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RESEARCH ARTICLE

ANTIMICROBIAL SUSCEPTIBILITY PATTERN OF STAPHYLOCOCCUS AUREUS ISOLATED FROM VARIOUS CLINICAL SAMPLES IN A TERTIARY CARE HOSPITAL

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Abstract

Background:
Staphylococcusaureusisanosocomialpathogen,causinghighmorbidityandmortality.TheprevalenceofMRSAinfectionandthesusceptibilitypatternofStaphylococcusaureusvarieswiththeregion.
WiththisbackgroundpresentstudywasundertakentodeterminetheprevalenceofstaphylococcusaureusandMethicillin-ResistantStaphylococcusaureus(MRSA)isolatesfromvariousclinicalsamplesandtheirantimicrobialsusceptibilitypatterninatertiarycarehospital.
MaterialsandMethods:
Inthisretrospectivestudy,atotalof240isolatesofStaphylococcusaureuswascollectedfromaclinicalspecimen,betweenJune2021toMay2022intheDepartmentofMicrobiology,MGMMedicalCollegeandHospital,Aurangabad.
Staphylococcusaureuswasidentifiedandtheirantibioticsusceptibilitytestingwasdeterminedbyusing Vitek2compactsystemanddatawereanalyzed.
Result:
Inourstudytotalof240Staphylococcusaureuswereisolatedandtheprevalenceof MSSAwas27.5%andtheprevalenceofMRSAwas72.5%fromvariousclinicalsamples.
Outof240Staphylococcusaureusisolates,116(48.33%)wereresistanttoBenzylpenicillin,followedbyCiprofloxacin212(88.33%),Levofloxacin212(88.33%),Erythromycin154(64.17%),Clindamycin122(50.83%),Trimethoprim/Sulfamethoxazole120(50.00%),Gentamicin56(23.33%),Rifampicin15(6.25%)andTigecycline6(2.50%).
Conclusion:
AhighprevalenceofMRSA(72.50%)wasobservedinourregion.Themosteffectiveantibioticsforthetreatmentof MRSAwereLinezolid,Vancomycin,Teicoplanin,andTetracycline.Theseantibioticsshouldbekeptreservedforthetreatmentof MRSAinfection. Regularsurveillanceofhospital-associatedinfectionsisrequiredforassessingthetrendsintheantibioticresistanceofpathogensforstrengtheningthecontrolmeasurestopreventthespreadandreducetheemergenceofmultidrug-resistantMRSAinfections.

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Introduction:-

Staphylococcusaureushasbeenfoundtobethemostclinicallyimportantspecies,withawidepresenceinnature.Itispartofthen ormalfloraofthehumanbodyandgenerallycarriedontheskinorinthenoseofhealthypeople,whichmakesitsimpletobetrans mittedthroughairorfomitesfrompatientsorcarriers[1].

Itisoneofthemostimportantpathogensaffectinghumans,andcausesawiderangeofinfectionsfromskinwoundsanddeeptiss ueinfectionstolife-threateningpneumonia,endocarditis,septicarthritis,andsepticaemia[2].

Staphylococcusaureusisanimportantpathogenofmanynosocomialandcommunity-basedinfectionscausinghighmorbidityandmortality[3].

Methicillin-ResistantStaphylococcusaureus(MRSA)isanMDRstrainofStaphylococcusaureus,resistanttopenicillin,cephalosporins, carbapenems,andmacrolides.Thiscausetoseriousendemicandepidemic MRSAinfections[4].

Variousstudiesfromdifferentpartsoftheworldshowanincreaseinthenumberof Methicillin-resistantStaphylococcusaureus(MRSA)[5,6,7].TheprevalenceofMethicillin-ResistantStaphylococcusaureus(MRSA)inIndiarangesfrom30–70%.30%inthenortheastpartofIndiato50%insouthIndia[8,9,10,11].

