Electronic Supplementary Material (ESI) for Nanoscale.

Supporting Information

A Drug-free Strategy to Combat Bacterial Infections with Magnetic Nanoparticles Biosynthesized in the Bacterial Pathogens

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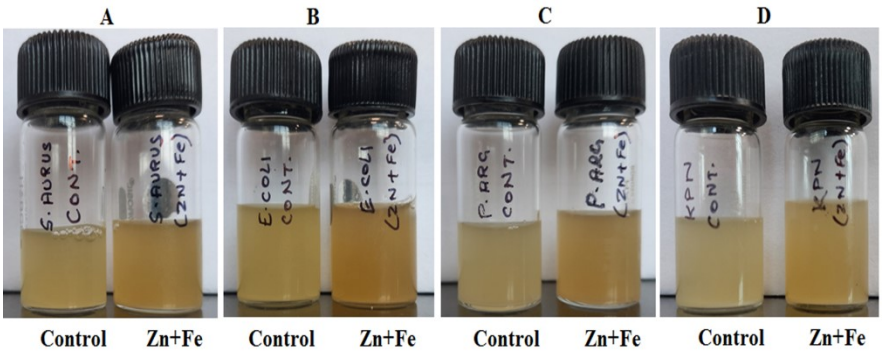

Figure S1: Bacteria treated with/without Fe and Zn. (A) *S. aureus;* (B) *E. coli;* (C) *P. aeruginosa;* (D) *K. pneumoniae.* Untreated bacteria served as control. Color change observed after 36 h treatment.

