7) & VAP developed in 9.21% [7/76] of
 554 children undergoing mechanical ventilation; CI: Confidence Interval

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558 **Table 3: Bi-variate association of factors for the occurrence of hospital-acquired infections**
 559 **among pediatric patients in Goba Referral Hospital, southeast Ethiopia 2019 (n=448)**

Variables	Category	Presence of HAIs		Crude RR
		Yes (57)	No (391)	
Sex	Male	30	218	0.88(0.55-1.45)
	Female	27	173	1
Age (months)	1-12	33	252	0.78(0.48-1.28)
	>12	24	139	1
Residence	Urban	12	117	0.65(0.36-1.20)
	Rural	45	274	1
Hospital Duration (median day)	≤ 6	17	220	1
	> 6	40	171	2.64(1.54-4.51)*
Admission Unit	NICU	27	174	1.10(0.68-1.79)
	Pediatrics	30	217	1
Patient Received Antimicrobials	Yes	17	154	1
	No	27	194	1.22(0.69-2.17)
	Unknown	13	43	2.33(1.21-4.50)*
Previous Hospitalization	Yes	7	39	1.22(0.58-2.53)
	No	50	352	1
Mechanical Ventilation	Yes	12	64	1.30(0.68-2.71)
	No	45	327	1
Presence of Urinary Catheters	Yes	2	7	1.77(0.50-6.17)
	No	55	384	1
Drainage Tube Inserted	Yes	14	39	2.42(1.42-4.12)*
	No	43	352	1
Severe acute malnutrition (SAM)	Yes	13	41	2.15(1.24-3.73)*
	No	44	350	1
Surgery After Admission	Yes	4	43	0.64(0.24-1.69)
	No	53	348	1

560 RR: Risk Ratio; * p-value < 0.05 (Crude)

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3 **Table 4: Multivariable logistic regression analysis on factors associated with hospital-**
4 **acquired infections among patients in Goba Referral Hospital, southeast Ethiopia 2019**
5 **(n=448)*†**
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Variables	Category	Patient with HAIs (n=57)	Adjusted RR	Attributable Risk (AR) ^a
Hospital Duration	≤ 6	17	1	
	> 6	40	2.58(1.52-4.38)**	0.12
Patient Received Antimicrobials	Yes	17	1	
	No	27	1.25(0.71-2.19)	
	Unknown	13	1.93(0.84-4.42)	
Drainage Tube Inserted	Yes	14	1.77(0.88-3.54)	
	No	43	1	
Severe acute malnutrition (SAM)	Yes	13	2.83(1.61-4.97)**	0.13
	No	44	1	

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24 *Hosmer and Lemeshow Test (p=0.166); RR: Risk Ratio; ** p-value < 0.05 (adjusted)

25 † Adjusted for age, sex, admission unit, mechanical ventilation, and presence of a urinary catheter

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27 ^aAttributable risk is the difference between the risk HAIs in the exposed group and the
28 unexposed group.
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4 570 **Figure Legends**

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6 571 Figure 1: Bar graph showing the age distribution of study participants by sex.

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8 572 Figure 2: Bar graph showing the type of HAIs by type of admission ward.

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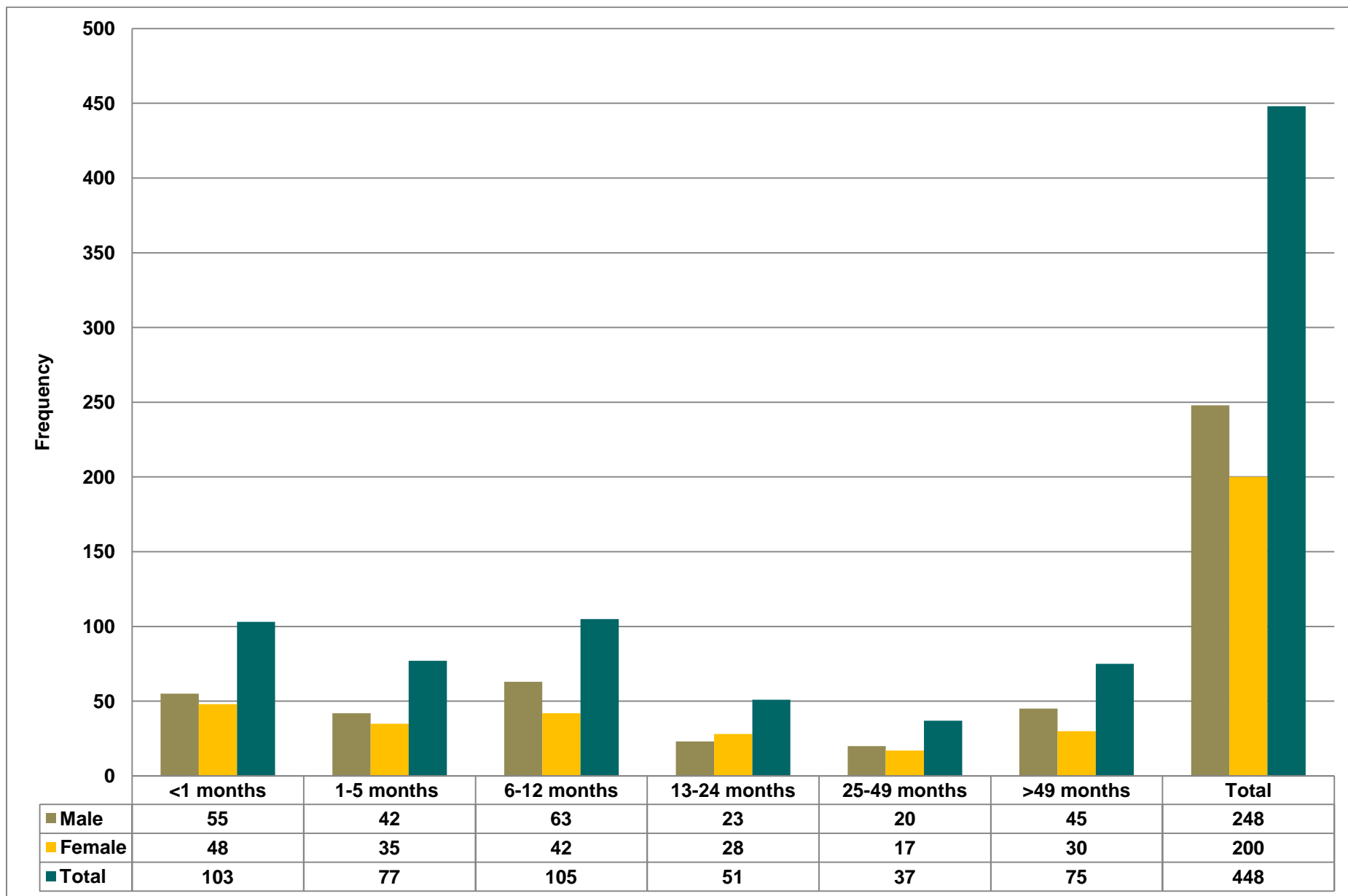
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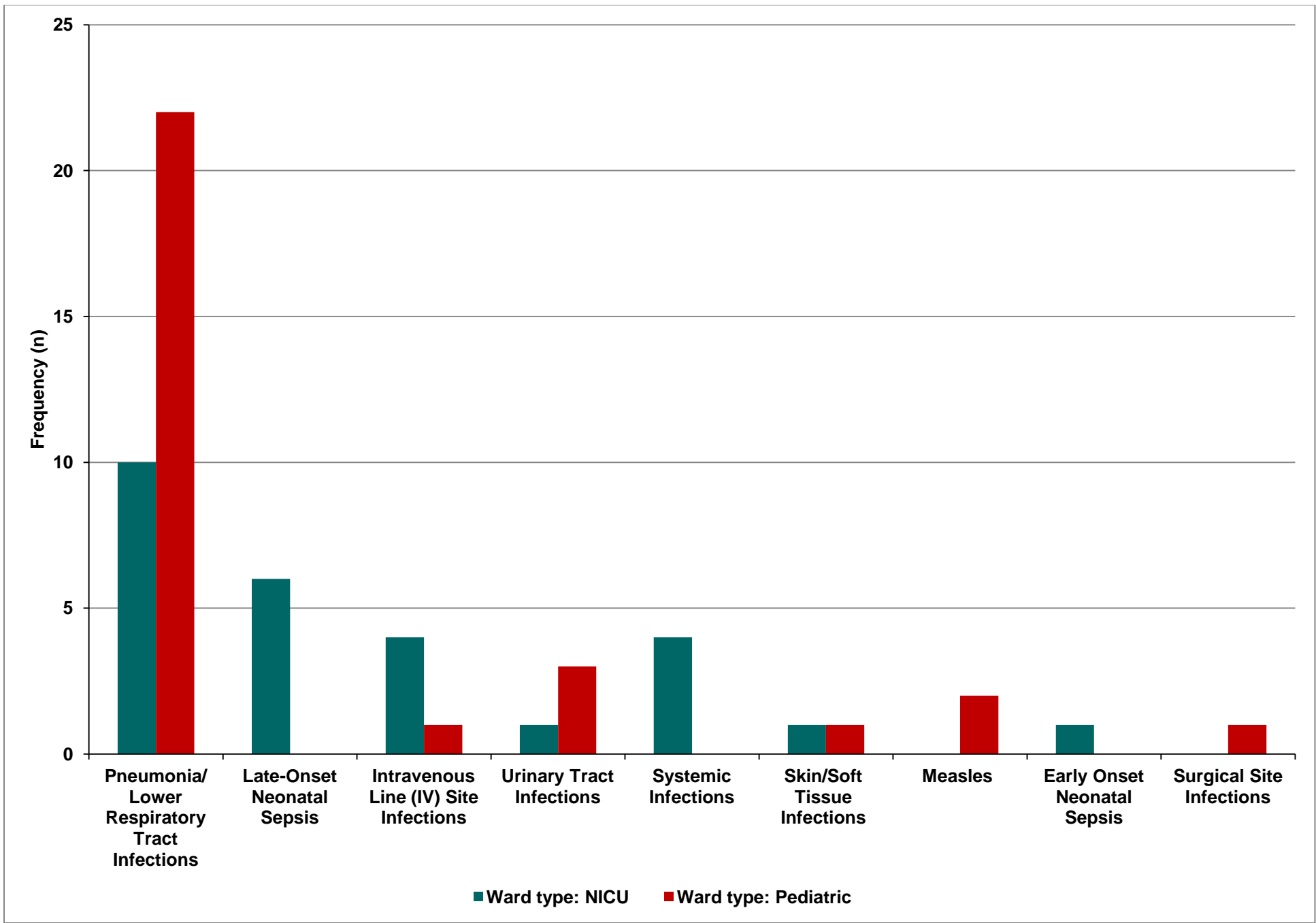
574 **Additional Files**

575 **S1 File: English version of the survey questionnaire**

576

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Data collection tool

1. Patient ID/CODE _____
2. Ward _____ Bed number _____ MRN _____
3. Age _____
4. Sex _____
5. Residence A. Urban _____ B. Rural _____
6. Reason for admission/Dx at the time of admission _____