SinceMRSAareresistanttoallβ-lactamantibiotics,thetherapeuticoptionsarelimitedsignificantly,andthereforetheiraccurateidentificationbecomesimport antforthepracticingphysicians,clinicalmicrobiologists,andpublichealthofficials,knowledgeofthelocalantimicrobialresi stancepatternsofMRSAisessentialtoguideempiricalandpathogen-specificantibiotictherapyandalsoiscriticalfortakingoptimaldecisionsininfectioncontrolpolicies[12,13].

Thepresentstudywasundertakentodeterminetheprevalenceofstaphylococcusaureusand Methicillin-ResistantStaphylococcusaureus(MRSA)isolatesfromvariousclinicalsamplesandtheirantimicrobialsusceptibilitypatter ninatertiarycarehospital.

MaterialandMethod:-

ThepresentstudywasaRetrospective,cross-sectionalstudyconductedintheDepartmentofMicrobiology,MGMMedicalCollegeandHospital,Aurangabad.Theduratio nofthestudywasfromJune2021toMay2022andwasapprovedbytheinstitutionalethicscommittee.Thesusceptibilitydataof Staphylococcusaureusisolatesinthestudyperiodwascollectedandanalysed.Thedataincludedthepatient'slocation,source ofisolate,andantibioticsusceptibilitypattern.

Atotalof240Staphylococcusaureusisolateswerecollectedfromdifferentclinicalsamplesfromtheoutpatientdepartment(O PD),inpatientdepartment(IPD),andICUlikePus,Blood,Urine,Sputum,andEndotrachealsecretion(ET).Allspecimenswer eprocessedasperstandardBacteriologicalprotocol.Thespecimenwasinoculatedon Bloodagar&MacConkeyagarandincu batedat37°Covernight.

Staphylococcusaureuswasidentifiedbyitscharacteristicgoldenyellowwithbeta-hemolyticcoloniesonbloodagar,GramstainshowingGram-positivecocciinclusters,mannitolfermentation,andpositivebycatalase,slide,andtubecoagulasemethods[14]

Abacterialsuspensionwaspreparedandprocessedasperthemanufacturesinstruction(BioMerieux)[15].Staphylococcusau reuswasidentifiedbyusingVitek2compactsystem(BioMerieux)[15].Thefinalresultswereobtainedandinterpretedbythe ID-GPCdatabase.ForQualitycontrol,StaphylococcusaureusATCCstrain29213wasused.

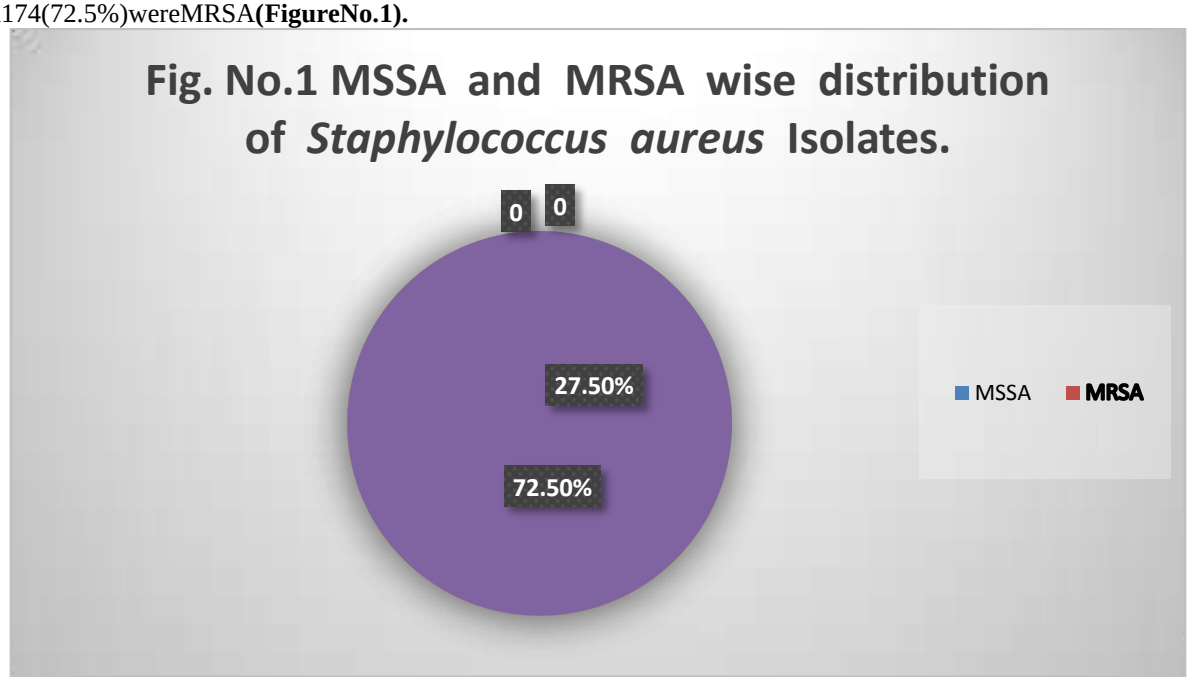
TheantibioticsusceptibilitypatternofStaphylococcusaureuswasalsointerpretedfromtheVITEK-2system.IsolatesforwhichcefoxitinscreenwaspositiveandoxacillinMICwas≥4µg/mlwereregardedasMRSAasperCLSIg uidelines.