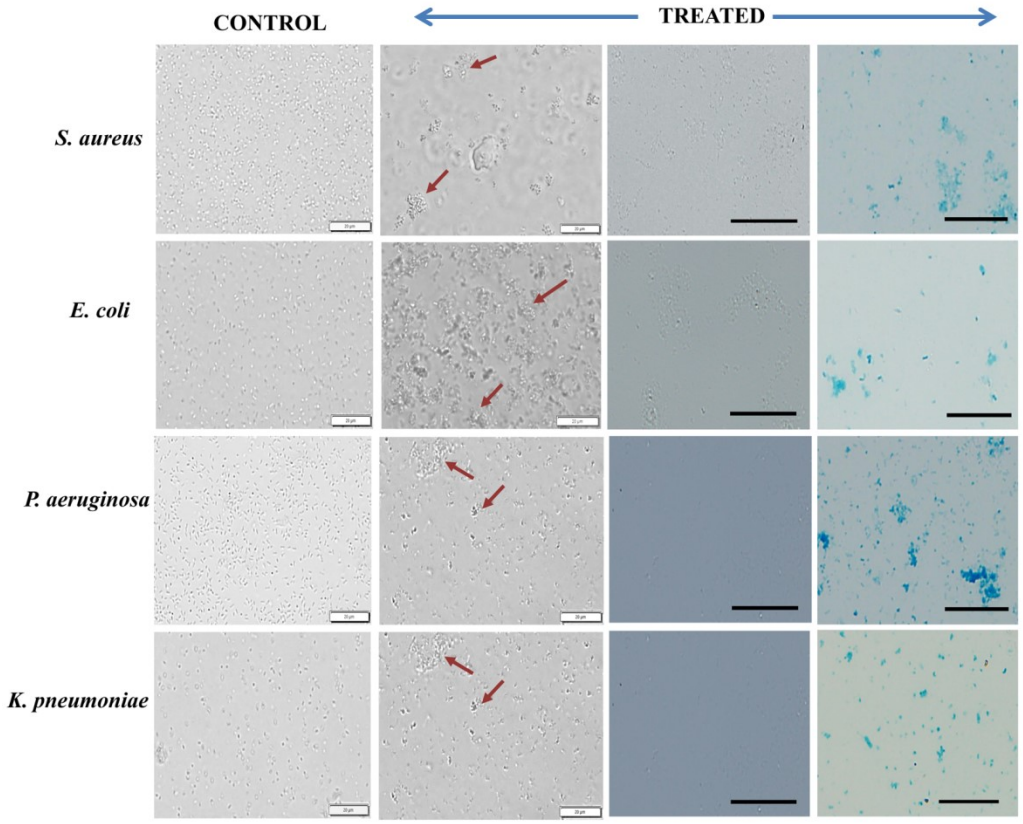

Figure S2: Bacterial response to Fe and Zn. Bright field images of untreated (1st column) and treated bacteria (2nd column). Arrows show bacterial aggregates. $FeCl_2$ and $FeCl_2$ + zinc gluconate treated bacteria stained with Perl's Prussian blue (3rd and 4th column); Scale bar represents 20 µM.

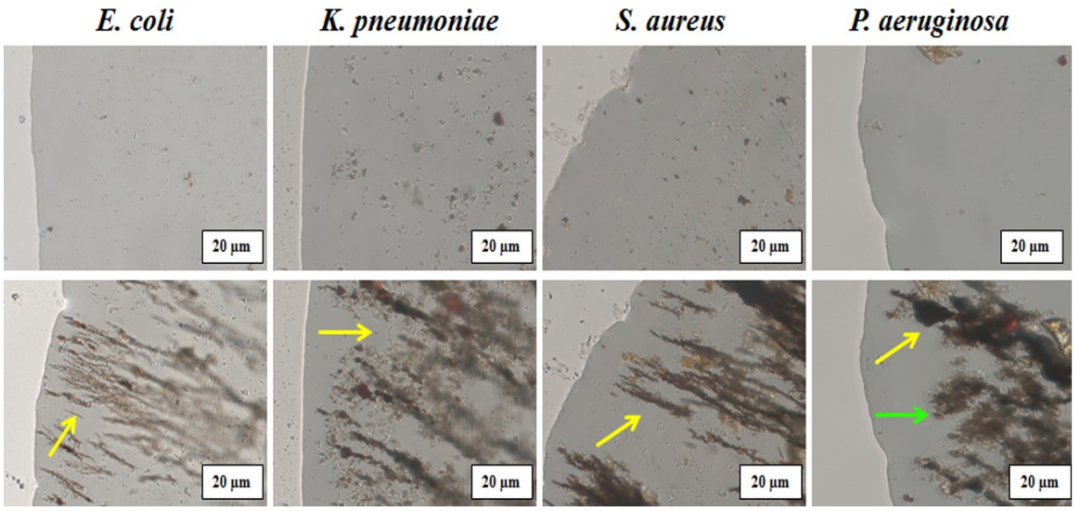

Figure S3: **Magnetic-field induced migration of MNPs**. Lysates of bacteria treated with Fe & Zn. Upper panel: Microscopic images of the periphery of a drop of lysate. Lower panel: Images of magnet-induced aggregation of nanoparticles. Yellow arrow represents magnetic nanoparticles and green arrow represents cell debris.

M1-M6

Magnetotaxis Videos

M1: Movie of untreated *S. aureus*.

M2: Movie of *S. aureus* treated with $FeCl_2$ + Zn gluconate.

M3: Movie of untreated *E. coli*.

M4: Movie of *E. coli* treated with $FeCl_2$ + Zn gluconate.

M5: Movie of untreated *P. aeruginosa*.

M6: Movie of *P. aeruginosa* treated with $FeCl_2$ + Zn gluconate.