7. Complete admission diagnoses _____
8. Date of admission _____
9. Patient health condition at the time of admission

10. Is there any other localized infection? Yes No
11. If yes, type of treatment given _____
12. Previous hospitalization Yes No
13. If yes for question 14:
 - a. Place (including ward) _____
 - b. Time (month/year) _____
 - c. Duration _____
14. Previous antibiotic use for the current illness A. Yes _____ B. No _____
15. If yes for question 15, specify _____
16. If yes for question 15, for how many days? _____ days
17. Being on mechanical ventilator? A. Yes _____ B. No _____
18. Presence of intravenous line? A. Yes _____ B. No _____
19. Presence of urinary catheters? A. Yes _____ B. No _____
If yes, for how long _____
20. Indication for catheterization _____

1
2
3 21. Drainage inserted ? A. Yes _____ B. No _____
4

5 If yes, for how long _____
6

7 22. Indication for drainage _____
8

9 23. Presence of invasive medical devices? A. Yes _____ B. No _____
10

11 24. If yes for questions 20,21,22,26 (more than one answer is possible)
12

13 A. Endotracheal tube? A. Yes _____ B. No _____
14

15 B. NGT A. Yes _____ B. No _____
16

17 C. Chest tube A. Yes _____ B. No _____
18

19 25. Peripheral intravenous line (IV) catheter A. Yes _____ B. No _____
20

21 26. Insertion of a urinary catheter A. Yes _____ B. No _____
22

23 27. Intubation A. Yes _____ B. No _____
24

25 28. Underlying diseases? A. Yes _____ B. No _____
26

27 29. If yes, underlying diseases (more than one answer is possible)
28

29 i. Diabetes mellitus vi. Cardiac disorders
30

31 ii. Chronic renal failure vii. Severe malnutrition (SAM)
32

33 iii. Hypertension viii. TB
34

35 iv. Chronic liver disease ix. Cancer
36

37 v. HIV/AIDS x. Others (specify)
38

39 30. Surgery since admission A. Yes _____ B. No _____
40

41 31. Surgical procedure done? A. Yes _____ B. No _____
42

43 If yes for question 36,
44

45 A. Type of surgery A. Elective _____ B. Emergency _____
46

47 B. Type of the procedure _____
48

49 C. Date _____ Time _____
50

51 D. Duration of the surgery _____ hours
52

53 E. Type of surgical wound A. Clean B. Clean contaminated C. Contaminated D.
54

55 Dirty
56

57 32. Antibiotic prophylaxis given? A. Yes _____ B. No _____
58

59 If yes for Q36, specify/name of antibiotic _____
60

If yes for Q36, how many doses? _____

33. Duration of stay hospital stay in days _____

1
2
3 34. Severe anaemia [haemoglobin <50 g/L (for patients older than 28 days) or haemoglobin
4 <90 g/L (for neonates)]

5
6 A. Yes _____ B. No _____ C. Unknown/not tested _____

7
8 35. Immune deficiency A. Yes _____ B. No _____ C. Unknown/not tested _____

9
10 36. Nutritional status WAZ score (Weight-for-age Z score) A. >-3 B. -3 to 4 C.<-4

11
12 37. McCabe score

13 A. Non-Fatal diseases

14 B. Ultimately fatal diseases

15 C. Rapidly fatal diseases

16 D. Unknown

17
18 38. American Society of Anesthesiology (ASA) classification

19 a. Normally health patient

20 b. Patient with mild systemic diseases

21 c. Patient with severe systemic disease that is not incapacitating

22 d. Patient with incapacitating systemic diseases that is a constant threat to life

23 e. Unknown

24
25 39. HIV status A. Reactive B. Non-reactive C. Unknown

26
27 40. Presence of HAIs based on CDC definition:

28
29 _____
30 _____

31
32 41. Type of HAIs:

33
34 _____
35 _____

36
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40
41
42
43
44 Name of data collectors : _____ Signature _____ date

45
46 Name of supervisor _____ Signature _____ date

STROBE 2007 (v4) checklist of items to be included in reports of observational studies in epidemiology*
Checklist for cohort, case-control, and cross-sectional studies (combined)

Section/Topic	Item #	Recommendation	Reported on page #
Title and abstract	1	(a) Indicate the study's design with a commonly used term in the title or the abstract	1
		(b) Provide in the abstract an informative and balanced summary of what was done and what was found	2
Introduction			
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	4-5
Objectives	3	State specific objectives, including any pre-specified hypotheses	5
Methods			
Study design	4	Present key elements of study design early in the paper	6
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	6
Participants	6	(a) <i>Cohort study</i> —Give the eligibility criteria, and the sources and methods of selection of participants. Describe methods of follow-up <i>Case-control study</i> —Give the eligibility criteria, and the sources and methods of case ascertainment and control selection. Give the rationale for the choice of cases and controls <i>Cross-sectional study</i> —Give the eligibility criteria, and the sources and methods of selection of participants	6
		(b) <i>Cohort study</i> —For matched studies, give matching criteria and number of exposed and unexposed <i>Case-control study</i> —For matched studies, give matching criteria and the number of controls per case	NA
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	7
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	7
Bias	9	Describe any efforts to address potential sources of bias	7
Study size	10	Explain how the study size was arrived at	NA
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	7
Statistical methods	12	(a) Describe all statistical methods, including those used to control for confounding	7
		(b) Describe any methods used to examine subgroups and interactions	NA
		(c) Explain how missing data were addressed	NA
		(d) <i>Cohort study</i> —If applicable, explain how loss to follow-up was addressed <i>Case-control study</i> —If applicable, explain how matching of cases and controls was addressed	NA

		<i>Cross-sectional study</i> —If applicable, describe analytical methods taking account of sampling strategy	
		(e) Describe any sensitivity analyses	NA
Results			
Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed	9
		(b) Give reasons for non-participation at each stage	9
		(c) Consider use of a flow diagram	NA
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	9
		(b) Indicate number of participants with missing data for each variable of interest	NA
		(c) <i>Cohort study</i> —Summarise follow-up time (eg, average and total amount)	NA
Outcome data	15*	<i>Cohort study</i> —Report numbers of outcome events or summary measures over time	NA
		<i>Case-control study</i> —Report numbers in each exposure category, or summary measures of exposure	NA
		<i>Cross-sectional study</i> —Report numbers of outcome events or summary measures	9-10
Main results	16	(a) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included	9-10
		(b) Report category boundaries when continuous variables were categorized	NA
		(c) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	9
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	NA
Discussion			
Key results	18	Summarise key results with reference to study objectives	11
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias	12
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	11-12
Generalisability	21	Discuss the generalisability (external validity) of the study results	12
Other information			
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	13

*Give information separately for cases and controls in case-control studies and, if applicable, for exposed and unexposed groups in cohort and cross-sectional studies.

Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at <http://www.plosmedicine.org/>, Annals of Internal Medicine at <http://www.annals.org/>, and Epidemiology at <http://www.epidem.com/>). Information on the STROBE Initiative is available at www.strobe-statement.org.

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Incidence and risk factors for hospital-acquired infection among pediatric patients in a teaching hospital: a prospective study in southeast Ethiopia

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Keywords:	PAEDIATRICS, NEONATOLOGY, PUBLIC HEALTH, EPIDEMIOLOGY, Infection control < INFECTIOUS DISEASES, Paediatric intensive & critical care < INTENSIVE & CRITICAL CARE

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4 1 **Incidence and risk factors for hospital-acquired infection**
5
6 2 **among pediatric patients in a teaching hospital: a**
7
8 3 **prospective study in southeast Ethiopia**
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10

11 4 Biniyam Sahiledengle^{1*}, Fekadu Seyoum², Daniel Abebe², Eshetu Nigussie Geleta³, Getahun
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17 Abstract

18 **Objectives:** In order to maximize the prevention of hospital-acquired infections (HAIs) and
19 antimicrobial resistance, data on the incidence of HAIs are crucial. In Ethiopia, data about the
20 occurrence of HAIs among hospitalized pediatric patients are lacking. We aim to determine the
21 incidence and risk factors of hospital-acquired infections among pediatric patients in Ethiopia.

22 **Design:** A prospective cohort study

23 **Setting:** A teaching hospital in southeast Ethiopia

24 **Participants:** 448 hospitalized pediatric patients admitted between November 1, 2018 and
25 June 30, 2019.

26 **Primary and secondary outcome measures:** Incidence and risk factors of hospital-
27 acquired infections.

28 **Results:** A total of 448 pediatric patients were followed for 3,227 patient days. The median age
29 of the patients was 8 months (interquartile range (IQR): 2-26 months). The incidence rate of
30 hospital-acquired infections was 17.7 per 1000 pediatrics days of follow up; while the overall
31 cumulative incidence was 12.7% (95% CI: 9.8-15.8) over eight months. Children who stayed
32 greater than 6 days in the hospital (median day) [adjusted RR: 2.58, 95%CI (1.52-4.38)], and
33 children with underlying disease conditions of severe acute malnutrition [adjusted RR: 2.83, 95%
34 CI (1.61-4.97)] had higher risks of developing hospital-acquired infections.

35 **Conclusions:** The overall cumulative incidence of hospital-acquired infections was about 13
36 per 100 admitted children. Length of stay in the hospital and underlying conditions of severe
37 acute malnutrition were found to be important factors associated with increased risk of hospital-
38 acquired infections.

39 **Keywords:** Nosocomial infection, Hospital-acquired infection, Pediatric patients, Ethiopia

41 **Strengths and limitations of this study**

- 42 • To the best of our knowledge, this is the first prospective study that examines the
43 incidence and risk factors of hospital-acquired infections (HAIs) among pediatric patients
44 in Ethiopia.
- 45 • We did not use laboratory culture to isolate organisms as a guide in addition to the
46 clinical criteria to confirm the results of HAIs-which could have affected our results.
- 47 • In this study, we focused on a small number of risk factors for hospital-acquired
48 infections; some important variables were not included, as well.

50 Introduction

51 There is a “perfect storm” on hospital-acquired infections (HAIs) among hospitalized patients at
52 any point in time throughout the globe. HAI is defined as an infection occurring in a patient
53 during the process of care in a hospital or other healthcare facilities that is not manifested or
54 incubating at the time of admission¹. Currently, it is a growing public health problem which
55 concerns both the medical and the general community, and a rising issue for patient safety and
56 quality of care in every level²⁻⁸. A study by Sheng et al. reported that 80% of hospitalized patient
57 deaths were linked to nosocomial infection (NI)⁹. Available evidences also showed that financial
58 burden, increased resistance of microorganisms to antimicrobials, prolonged hospital stay, and
59 sometimes deaths, are caused by HAIs^{10, 11, 12}.