IsolatesforwhichcefoxitinscreenwasnegativeandoxacillinMICwas≤2µg/mlwereregardedasMSSAasperCLSIguidelines.TheantibioticstestedincludedBenzylpenicillin,Gentamicin,Ciprofloxacin,Levofloxacin,Erythromycin,Rifampicin,Clindamycin,Trimethoprim/Sulfamethoxazole,Vancomycin,Linezolid,Teicoplanin,Tetracycline,andTigecycline.

TheVitek2resultswerereportedassusceptible(S),intermediate(I),orresistant(R)accordingtoCLSIguidelines.Alldatawereenteredinanexcelsheetandthedatawasstatisticallyanalysed.

Result:-

Atotalof240Staphylococcusaureuswerestudied.Outofthe240isolatesofStaphylococcusaureus,66(27.5%)wereMSSA,and174(72.5%)wereMRSA**(FigureNo.1).**



FigureNo.1:-

ThemajorityoftheisolateswereobtainedfromtheinpatientDepartmentfollowedbyICUandoutpatientDepartments.**(Table No.1)**

TableNo.1	Patients'wisedistributionofMSSAandMRSAIsolates.		
TypeofPatients	**MSSA(n=66)(n=%)**	**MRSA(n=174)(n=%)**	**Total(n=240) (n=%)**
OPD	6(9.09%)	33(18.97%)	39(16.25%)
IPD	35(53.03%)	96(55.17%)	131(54.58%)
ICU	25(37.88%)	45(25.86%)	70(29.17%)

TableNo.2	Gender-wisedistributionofMSSAandMRSAIsolates.		
Gender	**MSSA(n=66)(n=%)**	**MRSA(n=174)(n=%)**	**Total(n=240) (n=%)**
Male	40(60.61%)	102(58.62%)	142(59.17%)
Female	26(39.39%)	72(41.38%)	98(40.83%)

Outofthe240isolatesofStaphylococcusaureus,142(59.17%)wereisolatedfromMalepatientsand98(40.83%)wereisolatedfromFemalepatients.**(TableNo.2)**

TableNo.3	**Specimen-wisedistributionofMSSAandMRSAIsolates.**			
Sr.No.	**Specimen**	**MSSA(n=66)(n=%)**	**MRSA(n=174)(n=%)**	**Total(n=240) (n=%)**
1.	**Pus**	42(63.64%)	124(71.26%)	166(69.17%)
2.	**Blood**	14(21.21%)	34(19.54%)	48(20.00%)
3.	**ETsecretion**	6(9.09%)	12(6.90%)	18(7.50%)
4.	**Sputum**	2(3.03%)	3(1.72%)	5(2.08%)
5.	**Urine**	2(3.03%)	1(0.57%)	3(1.25%)