Name of the Bacteria	Conc. of Fe µg/ml	Conc. Of Zn µg/ml
E.coli (Control)	0.164±10	0.198±2
E.coli ($FeCl_2$)	0.179±7	0.213±4
E.coli (Fe+Zn)	28.33±3	0.602±10
S.aureus (Control)	0.116±12	0.227±5
S.aureus ($FeCl_2$)	0.169±6	0.283±8
S.aureus (Fe+Zn)	12.8±4	0.512±7

Table ST1: Estimation of Fe and Zn. IC-PMS analysis of Fe and Zn in the lysates of control and bacteria treated with / without $FeCl_2$, and zinc gluconate. Results represent values obtained from 3.8 x10^8 CFU

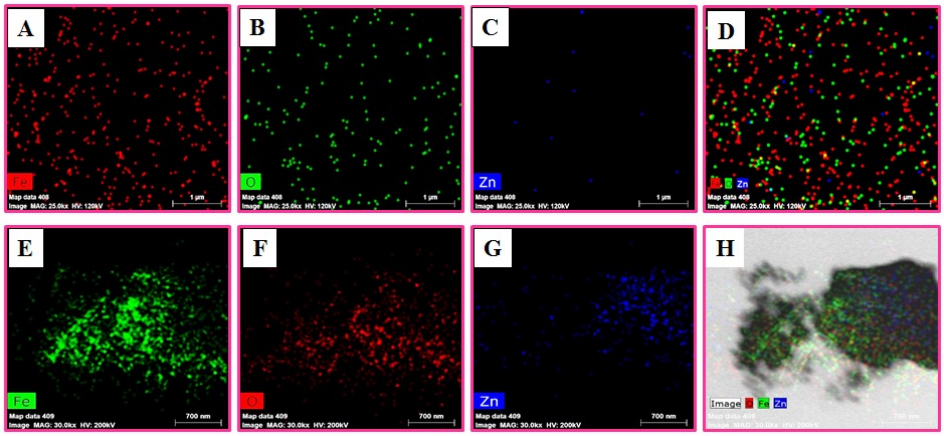

Figure S4: Elemental mapping using TEM. Distribution of iron, oxygen and zinc in treated bacteria. Upper panel represents *S. aureus* (A-C) and Lower panel *E. coli* (E-G). D & H indicate a combination of (A-C) and (E-G) respectively.

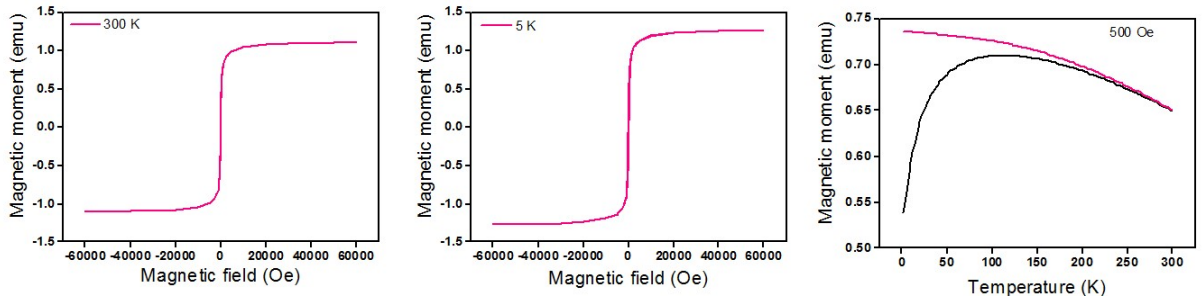

Figure S5: Magnetic measurements of nanoparticles biosynthesized in *E.coli*. Magnetization versus magnetic field measured at (A) 300 K, (B) 5K and (C) Measurements of Temperature Dependence of Magnetization (ZFC/FC curves).