60 Worldwide, it is estimated that hundreds of millions of patients every year in both developed and
61 developing countries are affected by HAIs⁷. In some Australian public hospitals, HAIs affect one
62 in every 74 hospitalizations¹³. In Europe, the total annual number of patients with HAIs in 2011–
63 2012 was estimated around 3.2 million. The prevalence of patients with at least one HAI in acute
64 care hospitals was 6.0% (country range 2.3%–10.8%)¹⁴. Moreover, throughout Europe, HAIs
65 accounted for 16 million additional days, with total costs estimated at approximately €7
66 billion^{14,15,16}. In the United States, approximately two million patients developed HAIs, and
67 nearly a hundred thousand of these patients were estimated to die annually. This ranked HAIs as
68 the fifth leading cause of death in acute care hospitals, and the risk of acquiring infection is 2 -20
69 times higher in some developing countries^{17,18}.

70 In some developing countries, the magnitude of HAIs remains underestimated and uncertain¹².
71 There is little information available on the epidemiology of HAIs in African countries^{19,20}.
72 Although data are sparse, evidence suggested that HAIs are considerably adding to the available
73 high burden of infections in some sub-Saharan African countries²¹. A systematic review by
74 Nejad et al reported that hospital-wide HAI prevalence in Africa varied between 2.5% and
75 14.8%. This review has shown that published studies were only conducted in 10 African
76 countries – emphasized there were paucities of information available among the epidemiology of
77 HAIs in many African countries¹⁹. In addition to this, a recent review by Irek et al (2018)
78 indicated that there was a scarcity of studies on HAIs in Africa – of the 35 eligible articles

1
2
3 79 retrieved, more than half (n = 21, 60%) were from East Africa only ²⁰. In addition, most of the
4
5 80 HAIs literatures only focused on adults, and the data on HAIs among the pediatric population in
6
7 81 sub-Saharan Africa were hardly available ^{15,19,22}. For example, a systematic review conducted by
8
9 82 the World Health Organization (WHO) in the year 2010, identified no reports on pediatric
10
11 83 nosocomial bacteremia in some African countries between 1995 and 2008 ¹⁵.

12
13 84 In Ethiopia, little is known about the incidence and prevalence of HAIs in the neonatal and
14
15 85 pediatric populations. Moreover, previously conducted studies focused only on adults, and many
16
17 86 of these were limited to surgical site infections ²³⁻²⁸, with an estimated prevalence of 10.9% ²⁴ to
18
19 87 66.5% ²⁷. The overall cumulative incidence was 35.8 per 100 patients²⁶. Furthermore, urinary
20
21 88 tract and bloodstream infections were found to be the commonest forms of HAIs in Ethiopia ²⁹⁻³³.
22
23 89 Surgery after admission ^{23,26}, underlying medical conditions^{23,25}, patients with catheters ^{23,25,26},
24
25 90 patient on mechanical ventilators²⁶, immune-deficient patients ^{23,25}, patients age ^{26,32,33}, hospital
26
27 91 types ³², the types of ward, and prolonged hospitalizations³³ were found to be important factors
28
29 92 associated with increased risks of HAIs in Ethiopia.

30
31 93 Up to date, there are no surveillance programs at the regional or national levels which targeted
32
33 94 HAIs in Ethiopia. The available evidence on HAIs in the country was originated from primary
34
35 95 studies. Moreover, to the best of our knowledge, there is not a single published report on the
36
37 96 incidence and risk factors of HAIs among pediatric patients in Ethiopia. In order to maximize the
38
39 97 prevention of hospital-acquired infections (HAIs) and antimicrobial resistance in Ethiopia,
40
41 98 epidemiological data on the incidence of HAIs are crucial because without a valid and precise
42
43 99 assessment of HAIs, the problem remains unnoticed. Therefore, this study was designed to
44
45 100 determine the incidence and risk factors of HAIs among pediatric patients in Goba Referral
46
47 101 Hospital, Southeast Ethiopia. The current study will help policymakers to improve their decision
48
49 102 makings and inputs for healthcare professionals, for the improvement of patient care.

104 **Methods**

105 **Study design and setting**

106 A hospital-based prospective follow up study was conducted from November 1, 2018, to June
107 30, 2019, at Mada Walabu University Goba Referral Hospital, Southeast Ethiopia. Goba
108 Referral Hospital is the only referral and teaching hospital in the Bale zone, serving over
109 1,787,575 million people. Goba Referral Hospital is located 445 km far from the capital city of
110 Ethiopia. According to the 2018 annual report of Goba Referral Hospital, the average outpatient
111 flow is over 96,661, and the annual admission is over 7,886 patients, of which 1,335 were
112 admitted in the pediatrics ward and Neonatal Intensive Care Unit (NICU). The hospital has a
113 total of 127 inpatients beds – of which 30 and 15 are in the pediatric ward and NICU,
114 respectively.

115 **Study population and eligibility criteria**

116 All patients (age less than 18 years) admitted to the pediatric ward and neonatal intensive care
117 unit (NICU) were enrolled, and those who at least stayed for 48 hours, were eligible for the
118 study. Enrolled patients who showed signs of infections and/or symptoms of infection within the
119 first 48 hours were excluded from the study.

120 **Data collection procedures**

121 Firstly, consent was sought from each of the child's parent/guardian before commencing any
122 study procedures. On admission, all children were evaluated clinically to exclude community-
123 acquired infections by a pediatrician. Afterwards, socio-demographic and clinical data were
124 collected through a structured questionnaire using individual patient chart investigation
125 approach-accordingly-a detailed clinical history of patients were taken and recorded. Patients
126 with no new signs or symptoms of infection after the first 48 hours from admission were
127 included and followed prospectively for the development of HAIs during their stay in the
128 hospital. Data were collected from enrolled patients on a daily basis: children were followed by a
129 pediatrician daily, charts were reviewed, and discussions with nurses and physician caring for the

1
2
3 130 patients were held. HAIs were confirmed by senior pediatrician specialists working in the
4
5 131 respective NICU and pediatrics ward (**Figure 1**).

6
7 132 Data were collected by trained physicians and one pediatrician. The Center for Diseases Control
8
9 133 and Prevention (CDC)/ National Health Care Safety Network (CDC/NHSN) Surveillance
10
11 134 Definition for hospital-acquired infections was used³⁴. In this study, the usage of any
12
13 135 antimicrobials and information on the use of different medical devices at the time of hospital
14
15 136 admission and before the diagnosis of HAIs were recorded, respectively (**S1 File**).

17 137 **Data quality control**

18
19
20
21 138 The data collection tool was adapted from different related pieces of literatures based on the
22
23 139 available evidences of HAIs^{1,23,26,32}. To ensure the quality of data, the data collection tool was
24
25 140 pre-tested before the data collection period. The training was given for data collectors on the
26
27 141 study procedures, and with practical exercise sessions. Data collection was closely supervised by
28
29 142 a principal investigator, and the collected data were checked for completeness, accuracy, and
30
31 143 consistency. In order to minimize the potential effects of confounder variables, multivariable
32
33 144 logistic regression model was used, and analyses were adjusted to known confounder, such as
34
35 145 age. In addition, the researchers try to reduce selection bias by including all admitted patients in
36
37 146 our follow ups. Moreover, to reduce the effect of observer bias the data collectors have no
38
39 147 preconceived expectations of what they should find in an examination.

40 148 **Operational definition**

41
42
43 149 **Hospital-Acquired Infection (HAI)** – a localized or systemic condition that results from an
44
45 150 adverse reaction in the presence of an infectious agent or its toxin, and occurring 48 hours or
46
47 151 longer after hospital admission, which was not incubating at the time of admission ^{14,19,23,26,32 34}

48 152 **Severe Anemia** - haemoglobin <50 g/L (for patients older than 28 days) or haemoglobin <90 g/L
49
50 153 (for neonates)

51 154 **Late-onset neonatal sepsis:** Infection occurring after birth, but excluding infections known to
52
53 155 have been transmitted across the placenta.

54 55 56 156 **Study variables**

1
2
3 157 The outcome variable of the study was the occurrence of hospital-acquired infections (HAIs).
4
5 158 The presence of HAIs were confirmed when the patients met the criteria for signs and symptoms
6
7 159 determined by the Center for Disease Control and Prevention³⁴, wherein, the independent
8
9 160 variables included: socio-demographic characteristics (age of the child, sex, place of residence,
10
11 161 and previous hospitalization), and clinical and other related variables (duration of hospitalization,
12
13 162 insertion of a urinary catheter, presence of peripheral intravenous (IV) catheter, received anti-
14
15 163 microbial, American Society of Anesthesiology (ASA) classification, intubation, surgery after
16
17 164 admission, underline disease-refers to Severe acute malnutrition (SAM) presented at the time of
18
19 165 admission, mechanical ventilator, and HIV status).

20 166 **Data processing and analysis**

21
22
23 167 Data were entered into Epi-data version 3.1 and exported to STATA version 14 statistical
24
25 168 software for further analysis. Descriptive statistics were computed to present the frequency
26
27 169 distribution of important variables. The cumulative incidence (incidence proportion) was
28
29 170 calculated as the number of new HAIs cases per person in the population over a defined period
30
31 171 of time; and it is the probability of developing HAIs over a stated study period (8 months). We
32
33 172 estimated the incidence rate as the number of HAIs cases per unit of time, and the denominator
34
35 173 represents the total amount of time "at-risk" without experiencing HAIs for all children whom
36
37 174 were being followed for 8 months. The incidence rate of HAIs was reported per 1000 patient
38
39 175 days. Multivariable logistic regression was used to identify factors with an increased risk of
40
41 176 HAIs. Variables, that were assumed confounders based on their statistical significant result in the
42
43 177 bivariate analysis, were included in the multivariable model. An adjusted risk ratio (ARR) with a
44
45 178 95% confidence interval (CI) was used to determine the strength of association. A p-value < 0.05
46
47 179 was used to declare statistical significances. Multicollinearity diagnosis was performed between
48
49 180 categorical variables by looking at values of variance inflation factors (VIF). The final model
50
51 181 fitness was assessed by using the Hosmer-Lemeshow goodness of fit test.

52 182 **Patient and public involvement**

53 183 Patients and the public were not involved in the planning, designing, and interpreting these data
54
55 184 analyses.

186 **Results**

187 **Socio-demographic characteristics of the study participants**

188 A total of 487 pediatrics patients were enrolled in this study. However, 39 pediatric patients
189 showed signs of infections and/or symptoms of the infection within the first 48 hours, and were
190 excluded from the study. The remaining 448 pediatric patients were followed up for the
191 occurrence of HAIs until their hospital discharge, referred to other healthcare facilities, or death.
192 Of the total patients included in the study, 201 (44.9%) were from the neonatal intensive care
193 unit (NICU), and the rest were from the pediatrics ward. Two hundred forty-eight (55.4%) of the
194 study participants were male with an overall male-to-female ratio of 1.24: 1. Also, the median
195 age of the participants was 8 months (interquartile range (IQR): 2-26 months). In addition, the
196 age distribution of the study participants by sex was presented in **Figure 2**. Moreover, three
197 hundred and ninety (71.2%) of the study participants were from rural areas. The median hospital
198 stay of the patients was 6 days (IQR: 3-9 days), and among them, 24 (5.4%) died. The overall
199 incidence density rate of the admitted pediatrics mortality was 7.44 per 1000 pediatrics days of
200 follow ups (**Table 1**).