Outof240Staphylococcusaureusisolateswereмainlyisolatedfromskinandsofttissueinfectionssuchaspus166(69.17%)followedbyblood48(20%),endotrachealsecretions18(7.50%),sputum5(2.8%)andurine3(1.25%).**(TableNo.3)**

TableNo.4		**AntimicrobialsensitivitypatternofMSSAandMRSAtothevariousantibiotics.**					
		MSSA(n=66)(n=%)			**MRSA(n=174)(n=%)**		
Sr.No.	**NameofAntibiotics**	Sensitive	Interme-diate	Resistant	Sensitive	Interme-diate	Resistant
1	**Gentamicin**	60(90.91%)	--	6(9.09%)	76(43.68%)	48(27.59%)	50(28.74%)
2	**Ciprofloxacin**	12(18.18%)	12(18.18%)	42(63.64%)	4(2.30%)	--	170(97.70%)
3	**Benzylpenicillin**	24(36.36%)	--	42(63.64%)	--	--	174(100%)
4	**Rifampicin**	--	--	--	60(34.48%)	--	15(8.62%)
5	**Clindamycin**	42(63.64%)	--	24(36.36%)	76(43.68%)	--	98(56.32%)
6	**Levofloxacin**	12(18.18%)	12(18.18%)	42(63.64%)	4(2.30%)	--	170(97.70%)
7	**Erythromycin**	30(45.45%)	6(9.09%)	30(45.45%)	40(22.99%)	--	124(71.26%)
8	**Trimethoprim/ Sulfamethoxazole**	42 (63.64%)	--	24(36.36%)	78(44.83%)	--	96(55.17%)
9	**Linezolid**	66(100%)	--	--	174(100%)	--	--
10	**Vancomycin**	66(100%)	--	--	174(100%)	--	--
11	**Tetracycline**	66(100%)	--	--	174(100%	--	--
12	**Tigecycline**	66(100%)	--	--	168(96.55%)	--	6 (3.45%)
13	**Teicoplanin**	66(100%)	--	--	174(100%	--	--

Themajorityofthe70(29.17%)StaphylococcusaureusisolateswereobtainedfromICUanddifferentwardssuchasSurgery78(32.50%)followedbyMedicine42(17.50%),Nephrology30(12.50%),OBGY8(3.33%),ENT7(2.92%),Ophthalmology3(1.25%)andOrthopaedics2(0.83%)wards.

Outof66(27.5%),MSSAisolatesallweresensitivetoLinezolid,Vancomycin,Tetracycline,Tigecycline,andTeicoplanin,followedbyGentamicin60(90.91%),Clindamycin42(63.64%),Trimethoprim/Sulfamethoxazole42(63.64%),Erythromycin30(45.45%),Benzylpenicillin24(36.36%),Ciprofloxacin12(18.18%)andLevofloxacin12(18.18%).

Outof66(27.5%),MSSAisolates12(18.18%)wereintermediatesensitivetoCiprofloxacin,Levofloxacin,andErythromycin6(9.09%).

Outof66(27.5%),MSSAisolates42(63.64%)wereresistanttoCiprofloxacin,Benzylpenicillin,andLevofloxacin,followedbyErythromycin30(45.45%),Clindamycin24(36.36%),Trimethoprim/Sulfamethoxazole24(36.36%)andGentamicin6(9.09%).

Outof174(72.5%),MRSAisolatesallweresensitivetoLinezolid,Vancomycin,Tetracycline,andTeicoplanin,followedbyTigecycline168(96.55%),Trimethoprim/Sulfamethoxazole78(44.83%),Gentamicin76(43.68%),Clindamycin76(43.68%),Rifampicin60(34.36%),Erythromycin40(22.99%),Ciprofloxacin4(2.30%)andLevofloxacin4(2.30%).

Outof174(72.5%),MRSAisolates48(27.59%)wereintermediatesensitivetoGentamicin.