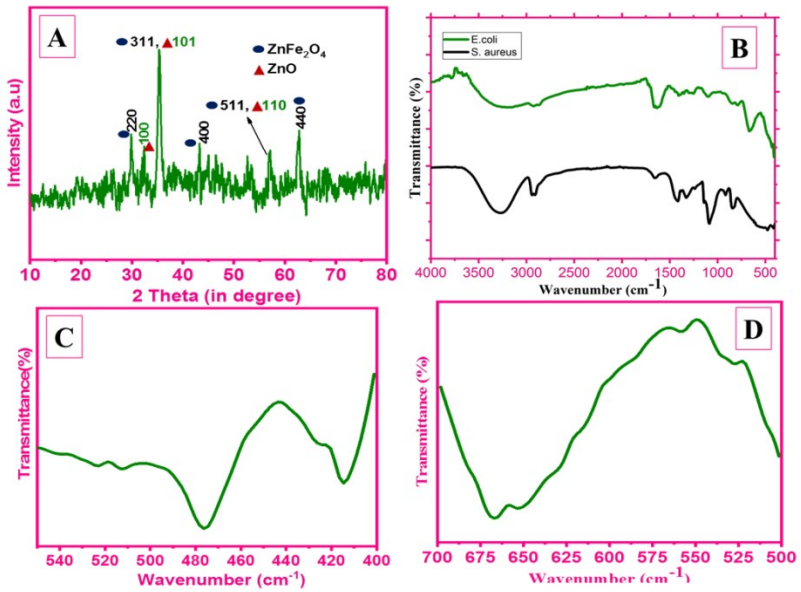

Figure S6: Characterization of Fe and Zn treated bacteria. (A) XRD diffraction pattern of *S. aureus* after calcination. (B) FT-IR of the treated bacteria after lyophilization of *S. aureus* and *E. coli.* (C) Peaks observed in the region from 476-417 cm^{-1} represent Zn-O bond (D).Peaks in the region from 670-550 mode represent Fe–O bonds.

Clinical Specimens			Antimicrobial Susceptibility																												
Sample No.	Infected Tissue	Micro-organism	Cefotaxime	Amikacin	Ceftazidime	Cefepime	Imipenum	Meropenem	Cefoperazone-sulbactam	Gentamycin	Aztreonam	Levofloxacin	Ceftriaxone	Tigecycline	Minocycline	Piperacilline+tazobactam	Cotrimoxazole	Eartapenem	Tetracycline	Chloramphenicol	Tobramycin	Netilmicin	Doxycycline	Ciprofloxacin	Clindamycin	Linezoid	Teicoplanin	Erythromycin	Vancomycin	Oxacillin	Colistin
S1	Blood	*S. aureus*	R	R	R	R	R	R	R															R	S	S	S	R	R	R	
S2	Blood	*E. coli*	R	R	R	R	R	R	R						S	R		R					S	R					R		
S3	Blood	*P. aeruginosa*		S		S	R	R	S	S	S	S		R							S			S							IS
S4	Blood	*K. pneumoniae*	R	R	R	R	R	R	R						S	R		R					S								
S5	Blood	*P. aeruginosa*		S		S	R	R	S	S	S	S		R							S			S							IS
S6	Blood	*E. coli*	R	R		R	R	R	R	R			R	S		R	R							R							IS
S7	Blood	*S. epiderdimis*	R	R	R	R	R	R	R															IS				R			
S8	Blood	*S. haemolyticus*	R	R	R	R	R	R	R															R				R			
S9	Abdomen	*E. coli*	R	R		R	R	R	R	R			R	S		R	R							R							IS
S10	Muscle	*E. coli*	R	S		R	S	S	IS	S			R	S		S	S	S						R							IS
S11	Bone	*E. coli*	R	R		R	R	R	R	R			R	S		R	R							R							IS

*Where, R= Resistance; S=Susceptibility ; IS=Intermediate susceptibility

Table ST2: Table represents the various infected specimens analyzed and its susceptibility to antibiotics