201 **Clinical characteristics of patients**

202 In this study, 46 (10.3%) of the participants had histories of previous hospitalizations within the
203 last 30 days. Fifty-four, (12.1%) of the children were diagnosed with severe acute malnutrition
204 (SAM) at the time of their admission. Severe anemia was reported among 41 (9.2%)
205 respondents. Overall, one hundred and seventy-one (38.2%) patients received antimicrobials at
206 the time of the study (**Table 1**).

207 **Incidence and type of hospital-acquired infection**

208 During the study period, 448 pediatric patients were followed for a total of 3,227 patient days. A
209 total of 57 patients experienced HAIs, and none of the study participants were identified with
210 more than one episode of HAIs. The mean time of diagnosis of HAIs in Goba Referral Hospital
211 is 7.20 (95% CI: 6.72, 7.66) patient days. The overall incidence rate of HAIs was 17.7 per 1000
212 pediatrics days of follow ups, while the cumulative incidence was 12.7% (95% CI: 9.8-15.8)
213 over eight months. The mean length of stay for the infected pediatric patients was 11.5 days
214 (95% CI: 9.5-13.4), while it was lower for the remaining patients, at 6.5 days.

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3 215 **Table 2** illustrates the proportion of HAIs among the pediatrics patients in Goba Referral
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5 216 Hospital. Hospital-acquired pneumonia was the commonest type of HAI which was observed
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7 217 among the pediatrics patients with a proportion of 56.1% (95%CI: 43.9-68.4), followed by late-
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9 218 onset neonatal sepsis 10.5% (95%CI: 3.5-19.3), and the least HAI observed were early onset of
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11 219 neonatal sepsis and surgical site infections, with an overall proportion of 1.8% each. In this
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13 220 study, the stratification of the types of HAIs by ward of admission revealed significant variability
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15 221 (p-value= 0.007) (**Figure 3**).
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223 **Risk factors of hospital-acquired infections**

19 224 **Table 3** showed the risk factors of HAIs among the pediatric patients in Goba Referral Hospital.
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21 225 Bivariate analysis of risk ratio has indicated that hospital duration (> 6 days), patients whom
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23 226 received antimicrobial medications, presence of drainage tubes, and children diagnosed for
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25 227 SAM, were predisposed to HAIs.

26 228 In the adjusted model, the risk of HAIs was 2.58 times more likely to be higher among children
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28 229 who stayed longer than or equal to 6 days (median day) than those who stayed less [adjusted RR:
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30 230 2.58, 95%CI (1.72-4.38)]. Patients with SAM conditions had 2.83 times higher risks of
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32 231 developing HAIs compared to its counterparts [adjusted RR: 2.83, 95% CI (1.61-4.97)]. Socio-
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34 232 demographic and some clinically related confounders could not show any statistically significant
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36 233 associations (**Table 4**).

37 234 In this study, we estimated the attributable risk, which estimates the excess risk of disease in
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39 235 those exposed compared to those non-exposed. The excess occurrence of HAIs among children
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41 236 with underlying SAM diseases attributable to their SAM condition is 13 per 100 (**Table 4**).
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240 Discussion

241 Hospital-acquired infections (HAIs) are current global challenges that increase morbidities,
242 mortality, and massive economic cost³⁵⁻³⁹. Yet, there remain limited data on the occurrences of
243 HAIs in hospitalized pediatric patients in Sub-Saharan African, including Ethiopia. This study
244 was designed to determine the incidence and risk factors of HAIs among pediatric patients in a
245 teaching hospital, southeast Ethiopia. The overall incidence rate of HAIs was 17.75 per 1000
246 pediatrics days of follow up while the cumulative incidence was 12.7% (95% CI: 9.8-15.8) over
247 eight months. Children who stayed longer than the median day (6 days) in the hospital, and
248 children with underlying disease conditions (Severe acute malnutrition), had higher risks of
249 developing HAIs.

250 In this study, the overall incidence rate of HAIs was 17.7 per 1000 pediatrics days of follow ups.
251 This finding is lower than a related prospective study by Ali et al (2018) from Southwest
252 Ethiopia, which reported an incidence of HAIs of 28.15 per 1000 patient days³⁹. The difference
253 might be associated with the nature of this study which involved only pediatrics patients
254 including those in intensive care; whereas, the study by Ali et al included adult study participants.
255 Also, variations in some studies could be attributed to differences in geographical locations and
256 the study settings (as in the case of Ali et al where the study they included a specialized
257 hospital). A previous before-and-after study conducted in a teaching hospital in Indonesia
258 involved children whom were admitted to the pediatric intensive care unit and pediatrics ward,
259 reported the incidence density rate of HAI 29.1 per 1000 patient days, which is similar to our
260 findings.³⁶

261 One of our findings has also revealed that the overall cumulative incidence of HAIs was 12.7%;
262 this is comparable to those reported from a study in the United States (11.9%)³⁷ which was
263 conducted in the pediatric intensive care unit, and (13.3%) in Poland³⁸. Also, the present 12.7%
264 of HAIs noted in our study population fell in the ranges of 9.8-15.8% , and is reported elsewhere
265^{14, 40, 41}, and the WHO pooled estimated for low-income countries 10.1%¹⁸. Conversely, similar
266 studies from Turkey reported a much higher prevalence of HAIs among children ranging
267 between 22.2 and 68.4%^{42,43}, and in a multicenter prospective study from Europe reported
268 18.5%⁴⁴ among pediatric patients.

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3 269 The present study also demonstrated that the occurrence of HAIs was higher among male
4 participants (52.6%) than females. This result was also supported by other studies conducted
5 270 elsewhere ^{40, 45-47}. In the same vein, one study carried out by Koch et al in Norway reported that
6 271 males present higher overall HAI prevalence than females⁴⁸.
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11 273 The commonest type of HAI observed in this study was hospital-acquired pneumonia (HAP),
12 274 which contributed to a proportion of 56.1% of the total HAIs. It may not be a surprise to see such
13 a high proportion of HAI in the NICU and pediatrics ward since most of the patients admitted in
14 275 intensive care are incapacitated and critical. Moreover, compared to adults, infants and neonates
15 276 are immunologically immature, and in many cases, vulnerable ^{49,50}. The finding was similar to
16 277 the study done in Tikur Anbessa Hospital, Ethiopia ³³. It is also true for other settings—in Iran
17 278 43.7% ⁵¹, India 50% ⁵², Vietnam 41.9% ⁵³, Morocco 34.5% ⁵⁴, Saudi Arabia 46.7% ⁵⁵, 52.2%
18 279 China ⁵⁶, and in a European multicenter prospective study 53% ⁴⁴. The high burden of HAP
19 280 among hospitalized pediatrics patients has important implications in terms of hospital length of
20 281 stay, healthcare cost, and mortality. The overall mortality attributed to HAP has been as high as
21 282 30 to 50% ⁵⁷. In this study, ventilator-associated pneumonia (VAP) developed in 9.21% [7/76] of
22 283 children who underwent mechanical ventilation. Our estimate is in line with studies conducted
23 284 on children reporting VAP, which occurs in 3 to 10% of ventilated pediatric ICU
24 285 patients.^{36,58,59,60}
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36 287 In this study, the risk of developing HAIs was three times higher among children who stayed
37 288 longer than or equal to the median six days than their counterparts. Despite this positive
38 289 association, this is not a proof that decreasing the length of stay neither increasing admission
39 290 days increase/decrease the occurrence of HAIs. Possible reversed causation may be one of the
40 291 mechanisms why this prolonged length of stay is associated with HAIs. Moreover, there is
41 292 evidence that HAIs cause a prolonged length of stay ⁶¹⁻⁶⁵. In our findings, the presence of
42 293 underlying diseases, such as SAM, was recognized as the main risk factor for HAIs. This was
43 294 consistent with the finding from another study in Ethiopia ²⁴, that underlying illnesses increased
44 295 the susceptibility of patients, and predisposed them to infections secondary to the reduction of
45 296 the patient's immune response that exacerbated the illnesses thru which in many cases, had
46 297 significant factors that contributed more to the acquisition of HAIs in neonates and pediatric
47 298 patients ^{41, 66, 67}.
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299 **Limitations of the study**

300 Several limitations on this prospective study needed to be considered. First, we did not assess the
301 healthcare workers' infection prevention practices that would have been associated with the
302 prevalence of HAIs. Second, the researchers did not examine the number of HAIs after the
303 patients were discharged. Third, despite that we followed the patients until their discharge, the
304 full burden of HAI could not be captured in this specific study, and is limited to in-hospital
305 assessment only, leaving outpatients whom may have potentially developed HAIs after
306 discharge. Fourth, we focused on a small number of risk factors for hospital-acquired infections
307 and some important variables were not included. Fifth, the used analysis does not take any time-
308 varying risk into account. Sixth, since there were limited information on the patients' medical
309 record folders more social determinant variables were not collected. In addition, this study is not
310 free from the effects of information bias as we are not utilized 'blinding'. Another limitation of
311 the study is that we could not adjust the results for the effect of social determinant variables on
312 HAIs because the information on these social determinant variables was not collected in our
313 study. Finally, laboratory cultures to isolate organisms as a guide were not utilized in addition to
314 the clinical criteria to confirm the results of HAIs because of financial constraints, laboratory
315 facilities, and expertise. Given the lack of microbiology data, endogenous infections may be
316 misclassified as HAIs. Since the study was conducted in a teaching referral hospital, the
317 generalization of the study findings was limited to these facilities.

318 **Conclusions**

319 The present study revealed that the cumulative incidence of hospital-acquired infections (HAIs)
320 was 13 per 100 admitted children. And the overall incidence rate of HAIs was 17.75 per 1000
321 pediatrics days. Length of stay in the hospital and patients with severe acute malnutrition (SAM)
322 conditions were associated with increased risk of hospital-acquired infections. Further studies are
323 strongly recommended to identify other important factors including isolating of bacterial, fungal,
324 and viral agents responsible for HAIs in the region.

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329

330 **Contributors**

331 BS has made substantial contributions to conception and design, acquisitions of data, analysis,
332 and interpretation of data. He has written the draft manuscript and provided final approval of the
333 version to be published. FS, DA, ENG, GN, AK, DW, YT, DZ, and BJEQ has made substantial
334 contribution's as well, to design, acquisition of data and analysis, interpretation of data, and
335 revisions of the the article, critically for important intellectual content and provided final
336 approval of the version to be published. All authors read and approved the final manuscript.

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342 **Competing interests**

343 The authors declare that they have no competing interests.

344 **Ethics approval**

345 Ethical clearance was obtained from the Ethical Review Committee of Madda Walabu
346 University (Ref.No: RMW 14/66/64) and a formal letter from Madda Walabu University
347 Research Community Engagement and Technology Transfer Vice President Office was
348 submitted. Written consents from the parents/ legal guardians were obtained after explaining the
349 objectives of the study. Identified pediatric patients having hospital-acquired infections were
350 formally communicated to the physicians and nurses who were in charge of the patients for
351 additional health care services. Throughout the data collection period, confidentiality and privacy
352 of the patients were observed, and a unique identification code rather than their names were
353 substituted.