Outof174(72.5%),MRSAisolatesallwereresistanttoBenzylpenicillin,followedbyCiprofloxacin170(97.70%),Levofloxacin170(97.70%),Erythromycin124(71.26%),Clindamycin98(56.32%),Trimethoprim/Sulfamethoxazole96(55.17%),Gentamicin50(28.74%),Rifampicin15(8.62%)andTigecycline6(3.45%).**(TableNo.4)**

Therewasnoresistancedocumentedagainst Linezolid, Vancomycin, Tetracycline, and Teicoplanin. Allthe122Clindamycinresistantisolates,85wereinducibleClindamycinresistance.Theantimicrobialsensitivitytesting of MRSA and MSSA showsthatMRSAisresistanttomostantibioticsascomparedtoMSSA.

Discussion:-

Methicillin-resistantStaphylococcusaureus(MRSA)hascausedsepticaemia,pneumonia,woundinfections,septicarthritis,osteomyelitis,toxicshocksyndrome,andhospital-acquiredaswellascommunity-acquiredinfections,withsignificantratesofmorbidityandmortality[16]

Therapidevolutionofantibioticresistance in Staphylococcusaureusisofconsiderableconcern. Among Gram-positivebacteria, Staphylococcusaureusisknownforresistancetovariouscommonlyusedantibiotics. Therefore, accurateidentificationisneedednotonlyforchoosingtheappropriateantibioticbutalsotocontroltheendemicityofMRSA. MRSA(Methicillin-resistantStaphylococcusaureus)isaseriouspublichealthproblemandaneconomicburdenonnationalhealthcaresystems.

Inourstudy,outof240isolatesofStaphylococcusaureus,themajorityoftheisolateswereobtainedfrompussamples166(69.17%),whichformedthelargestgroupofsamplesfollowedbyBlood48(20.00%),ETsecretion18(7.50%),sputum5(2.08%)andurine3(1.25%). A similartypeofpatternwasalsoobservedbySapkotaJetal[17]. Thestudywasconducted in TamilNadubyV.VasukiandS.Ananthasankarietal.alsoshowedthatpus&woundswabsaccountedforthemajority(57.8%)ofisolatesfollowedbysputum,blood,urine,andCSF[13].

Similarly,Himanietal.hasalsoreportedthatthemajorityofStaphylococcusaureusisolateswerefrompus(78.53%)followedbyendotrachealsecretion,urine&bodyfluids[18]. Onthecontrary,Sajinaetal.intheirstudyisolatedthemaximumnumberofS.aureusfromurine(39.6%)followedbyblood(16.7%),sputum(20.8%)pus(13.2%)&Bodyfluid(0.7%)[4].

Inourstudy,outof240Staphylococcusaureusisolates,66(27.5%)wereMSSA,and174(72.5%)wereMRSA. Similarly,SapkotaJetal.reported70.64%MRSAand29.36%MSSAisolatesintheirstudy[17]. Likewise,ShilpaAroraetal.intheirstudyconductedintheDepartmentofMicrobiology,Govt.MedicalCollege,Amritsar,Indiahasalsoreported135(56%)MSSAand115(46%)wereMRSAisolates[9].

LKKhanaletal.observedthatin600isolatesofStaphylococcusaureus,192(32.00%)wereMSSA,and408(68.00%)wereMRSAintheirstudy[19]. NabamitaChaudhuryet.alobservedthatin358isolatesofStaphylococcusaureus,151(45.18)wereMSSA,and207(57.82%)MRSAintheirstudywasconductedinWestBengal,India[20].

Likewise,GeetaSHetal.intheirstudyconductedinBangalore,Indiahavealsoreported166(72.29%)MSSAand44(26.51%)MRSAisolates[12]. Abdel-AtyEAlfekyet.al.observedthatoutof170isolationStaphylococcusaureus,32(18.08%)wereMSSAand138(81.02%)wereMRSAintheirstudyfromEgypt[21]. Himanietal.hasalsoreportedthat66(40.4%)isolatesofStaphylococcusaureuswereMRSA[18].