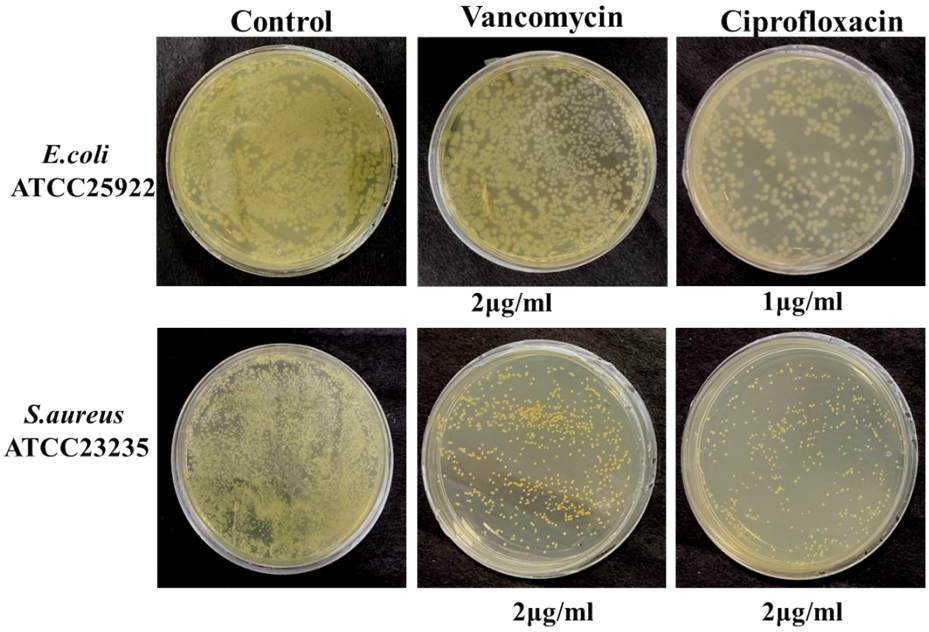

Figure S7: **Susceptibility of ATCC strains of *E.coli* and *S.aureus* to vancomycin and ciprofloxacin**. The respective ATCC strain of bacteria was treated with vancomycin/ ciprofloxacin (1-2 µg/mL) for 24 h. Representative images of the bacterial colonies grown on agar plates