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4 354 **Data sharing statement**

5 355 Data will be available upon request from the corresponding authors.
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44
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References

1. Prevention of hospital-acquired infections: a practical guide. Geneva: World Health Organization; 2002.
2. Emerson CB, Eyzaguirre LM, Albrecht JS, Comer AC, Harris AD, and Furuno JP. Healthcare-Associated Infection and Hospital Readmission. *Infection control and hospital epidemiology: the official journal of the Society of Hospital Epidemiologists of America*. 2012;33(6):539-44
3. Bates DW, Larizgoitia I, Prasopa-Plaizier N, Jha AK. Global priorities for patient safety research. *BMJ* 2009; 338: b1775.
4. WHO. WHO Guidelines on Hand Hygiene in Health Care: a Summary. World Health Organization (WHO). 2009. Geneva, Switzerland,
5. Geffers C, Gastmeier P. Nosocomial infections and multidrug-resistant organisms in Germany: epidemiological data from KISS (the Hospital Infection Surveillance System). *Dtsch Arztebl Int*. 2011; 108(6):87–93.
6. Lul R. Prevention and Control of Hospital-Related Infections in Low and Middle Income Countries. *The Open Infectious Diseases Journal*. 2010; 4:125-131
7. Allegranzi B, Storr J, Dziekan G, Leotsakos A, Donaldson L & Pittet D. The First Global Patient Safety Challenge “Clean Care is Safer Care”: from launch to current progress and achievements. *Journal of Hospital Infection*. 2007; 65(s2):115–123.
8. Rosenthal VD, Maki DG, Mehta Y, Leblebicioglu H, Memish ZA, Al-Mousa HH, Balkhy H, Hu B, Alvarez-Moreno C, Medeiros EA, Apisarnthanarak A. International Nosocomial Infection Control Consortiu (INICC) report, data summary of 43 countries for 2007-2012. Device-associated module. *American journal of infection control*. 2014 Sep 1;42(9):942-56.
9. Sheng WH, Wang JT, Lin MS, Chang SC. Risk factors affecting in-hospital mortality in patients with nosocomial infections. *J Formos Med Assoc*. 2007;106(2):110—8.
10. Pittet D, Donaldson L. Clean Care is Safer Care: a worldwide priority. *Lancet* 2005; 366: 1246-7
11. Uwaezuoke S, Obu H. Nosocomial infections in neonatal intensive care facilities: cost-effective control strategies in resource-limited countries. *Nigeria Journal of Pediatrics*. 2013; 40(2): 125-132.

- 1
2
3 387 12. Allegranzi B, Pittet D. Preventing infections acquired during healthcare delivery. *Lancet*
4 388 2008; 372: 1719-20
- 5
6 389 13. Independent Hospital Pricing Authority (AU). Activity Based Funding Admitted Patient Care
7 390 2015-16, acute admitted episodes, excluding same day.
- 8
9 391 14. European Centre for Disease Prevention and Control (ECDC). Point prevalence survey of
10 392 healthcare associated infections and antimicrobial use in European acute care hospitals.
11 393 Stockholm: ECDC. 2013.
- 12
13 394 15. Allegranzi B, Bagheri S, Combescure C, Graafmans W, Attar H, Donaldson L et al. Burden
14 395 of Endemic Health Care-Associated Infection in developing countries: Systematic review and
15 396 meta-analysis. *Lancet*. 2011; 377: 288-241.
- 16
17 397 16. Shelley S, Walter H, Robyn K, Christine B, Bonnie B, et al. Prevalence of
18 398 Healthcare Associated Infections in Acute Care Hospitals in Jacksonville, Florida. *Infection*
19 399 control and hospital epidemiology. 2012; 33(3):283–91
- 20
21 400 17. Nelson S, Stone PW, Jordan S, Pogorzelska M, Halpin H, Vanneman M, Larson E. Patient
22 401 safety climate: Variation in perceptions by infection preventionists and quality directors.
23 402 *Interdisciplinary perspectives on infectious diseases*. 2011;2011.
- 24
25 403 18. World health organization (WHO). Infection prevention and control in health care: time for
26 404 collaborative action. Regional Committee for the Eastern Mediterranean. EM/RC57/6. WHO.
27 405 2010.
- 28
29 406 19. Nejad SB, Allegranzi B, Syed SB, Ellis B, Pittet D. Health-care-associated infection in
30 407 Africa: a systematic review. *Bulletin of the World Health Organization*. 2011;89:757-65.
- 31
32 408 20. Irek EO, Amupitan AA, Obadare TO, Aboderin AO. A systematic review of healthcare-
33 409 associated infections in Africa: An antimicrobial resistance perspective. *African journal of*
34 410 *laboratory medicine*. 2018;7(2):1-9.
- 35
36 411 21. Rothe C, Schlaich C, Thompson S. Healthcare-associated infections in sub-Saharan Africa. *J*
37 412 *Hosp Infect*. 2013;85(4):257–67
- 38
39 413 22. Zaidi AK, Huskins WC, Thaver D, Bhutta ZA, Abbas Z, Goldmann DA. Hospital-acquired
40 414 neonatal infections in developing countries. *Lancet* 2005; 365: 1175–88
- 41
42 415 23. Yallem WW, Kumie A, Yehuala FM. Risk factors for hospital-acquired infections in
43 416 teaching hospitals of Amhara regional state, Ethiopia: A matched-case control study. *PloS*
44 417 *one*. 2017 Jul 18;12(7):e0181145.

- 1
2
3 418 24. Mulu W, Kibru G, Beyene G, Damtie M. Postoperative nosocomial infections and
4 antimicrobial resistance pattern of bacteria isolates among patients admitted at Felege Hiwot
5 419 Referral Hospital, Bahirdar, Ethiopia. *Ethiopian journal of health sciences*. 2012;22(1):7-18.
6 420
7 421 25. Gedebe M, Habte-Gabr E, Kronvall G, Yoseph S. Hospital-acquired infections among
8 422 obstetric and gynaecological patients at Tikur Anbessa hospital, Addis Ababa. *J Hosp Infect*.
9 423 1988;11(1):50–9.
10 424 26. Endalafer N, Gebre-Selassie S, Kotiso B. Nosocomial bacterial infections in a tertiary
11 425 hospital in Ethiopia. *J Infect Prev*. 2011;12(1):38–43.
12 426 27. Feleke T, Eshetie S, Dagne M, Endris M, Abebe W, Tiruneh M, Moges F. Multidrug-
13 427 resistant bacterial isolates from patients suspected of nosocomial infections at the University
14 428 of Gondar Comprehensive Specialized Hospital, Northwest Ethiopia. *BMC research notes*.
15 429 2018 Dec;11(1):602.
16 430 28. Amenu D, Belachew T, Araya F. Surgical site infection rate and risk factors among obstetric
17 431 cases of Jimma University Specialized Hospital, Southwest Ethiopia. *Ethiopian journal of*
18 432 *health sciences*. 2011;21(2):91-100.
19 433 29. Melaku S, Gebre-Selassie S, Damtie M, Alamrew K. Hospital acquired infections among
20 434 surgical, gynaecology and obstetrics patients in Felege-Hiwot referral hospital, Bahir Dar,
21 435 northwest Ethiopia. *Ethiopian medical journal*. 2012 Apr;50(2):135-44
22 436 30. Messele G, Woldemedhin Y, Demissie M, Mamo K, Geyid A. Common causes of
23 437 nosocomial infections and their susceptibility patterns in two hospitals in Addis Ababa.
24 438 *Ethiop J Health Biomed Sci* 2009; 2: 3-8.
25 439 31. Melaku S, Kibret M, Abera B, Gebre-Sellassie S. Antibiogram of nosocomial urinary tract
26 440 infections in Felege Hiwot referral hospital, Ethiopia. *African health sciences*.
27 441 2012;12(2):134-9.
28 442 32. Walelegn W, Abera K, Feleke M (2016). Point prevalence of hospital-acquired infections in
29 443 two teaching hospitals of Amhara region in Ethiopia. *Drug, Healthcare and Patient Safety*.
30 444 2016; 8:71-76.
31 445 33. Mikyas D, Sileshi L. The Prevalence of Nosocomial Infections and Associated Risk Factors
32 446 in Pediatric Patients in Tikur Anbessa Hospital. *Ethiopian Journal of Pediatrics and Child*
33 447 *Health*. 2008; 5(5):4-16.

- 1
2
3 448 34. CDC/NHSN. CDC/NHSN surveillance definition of health care-associated infection and
4 449 criteria for specific types of infections in the acute care setting. *Am Journal Infect Control*.
5 450 2008; 36:309-32.
6
7
8 451 35. Joram N, de Saint Blanquat L, Stamm D, Launay E, Gras-Le Guen C. Healthcare-associated
9 452 infection prevention in pediatric intensive care units: a review. *European journal of clinical*
10 453 *microbiology & infectious diseases*. 2012 Oct 1;31(10):2481-90.
11
12 454 36. Murni IK, Duke T, Kinney S, Daley AJ, Soenarto Y. Reducing hospital-acquired infections
13 455 and improving the rational use of antibiotics in a developing country: an effectiveness study.
14 456 *Arch Dis Child*. 2015;100:454–459.
15
16 457 37. Grohskopf LA, Sinkowitz-Cochran RL, Garrett DO, Sohn AH, Levine GL, Siegel JD, Stover
17 458 BH, Jarvis WR, Networka PP. A national point-prevalence survey of pediatric intensive care
18 459 unit-acquired infections in the United States. *The Journal of pediatrics*. 2002 Apr
19 460 1;140(4):432-8.
20
21 461 38. Deptuła A, Trejnowska E, Ozorowski T, Hryniewicz W. Risk factors for healthcare-
22 462 associated infection in light of two years of experience with the ECDC point prevalence
23 463 survey of healthcare-associated infection and antimicrobial use in Poland. *Journal of Hospital*
24 464 *Infection*. 2015 Aug 1;90(4):310-5.
25
26 465 39. Ali S, Birhane M, Bekele S, Kibru G, Teshager L, Yilma Y, Ahmed Y, Fentahun N, Assefa
27 466 H, Gashaw M, Gudina EK. Healthcare associated infection and its risk factors among
28 467 patients admitted to a tertiary hospital in Ethiopia: longitudinal study. *Antimicrobial*
29 468 *Resistance & Infection Control*. 2018 Dec;7(1):2.
30
31 469 40. Askarian M, Yadollahi M, Assadian O. Point prevalence and risk factors of hospital acquired
32 470 infections in a cluster of university-affiliated hospitals in Shiraz, Iran. *Journal of infection*
33 471 *and public health*. 2012 Apr 1;5(2):169-76.
34
35 472 41. Olivier C, Kunneke H, O'Connell N, Von Delft E, Wates M, Dramowski A. Healthcare-
36 473 associated infections in paediatric and neonatal wards: A point prevalence survey at four
37 474 South African hospitals. *South African Medical Journal*. 2018;108(5):418-22.
38
39 475 42. Teke TA, Tanır G, Bayhan Gİ, Öz FN, Metin Ö, Özkan Ş. Clinical and microbiological
40 476 features of resistant gram-negative bloodstream infections in children. *Journal of infection*
41 477 *and public health*. 2017 Mar 1;10(2):211-8.
42
43
44
45
46
47
48
49
50
51
52
53
54
55
56
57
58
59
60