SanjeevSahaietal.observedtheisolationof31%MRSAintheirstudyfromUttarPradesh[4]. ThehighestisolationofMRSAwasobservedinatertiarycarehospitalinKeralabyAnithaMadhavanetal.whoreportedtheisolationof72%ofMRSA,whichismuchhigherthanourstudy[22].

Likewise,SangeetaJoshietal.hasreportedhigherisolationofMRSA(53%)intheirstudyfromtheIndianNetworkforSurveillanceofAntimicrobialResistance(INSAR)group,India[23].Onthecontrary,V.Vasuki&S.Ananthasankarietal.intheirstudyhaveobservedthatonly26(57.8%)ofS.aureusisolateswerefoundtobeMRSAwhichismuchlowerthanourstudy[13].Similarly,SanjeevSahaietal.fromChandigarhreportedalow31(31%)isolationofMRSAintheirstudy[4].

TheMRSAisolateswereassociatedwithahighlevelofco-resistancetoothergroupsofantimicrobialagents.

Inourstudy,outof66(100%),MSSAisolatesallweresensitivetoLinezolid,Vancomycin,Tetracycline,Teicoplanin,followedby60(90.91%)sensitivetoGentamicin,12(18.18%)weresensitivetoCiprofloxacin,24(36.36%)weresensitivetoBenzylpenicillin,42(63.64%)weresensitivetoclindamycin,12(18.18%)weresensitivetoLevofloxacin,30(45.45%)weresensitivetoErythromycinand42(63.64%)weresensitiveTrimethoprim/Sulfamethoxazole.

AlloftheMRSAisolateswere50(28.74%)resistanttoGentamicin,170(97.70%)wereresistanttoCiprofloxacin,98(56.32%)wereresistanttoClindamycin,170(97.70%)wereresistanttoLevofloxacin,124(71.26%)wereresistanttoErythromycin,96(55.17%)toTrimethoprim/Sulfamethoxazoleand6(3.45%)toTigecycline.AlltheStaphylococcusaureusisolatesweresensitivetoLinezolid,Vancomycin,Tetracycline,andTeicoplanin.

Similarly,V.Vasuki&S.Ananthasankarietal.observedintheirstudythatabout60-80%ofMRSAisolateswereresistanttoCiprofloxacin,Erythromycin,Gentamicin,andTetracycline[13].Similarly,Himanietal.hasalsoreportedthatMRSAisolateswerefoundtohavemulti-drugresistance.Morethan70%ofMRSAwereresistanttoCotrimoxazole,Ciprofloxacin,Gentamicin,Erythromycin,andTetracycline[18].

Likewise,GeetaSHetal.hasreported95.5%resistancetoCiprofloxacin&Ampicillin,75%resistancetoGentamicin&68%resistancetoErythromycin,48%resistancetoCotrimoxazole&52%toClindamycininMRSAisolates[12].Intheirstudy,SapkotaJetal.observedthatallMRSAstrainswereresistanttopenicillin,47.87%wereresistanttoCiprofloxacin,46.81%wereresistanttoGentamicin,42.55wereresistanttoCotrimoxazole,34.04%wereresistanttoTetracycline,78.72%wereresistanttoErythromycinand78.72%wereresistanttoClindamycin[17].

InastudyfromnorthIndia,theprevalenceofMRSAwas30-70percentandMRSAisolateswerefoundtobemoreresistanttootherantibioticsthanMSSA[2,4,9,10,18].

InastudyfromsouthIndia,theprevalenceofMRSAwas40-80percentandMRSAisolateswerefoundtobemoreresistanttootherantibioticsthanMSSA[8,11,13,24].

Inastudyfromothercountries,theprevalenceofMRSAwas30-80percent[1,6,17,21,25].