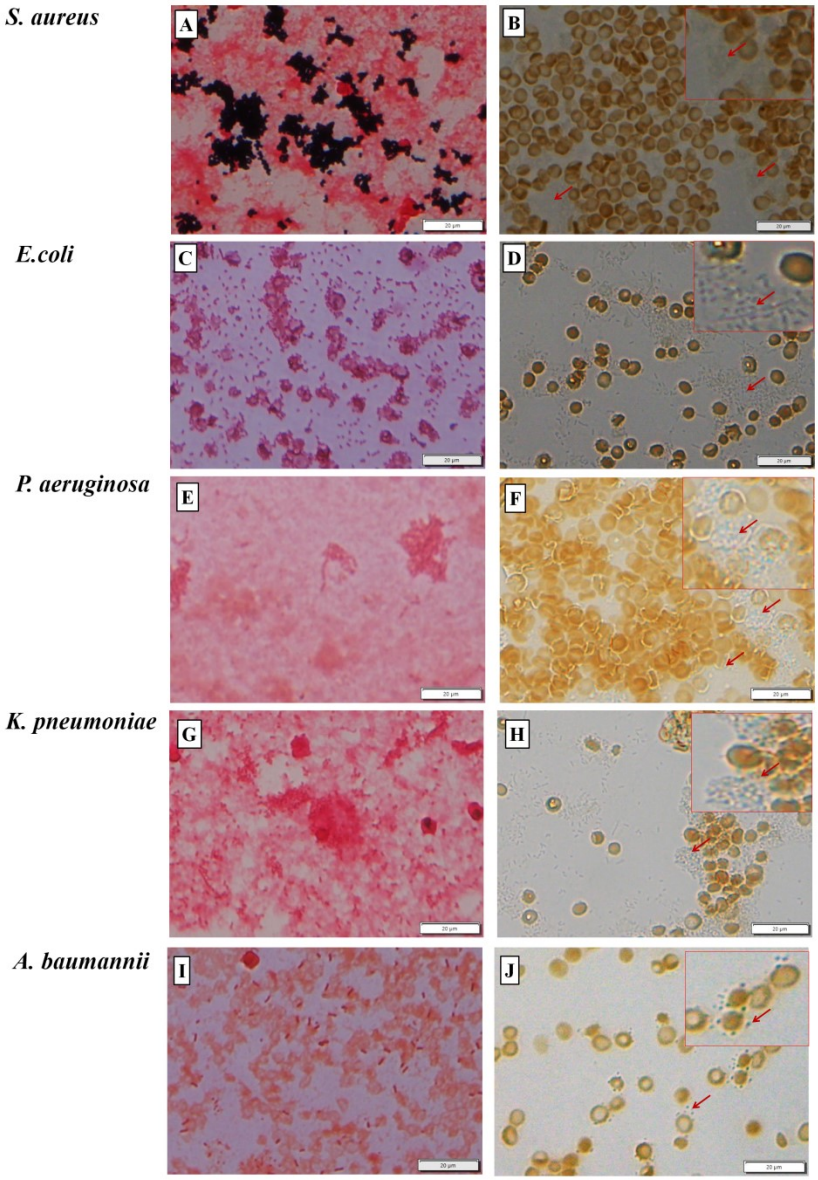

Figure S8: Clinical strains tested for the presence of iron oxide. **(A, C, E, G, I**). Gram-staining of respective bacteria. (**B, D, F, H, J**) Blood smear of respective bacterium stained with Prussian blue. Inset shows the magnified image. Arrows indicate blue color obtained after Prussian blue staining. Scale bar represents 20 µm.

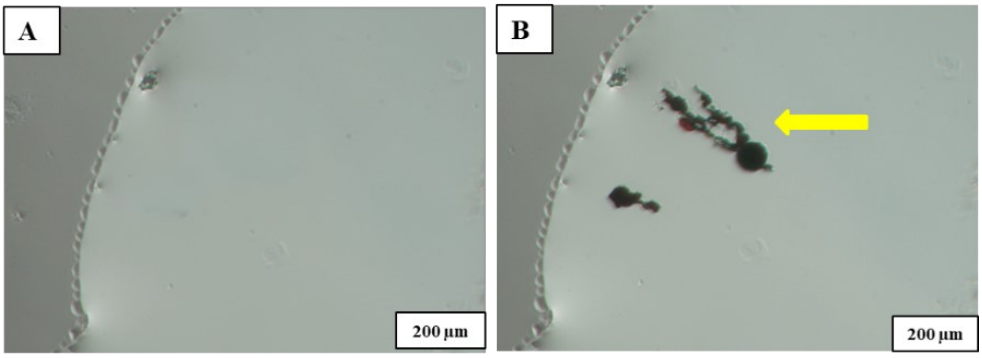

Figure S9: **Magnetic-field induced migration of MNPs obtained from *S. epiderdimis***: **A**. Microscopic image of the periphery of a drop of *S. epiderdimis* lysate. **B**. The lysate exposed to magnet. Arrow indicates the alignment of MNPs along the magnetic field lines.