- 1
2
3 478 43. Atici S, Soysal A, Kadayifci EK, Karaaslan A, Akkoç G, Yakut N, Demir SÖ, Girgin Fİ,
4 479 Çulha G, Altınkanat G, Öztürk N. Healthcare-associated infections in a newly opened
5 480 pediatric intensive care unit in Turkey: Results of four-year surveillance. *The Journal of*
6 481 *Infection in Developing Countries*. 2016 Mar 31;10(03):254-9.
- 7 482 44. Raymond J, Aujard Y, European Study Group. Nosocomial infections in pediatric patients a
8 483 European, multicenter prospective study. *Infection Control & Hospital Epidemiology*. 2000
9 484 Apr;21(4):260-3.
- 10 485 45. Offner PJ, Moore EE, Biffl WL. Male gender is a risk factor for major infections after
11 486 surgery. *Archives of Surgery*. 1999 Sep 1;134(9):935-40.
- 12 487 46. Wałaszek M, Kosiarska A, Gniadek A, Kołpa M, Wolak Z, Dobroś W, Siadek J. The risk
13 488 factors for hospital-acquired pneumonia in the Intensive Care Unit. *Przegl Epidemiol*.
14 489 2016;70(1):15-20.
- 15 490 47. Ahmed M, Alam SN, Khan O, Manzar S. Postoperative wound infection: a surgeon's
16 491 dilemma. *Pak J Surg*. 2007 Jan;23(1):41-7.
- 17 492 48. Koch AM, Nilsen RM, Eriksen HM, Cox RJ, Harthug S. Mortality related to hospital-
18 493 associated infections in a tertiary hospital; repeated cross-sectional studies between 2004-
19 494 2011; 2015.
- 20 495 49. Brady MT. Health care-associated infections in the neonatal intensive care unit. *American*
21 496 *journal of infection control*. 2005 Jun 1;33(5):268-75.
- 22 497 50. Saiman L. Risk factors for hospital-acquired infections in the neonatal intensive care unit. In
23 498 *Seminars in perinatology*. 2002 Oct 1; 26(5):315-321.
- 24 499 51. Behzadnia S, Davoudi A, Rezai MS, Ahangarkani F. Nosocomial infections in pediatric
25 500 population and antibiotic resistance of the causative organisms in north of iran. *Iranian Red*
26 501 *Crescent Medical Journal*. 2014 Feb;16(2).
- 27 502 52. Singh S, Chaturvedi R, Garg SM, Datta R, Kumar A. Incidence of healthcare associated
28 503 infection in the surgical ICU of a tertiary care hospital. *Medical journal armed forces India*.
29 504 2013 Apr 1;69(2):124-9.
- 30 505 53. Thu TA, Hung NV, Quang NN, Archibald LK, Harun-Or-Rashid M, Sakamoto J. A point-
31 506 prevalence study on healthcare-associated infections in Vietnam: public health implications.
32 507 *Infection Control & Hospital Epidemiology*. 2011 Oct;32(10):1039-41.

- 1
2
3 508 54. Razine R, Azzouzi A, Barkat A, Khoudri I, Hassouni F, Chefchaoui AC, Abouqal R.
4 509 Prevalence of hospital-acquired infections in the university medical center of Rabat,
5 510 Morocco. *International archives of medicine*. 2012 Dec;5(1):26.
- 6
7
8 511 55. Balkhy HH, Cunningham G, Chew FK, Francis C, Al Nakhli DJ, Almuneef MA, Memish
9 512 ZA. Hospital-and community-acquired infections: a point prevalence and risk factors survey
10 513 in a tertiary care center in Saudi Arabia. *International journal of infectious diseases*. 2006 Jul
11 514 1;10(4):326-33.
- 12
13
14 515 56. Le NK, Wertheim HF, Vu PD, Khu DT, Le HT, Hoang BT, Vo VT, Lam YM, Vu DT,
15 516 Nguyen TH, Thai TQ. High prevalence of hospital-acquired infections caused by gram-
16 517 negative carbapenem resistant strains in Vietnamese pediatric ICUs: A multi-centre point
17 518 prevalence survey. *Medicine*. 2016 Jul;95(27).
- 18
19
20 519 57. American Thoracic Society, Infectious Diseases Society of America. Guidelines for the
21 520 management of adults with hospital-acquired, ventilator-associated, and healthcare-
22 521 associated pneumonia. *American journal of respiratory and critical care medicine*. 2005 Feb
23 522 15;171(4):388.
- 24
25
26 523 58. Almuneef M, Memish ZA, Balkhy HH, Alalem H, Abutaleb A. Ventilator-associated
27 524 pneumonia in a pediatric intensive care unit in Saudi Arabia: a 30-month prospective
28 525 surveillance. *Infection Control & Hospital Epidemiology*. 2004;25(9):753-8.
- 29
30
31 526 59. Elward AM, Warren DK, Fraser VJ. Ventilator-associated pneumonia in pediatric intensive
32 527 care unit patients: risk factors and outcomes. *Pediatrics*. 2002;109(5):758-64.
- 33
34
35 528 60. Foglia E, Meier MD, Elward A. Ventilator-associated pneumonia in neonatal and pediatric
36 529 intensive care unit patients. *Clinical microbiology reviews*. 2007;20(3):409-25.
- 37
38
39 530 61. Sarvikivi E, Kärki T, Lyytikäinen O, Finnish NICU Prevalence Study Group. Repeated
40 531 prevalence surveys of healthcare-associated infections in Finnish neonatal intensive care
41 532 units. *Journal of Hospital Infection*. 2010 Oct 1;76(2):156-60.
- 42
43
44 533 62. Sangrasi AK, Leghari AA, Memon A, Talpur AK, Qureshi GA, Memon JM. Surgical site
45 534 infection rate and associated risk factors in elective general surgery at a public sector medical
46 535 university in Pakistan. *International wound journal*. 2008 Mar;5(1):74-8.
- 47
48
49 536 63. Khaleid M, Haleim A, Zein K. ET: surgical site infections and associated risk factors in
50 537 Egyptian orthopedic patients. *J Am Sci*. 2010;6(7):272-80.
- 51
52
53
54
55
56
57
58
59
60

- 1
2
3 538 64. Arefian H, Hagel S, Fischer D, Scherag A, Brunkhorst FM, Maschmann J, Hartmann M.
4
5 539 Estimating extra length of stay due to healthcare-associated infections before and after
6
7 540 implementation of a hospital-wide infection control program. *PloS one*. 2019
8
9 541 17;14(5):e0217159.
- 10 542 65. Zhou Q, Fan L, Lai X, Tan L, Zhang X. Estimating extra length of stay and risk factors of
11
12 543 mortality attributable to healthcare-associated infection at a Chinese university hospital: a
13
14 544 multi-state model. *BMC Infectious Diseases*. 2019 Dec 1;19(1):975.
- 15 545 66. Shahunja KM, Ahmed T, Faruque AS, Shahid AS, Das SK, Shahrin L, Hossain MI, Islam
16
17 546 MM, Chisti MJ. Experience with nosocomial infection in children under 5 treated in an urban
18
19 547 diarrheal treatment center in Bangladesh. *Global pediatric health*. 2016 Mar
20
21 548 4;3:2333794X16634267.
- 22 549 67. Dramowski A, Whitelaw A, Cotton MF. Burden, spectrum, and impact of healthcare-
23
24 550 associated infection at a south African children's hospital. *Journal of Hospital Infection*. 2016
25
26 551 Dec 1;94(4):364-72.

553 **Table 1: Demographic and clinical characteristics of patients who participated in the study**
 554 **in Goba Referral Hospital, southeast Ethiopia 2019 (n=448)**

Variables	Category	n (%)
Patient age, Median (IQR): 8 months (2-26 months)		
Sex	Male	248 (55.4)
	Female	200 (44.6)
Ward	Neonatal Intensive Care Unit (NICU)	201 (44.9)
	Pediatrics	247 (55.1)
Resident	Urban	129 (28.8)
	Rural	319 (71.2)
Previous Hospitalization ^a	Yes	46 (10.3)
	No	402 (89.7)
Mechanical Ventilation	Yes	76 (17.0)
	No	372 (83.0)
Presence of peripheral intravenous (IV) catheter ^b	Yes	430 (96.0)
	No	18 (4.0)
Presence of Urinary Catheters	Yes	9 (2.0)
	No	439 (98.0)
Drainage Tube Inserted ^c	Yes	53 (11.8)
	No	395 (88.2)
Underlying Severe acute malnutrition (SAM) Diseases ^d	Yes	54 (12.1)
	No	394 (87.9)
Surgery After Admission	Yes	47 (10.5)
	No	401 (89.5)
Patient Received Antimicrobials ^e	Yes	171 (38.2)
	No	221 (49.3)
	Unknown	56 (12.5)
Severe Anemia	Yes	41 (9.2)
	No	375 (83.7)
	Unknown	32 (7.1)
Hospital Duration (median day)	≤ 6	237 (52.9)
	> 6	211 (47.1)
HIV status	Positive	2 (0.4)
	Negative	393 (87.7)
	Not tested	53 (11.8)
American Society of Anesthesiology (ASA) Classification	Normally health patient	72 (16.1)
	Patient with mild systemic diseases	235 (52.5)
	Severe systemic disease that is not incapacitating	100 (22.3)
	Incapacitating systemic diseases that is a constant threat to life	36 (8.0)

	Unknown	5 (1.1)
Gestational age (n=191)	< 37 weeks	83 (43.5)
	≥ 37 weeks	108 (56.5)
Birth weight (n=191) ^f	< 2500gm	46 (24.1)
	≥ 2500 gm	145 (75.9)

555 ^a History of the previous hospitalization for either the same as the current reason of admission or
 556 other ailments within the last 30 days

557 ^bPeripheral intravenous (IV) catheter: A peripheral intravenous (IV) catheter is inserted into
 558 small peripheral veins to provide access to administer IV fluids and medications.

559 ^cDrainage tube: insertion of a chest tube, endotracheal, and nasogastric (NG) intubation.

560 ^d Severe acute malnutrition (SAM) diagnosed at the time of hospital admission.

561 ^e The use of antimicrobials before admission either through intravenous (IV), intramuscular (IM)
 562 or oral (PO) administration.

563 ^fAny neonate weighting less than 2500 gm at birth irrespective of gestational age was considered
 564 low birth weight (LBW).