Staphylococcusaureus,oneoftheoldestpathogensknownisstilloneofthecommonestcausesofpyogenicinfectionsinhumans.Persistentlyhigh&increasingratesofMRSAamongStaphylococcusaureusisolateshavebeenobservedinhealthcaresettingsinmanyregionsofIndia.

Worldwide,MRSAhasemergedasamajorcauseofhospital-acquiredinfections.Thepossiblepredisposingfactorisincludedthatincreasethechanceofemergenceandspreadof MRSAareprolongedandrepeatedhospitalization,indiscriminateuseofantibiotics,lackofawareness,intravenousdrugabuse,andpresenceofindwellingmedicaldevices.TheprevalenceofMRSAconsiderablyvariedamongdifferentstudieswiththehighestratesof>50%inNorthandSouthIndia.

Conclusion:-

StaphylococcusaureusisanimportantcauseofHospitalassociatedinfections(HAI)andCommunityassociatedinfections(CAI).Treatinginfectionsresultingfromthesemicroorganismsmaybechallengingduetotheincreasingrangeof Staphylococcusaureus,thatareresistanttoBeta–lactamantibiotics.Accuratedesignationofantimicrobialsusceptibilitypatternoftheinfectingmicroorganismsisacriticallyimportantelementinmakingappropriatetherapeuticdecisions,duetomulti-drugresistanceinStaphylococcusaureusinfections.

Inourstudytotalof240StaphylococcusaureuswereisolatedandtheprevalenceofMSSAwas27.5%andtheprevalenceofMRSAwas72.5%fromvariousclinicalsamples.ThemaximumnumberofStaphylococcusaureuswasisolatedfromtheinpatient DepartmentfollowedbyICUandoutpatientDepartment.

Outof66(27.5%),MSSAisolates42(63.64%)wereresistanttoCiprofloxacin,Benzylpenicillin,andLevofloxacin,followed byErythromycin30(45.45%),Clindamycin24(36.36%),Trimethoprim/Sulfamethoxazole24(36.36%)andGentamicin6(9.09%).

Outof174(72.5%),MRSAisolatesallwereresistanttoBenzylpenicillin,followedbyCiprofloxacin170(97.70%),Levofloxa cin170(97.70%),Erythromycin124(71.26%),Clindamycin98(56.32%),Trimethoprim/Sulfamethoxazole96(55.17%),G entamicin50(28.74%),Rifampicin15(8.62%)andTigecycline6(3.45%).

Therewasnoresistancedocumentedagainst Linezolid, Vancomycin, Tetracycline, and Teicoplanin. Resistancetoantibiotic samongtheMethicillin-resistantStaphylococcusaureus,MRSAisolateswasmorethanthatinmethicillin-sensitiveStaphylococcusaureus(MSSA).Allthe122Clindamycinresistantisolates,85wereinducibleClindamycinresistan ce.

Thepresentstudyindicatesthehighprevalenceof Methicillin-resistantStaphylococcusaureus(MRSA)174(72.50%)andthelowprevalenceofMethicillin-sensitiveStaphylococcusaureus(MSSA)66(27.50%)inourregion.

Therefore,regularsurveillanceofhospital-associatedinfectionsisrequiredforassessingthetrendsintheantibioticresistanceofpathogensforstrengtheningthecontrolm easurestopreventthespreadandreducetheemergenceofmultidrug-resistantMRSAinfections.

Irrationaluseofantibiotics,absenceofantimicrobialstewardshipprograminhospitals,lackofsurveillanceandreportingsyst em,failuretoobserveinfectioncontrolpracticeslikehandwashing,andbarriernursingcouldbesomereasonsforthisproblem.

TheantimicrobialsensitivitytestingofMRSAandMSSAshowsthatMRSAisresistanttomostantibioticsascomparedtoMSS A.

Themosteffectiveantibiotics forthetreatmentofMRSAwere Linezolid, Vancomycin, Teicoplanin, and Tetracycline. These antibioticsshouldbekeptreservedforthetreatmentofMRSAinfection.Otheroptionsshouldbeconsideredforthetreatmentof MSSAinfection.

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