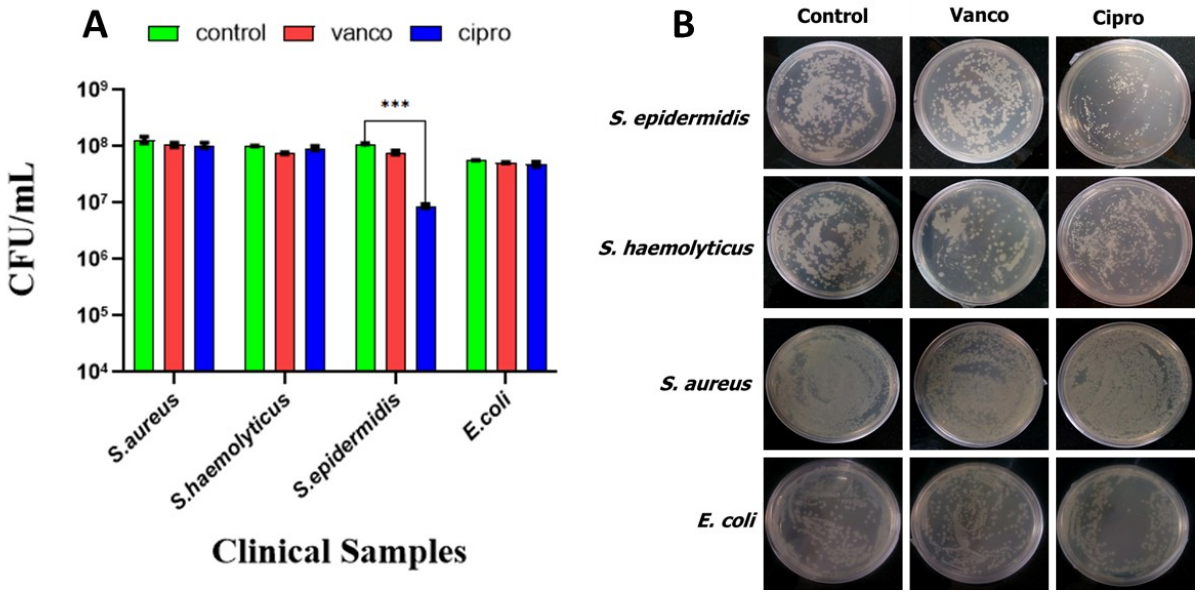

Figure S10: **Susceptibility of bacteria (clinical specimens) to vancomycin and ciprofloxacin**. The respective bacteria isolated from the infected blood specimens were treated with vancomycin/ ciprofloxacin (2 µg/ml) for 24 h. **(A)** The number of bacterial colonies obtained after respective treatment. The data represents the mean ± SD obtained from 3 experiments in which N=3 in each group. Two-way ANOVA Bonferroni multiple comparison test where *** represents p-value <0.001 **(B)** Representative images of the bacterial colonies grown on agar plates.

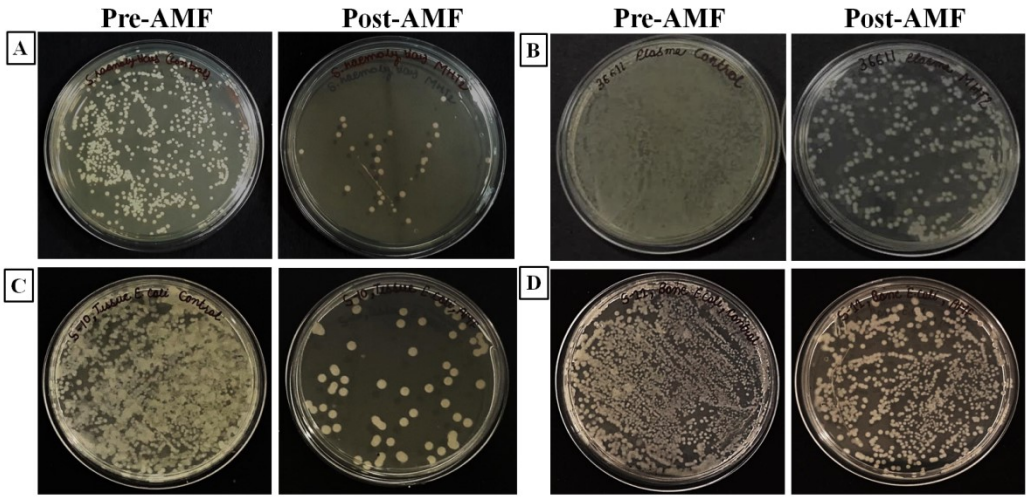

Figure S11: Effect of AMF on infected clinical specimens: Bacterial colonies obtained from pre- and post-AMF exposed samples A **& B** represent *S. haemolyticus* and *E. coli* infected blood samples exposed to AMF (347 KHz, 400 Oe); **C & D** represents *E .coli* infected muscle and bone specimens exposed to AMF at 405 KHz, 400 Oe respectively.