566 **Table 2: Proportion of hospital-acquired infections among pediatric patients in Goba**
 567 **Referral Hospital, Ethiopia (n=57)**

Hospital-acquired infections	Number	Proportion	95% CI
Pneumonia/ Lower Respiratory Tract Infections/ ^a	32	56.1	43.9-68.4
Late-Onset Neonatal Sepsis	6	10.5	3.5-19.3
Intravenous Line (IV) Site Infections	5	8.8	1.8-15.8
Urinary Tract Infections	4	7.0	1.8-14.0
Systemic Infections	4	7.0	1.8-14.0
Skin/Soft Tissue Infections	2	3.5	0.0-8.8
Measles	2	3.5	0.0-8.8
Early Onset Neonatal Sepsis	1	1.8	0.0-5.3
Surgical Site Infections	1	1.8	0.0-7.0

568 ^a including ventilator-associated pneumonia (VAP) (n=7) & VAP developed in 9.21% [7/76] of
 569 children undergoing mechanical ventilation; CI: Confidence Interval

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571

573 **Table 3: Bi-variate association of factors for the occurrence of hospital-acquired infections**
 574 **among pediatric patients in Goba Referral Hospital, southeast Ethiopia 2019 (n=448)**

Variables	Category	Presence of HAIs		Crude RR
		Yes (57)	No (391)	
Sex	Male	30	218	0.88(0.55-1.45)
	Female	27	173	1
Age (months)	1-12	33	252	0.78(0.48-1.28)
	>12	24	139	1
Residence	Urban	12	117	0.65(0.36-1.20)
	Rural	45	274	1
Hospital Duration (median day)	≤ 6	17	220	1
	> 6	40	171	2.64(1.54-4.51)*
Admission Unit	NICU	27	174	1.10(0.68-1.79)
	Pediatrics	30	217	1
Patient Received Antimicrobials	Yes	17	154	1
	No	27	194	1.22(0.69-2.17)
	Unknown	13	43	2.33(1.21-4.50)*
Previous Hospitalization	Yes	7	39	1.22(0.58-2.53)
	No	50	352	1
Mechanical Ventilation	Yes	12	64	1.30(0.68-2.71)
	No	45	327	1
Presence of Urinary Catheters	Yes	2	7	1.77(0.50-6.17)
	No	55	384	1
Drainage Tube Inserted	Yes	14	39	2.42(1.42-4.12)*
	No	43	352	1
Severe acute malnutrition (SAM)	Yes	13	41	2.15(1.24-3.73)*
	No	44	350	1
Surgery After Admission	Yes	4	43	0.64(0.24-1.69)
	No	53	348	1

575 RR: Risk Ratio; * p-value < 0.05 (Crude)

577 **Table 4: Multivariable logistic regression analysis on factors associated with hospital-**
 578 **acquired infections among patients in Goba Referral Hospital, southeast Ethiopia 2019**
 579 **(n=448)*†**

Variables	Category	Patient with HAIs (n=57)	Adjusted RR	Attributable Risk (AR) ^a
Hospital Duration	≤ 6	17	1	
	> 6	40	2.58(1.52-4.38)**	0.12
Patient Received Antimicrobials	Yes	17	1	
	No	27	1.25(0.71-2.19)	
	Unknown	13	1.93(0.84-4.42)	
Drainage Tube Inserted	Yes	14	1.77(0.88-3.54)	
	No	43	1	
Severe acute malnutrition (SAM)	Yes	13	2.83(1.61-4.97)**	0.13
	No	44	1	

580 *Hosmer and Lemeshow Test (p=0.166); RR: Risk Ratio; ** p-value < 0.05 (adjusted)

581 † Adjusted for age, sex, admission unit, mechanical ventilation, and presence of a urinary catheter

582 ^aAttributable risk is the difference between the risk HAIs in the exposed group and the
 583 unexposed group.

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4 **585 Figure Legends**

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6 586 Figure 1: A flow chart of sampling procedure.

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8 587 Figure 2: Bar graph showing the age distribution of study participants by sex.

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10 588 Figure 3: Bar graph showing the type of HAIs by type of admission ward.
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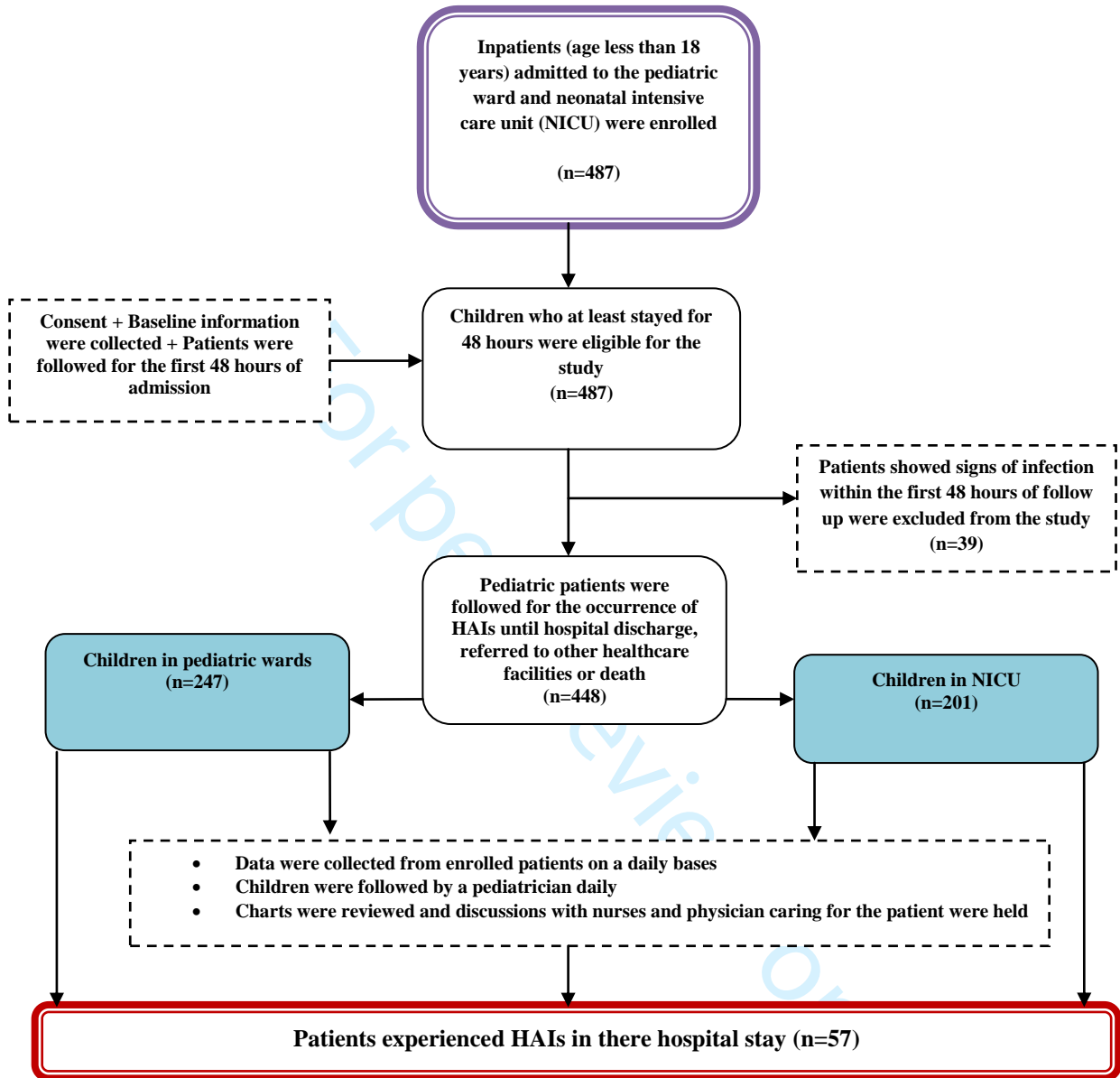
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4 590 **Additional Files**

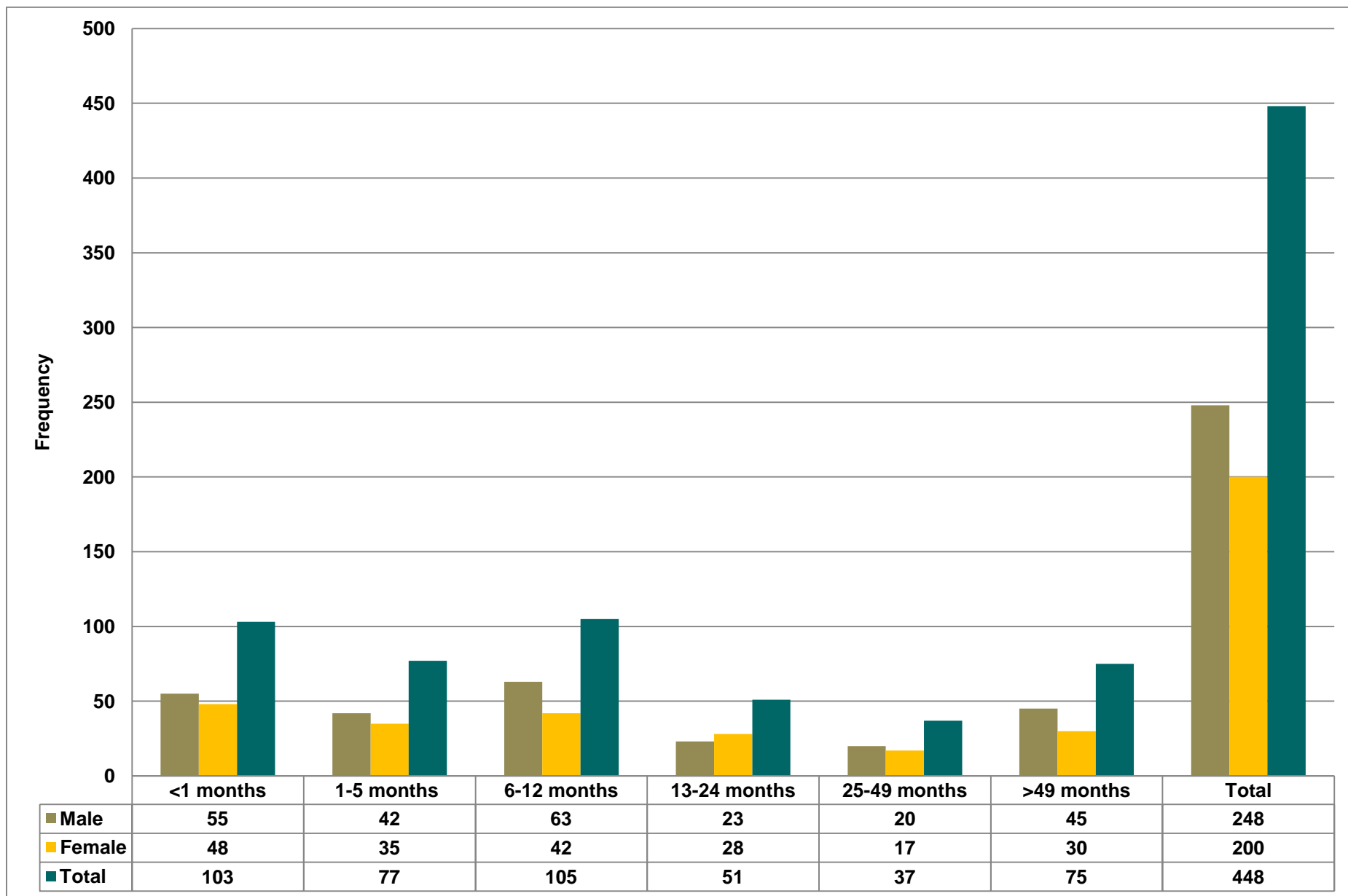
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6 591 **S1 File: English version of the survey questionnaire**

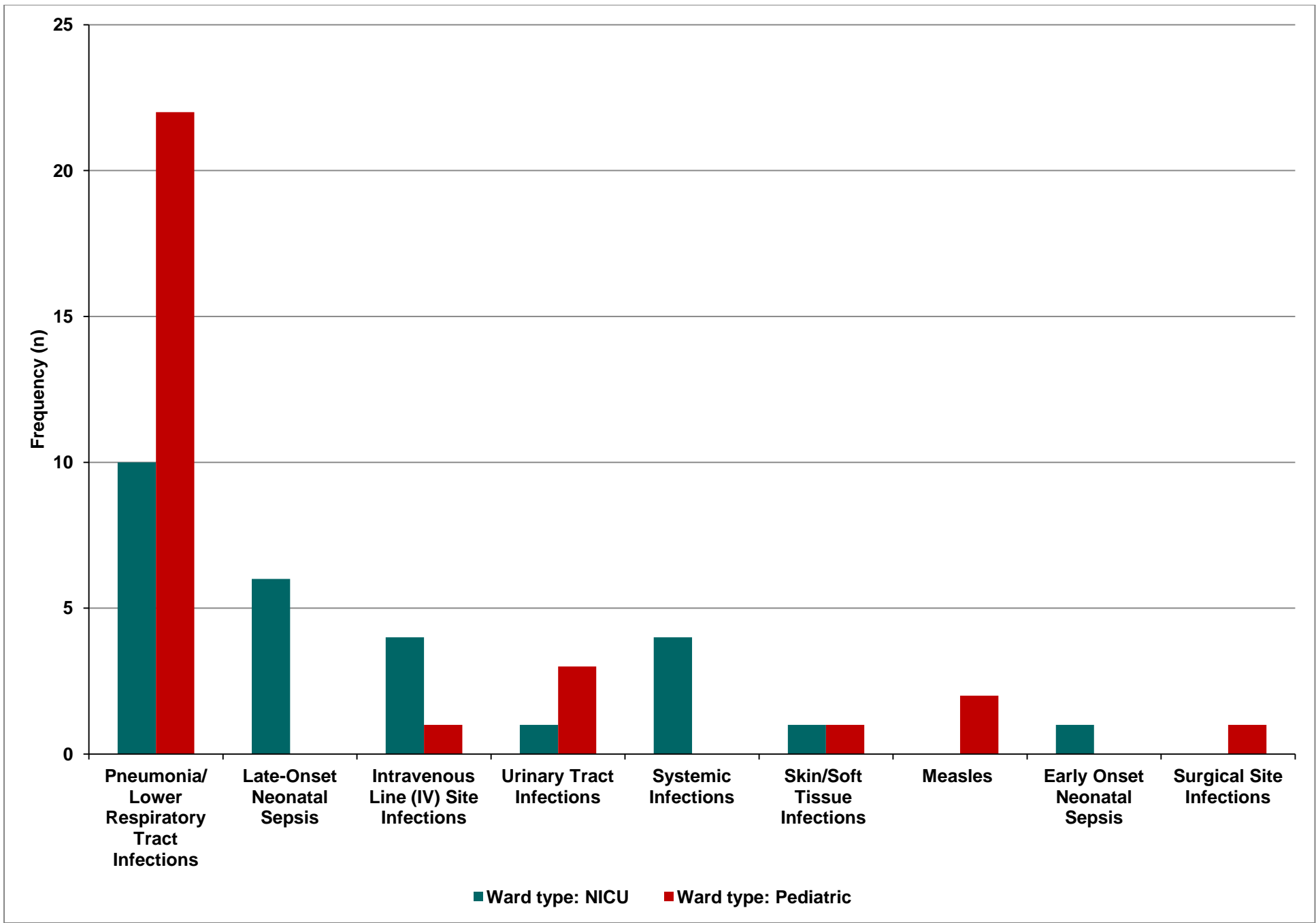
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Data collection tool

1. Patient ID/CODE _____
2. Ward _____ Bed number _____ MRN _____
3. Age _____
4. Sex _____
5. Residence A. Urban _____ B. Rural _____
6. Reason for admission/Dx at the time of admission _____

7. Complete admission diagnoses _____
8. Date of admission _____
9. Patient health condition at the time of admission

10. Is there any other localized infection? Yes No
11. If yes, type of treatment given _____
12. Previous hospitalization Yes No
13. If yes for question 14:
 - a. Place (including ward) _____
 - b. Time (month/year) _____
 - c. Duration _____
14. Previous antibiotic use for the current illness A. Yes _____ B. No _____
15. If yes for question 15, specify _____
16. If yes for question 15, for how many days? _____ days
17. Being on mechanical ventilator? A. Yes _____ B. No _____
18. Presence of intravenous line? A. Yes _____ B. No _____
19. Presence of urinary catheters? A. Yes _____ B. No _____
If yes, for how long _____
20. Indication for catheterization _____

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2
3 21. Drainage inserted ? A. Yes _____ B. No _____
4

5 If yes, for how long _____
6

7 22. Indication for drainage _____
8

9 23. Presence of invasive medical devices? A. Yes _____ B. No _____
10

11 24. If yes for questions 20,21,22,26 (more than one answer is possible)
12

13 A. Endotracheal tube? A. Yes _____ B. No _____
14

15 B. NGT A. Yes _____ B. No _____
16

17 C. Chest tube A. Yes _____ B. No _____
18

19 25. Peripheral intravenous line (IV) catheter A. Yes _____ B. No _____
20

21 26. Insertion of a urinary catheter A. Yes _____ B. No _____
22

23 27. Intubation A. Yes _____ B. No _____
24

25 28. Underlying diseases? A. Yes _____ B. No _____
26

27 29. If yes, underlying diseases (more than one answer is possible)
28

29 i. Diabetes mellitus vi. Cardiac disorders
30

31 ii. Chronic renal failure vii. Severe malnutrition (SAM)
32

33 iii. Hypertension viii. TB
34

35 iv. Chronic liver disease ix. Cancer
36

37 v. HIV/AIDS x. Others (specify)
38

39 30. Surgery since admission A. Yes _____ B. No _____
40

41 31. Surgical procedure done? A. Yes _____ B. No _____
42

43 If yes for question 36,
44

45 A. Type of surgery A. Elective _____ B. Emergency _____
46

47 B. Type of the procedure _____
48

49 C. Date _____ Time _____
50

51 D. Duration of the surgery _____ hours
52

53 E. Type of surgical wound A. Clean B. Clean contaminated C. Contaminated D.
54

55 Dirty
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57 32. Antibiotic prophylaxis given? A. Yes _____ B. No _____
58

59 If yes for Q36, specify/name of antibiotic _____
60

If yes for Q36, how many doses? _____

33. Duration of stay hospital stay in days _____

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3 34. Severe anaemia [haemoglobin <50 g/L (for patients older than 28 days) or haemoglobin
4 <90 g/L (for neonates)]

5
6 A. Yes _____ B. No _____ C. Unknown/not tested _____

7
8 35. Immune deficiency A. Yes _____ B. No _____ C. Unknown/not tested _____

9
10 36. Nutritional status WAZ score (Weight-for-age Z score) A. >-3 B. -3 to 4 C.<-4

11
12 37. McCabe score

13 A. Non-Fatal diseases

14 B. Ultimately fatal diseases

15 C. Rapidly fatal diseases

16 D. Unknown

17
18 38. American Society of Anesthesiology (ASA) classification

19 a. Normally health patient

20 b. Patient with mild systemic diseases

21 c. Patient with severe systemic disease that is not incapacitating

22 d. Patient with incapacitating systemic diseases that is a constant threat to life

23 e. Unknown

24
25 39. HIV status A. Reactive B. Non-reactive C. Unknown

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27 40. Presence of HAIs based on CDC definition:

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32 41. Type of HAIs:

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44 Name of data collectors : _____ Signature _____ date

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46 Name of supervisor _____ Signature _____ date

STROBE 2007 (v4) checklist of items to be included in reports of observational studies in epidemiology*
Checklist for cohort, case-control, and cross-sectional studies (combined)

Section/Topic	Item #	Recommendation	Reported on page #
Title and abstract	1	(a) Indicate the study's design with a commonly used term in the title or the abstract	1
		(b) Provide in the abstract an informative and balanced summary of what was done and what was found	2
Introduction			
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	4-5
Objectives	3	State specific objectives, including any pre-specified hypotheses	5
Methods			
Study design	4	Present key elements of study design early in the paper	6
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	6
Participants	6	(a) <i>Cohort study</i> —Give the eligibility criteria, and the sources and methods of selection of participants. Describe methods of follow-up <i>Case-control study</i> —Give the eligibility criteria, and the sources and methods of case ascertainment and control selection. Give the rationale for the choice of cases and controls <i>Cross-sectional study</i> —Give the eligibility criteria, and the sources and methods of selection of participants	6
		(b) <i>Cohort study</i> —For matched studies, give matching criteria and number of exposed and unexposed <i>Case-control study</i> —For matched studies, give matching criteria and the number of controls per case	NA
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	7
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	7
Bias	9	Describe any efforts to address potential sources of bias	7
Study size	10	Explain how the study size was arrived at	NA
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	7
Statistical methods	12	(a) Describe all statistical methods, including those used to control for confounding	7
		(b) Describe any methods used to examine subgroups and interactions	NA
		(c) Explain how missing data were addressed	NA
		(d) <i>Cohort study</i> —If applicable, explain how loss to follow-up was addressed <i>Case-control study</i> —If applicable, explain how matching of cases and controls was addressed	NA

		<i>Cross-sectional study</i> —If applicable, describe analytical methods taking account of sampling strategy	
		(e) Describe any sensitivity analyses	NA
Results			
Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed	9
		(b) Give reasons for non-participation at each stage	9
		(c) Consider use of a flow diagram	NA
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	9
		(b) Indicate number of participants with missing data for each variable of interest	NA
		(c) <i>Cohort study</i> —Summarise follow-up time (eg, average and total amount)	NA
Outcome data	15*	<i>Cohort study</i> —Report numbers of outcome events or summary measures over time	NA
		<i>Case-control study</i> —Report numbers in each exposure category, or summary measures of exposure	NA
		<i>Cross-sectional study</i> —Report numbers of outcome events or summary measures	9-10
Main results	16	(a) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included	9-10
		(b) Report category boundaries when continuous variables were categorized	NA
		(c) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	9
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	NA
Discussion			
Key results	18	Summarise key results with reference to study objectives	11
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias	12
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	11-12
Generalisability	21	Discuss the generalisability (external validity) of the study results	12
Other information			
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	13

*Give information separately for cases and controls in case-control studies and, if applicable, for exposed and unexposed groups in cohort and cross-sectional studies.

Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at <http://www.plosmedicine.org/>, Annals of Internal Medicine at <http://www.annals.org/>, and Epidemiology at <http://www.epidem.com/>). Information on the STROBE Initiative is available at www.strobe-statement.org.