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RESEARCH ARTICLE

VENTILATOR-ASSOCIATED PNEUMONIA IN A TERTIARY CARE INTENSIVE CARE UNIT: RISK FACTORS AND MICROBIAL PROFILE

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Abstract

Forcreatingefficientpreventativestrategies,knowledgeoftheetiology,antibioticresistancepatternsandriskfactorsfordevelopingVentilatorassociatedpneumonia[VAP]inICUpatientsisessential.Thisprospectiveobservationalcross-sectionaltwo-yearstudywasdonetorecognizeriskfactorsforthedevelopmentofVAP,causalagentsandtheirantimicrobialsusceptibilitypattern.FiftylateonsetVAPand26earlyonsetVAPpatientswereexamined.Prolongedmechanicalventilation,reintubation,andtracheostomywereidentifiedasimportantriskfactors.AcinetobacterbaumanniicomplexKlebsiellapneumoniaewerethemainbacterialpathogens.Theideaofdifferentiatingpathogensbasedonlateandearlyonset VAPmaynolongerbeusefulforempiricaltherapy.Identifyingtheriskfactorscanaidinpreventionof VAPinICUpatients.

Introduction:-

InICUpatients,ventilator-associatedpneumonia(VAP)isatypicalhospital-acquiredinfectionassociatedwithhighermortalityandmorbidity .[1,2,3]Dependingonthetypeofhospitalorintensivecareunit,andthepopulationstudied,theincidenceofVAPdiffersacrossstudies.[4,5,6].Early-onsetVAPtypicallyhasabetterprognosis,islesssevere,andismorelikelytobetheresultofbacteriathatareantibiotic-sensitive.Multidrug-resistant(MDR)microorganismsarethesourceoflate-onsetVAP,whichislinkedtohighermorbidityandmortalityrates.[7]Therearevariousriskfactorsthatarecloselyrelatedtobothearly-onsetandlate–onsetVAP.[4]Thedemographicofpatientsinanintensivecareunit,thelocalepidemiology,thelengthofthehospitalstay,andanypastantibioticmedicationallplayasignificantroleindeterminingthecausativeagents.[3,5,7,8]

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Gram-negativebacteriasuchAcinetobacterspp.,Escherichiacoli,Klebsiellapneumoniae,andPseudomonasaeruginosaandStaphylococcusaureusamongGrampositivecocciarefrequentetiologicagents.[3,9,10]knowledgeofantimicrobialsusceptibilitypatternofpathogenscausingVAPisessentialforoptimalantibiotictherapy. [3,8,10]

Withthisbackgroundourstudyaimstodetectbacterialpathogensof VAP,determinetheirantibioticresistancepatternanddeterminetheprimaryriskfactorsfortheemergenceofVAPinadmittedICUpatientsinMGMmedicalcollegeandhospital,Aurangabad.

Material&Methods:-

Thisprospectiveobservationalcross-sectionalstudywasundertakenafterapprovalbyiInstitutionalethicalcommittee.Thestudywasconductedinintensivecareunits(ICU)ofMGMMedicalCollege&HospitalAurangabad,Maharashtra(India)fromJanuary2019toDecember2020.

AllVAPpatientshavingtheageof18orolderwasincludedinthestudy.Patientintubatedinotherhospitalanddevelopedpneumoniaonadmissionorwithin48hrsofintubation&thosesuspectedVAPcaseslackingbacteriologicalconfirmationwereexcluded.

AccordingtoCDCguidelines,ventilator-associatedpneumonia(VAP)wasidentified.[8]Theclassificationwasdonebasedonthedurationofmechanicalventilationuntilthedateofevent[DOE].Early-onsetVAPwasdefinedasVAPthatappearedwithinthefirst4daysofhospitalization,andlate–onsetVAPasVAPthatappearedbeyondthose4days.[2,7,8].Theanalysisonlyincludedthefirstepisode;followingepisodeswerenotincluded.

Gramstaining,cultureandantimicrobialsusceptibilitytest(AST)ofendotrachealtubeaspirate(ETA)obtainedfromthesepatientswascarriedout.AllsampleswereinoculatedonMacConkey'sagarand5%sheepbloodagarusingacalibratedloop.Theplateswereincubatedovernightat37^{o}C.Thosecasesinwhichgramstainshowed<10squamousepithelialcellsand>25neutrophilsandonculturegrowthoforganismwithcolonycountmorethan10^{5}CFU/mlwereincludedinthestudy.AfterInitialcharacterizationoftheisolatesusinggramstain,colonymorphologyandbiochemicalreactionslikecatalase,oxidaseetc;VitekIDandASTcardswereselected&bacterialsuspensionwasprocessedforspeciesidentification&antimicrobialsusceptibilitytestingasperthemanufacturesinstructions(BioMerieux).AntimicrobialagentsthatareavailableinVitek2ASTpanelswereincludedinthestudy.

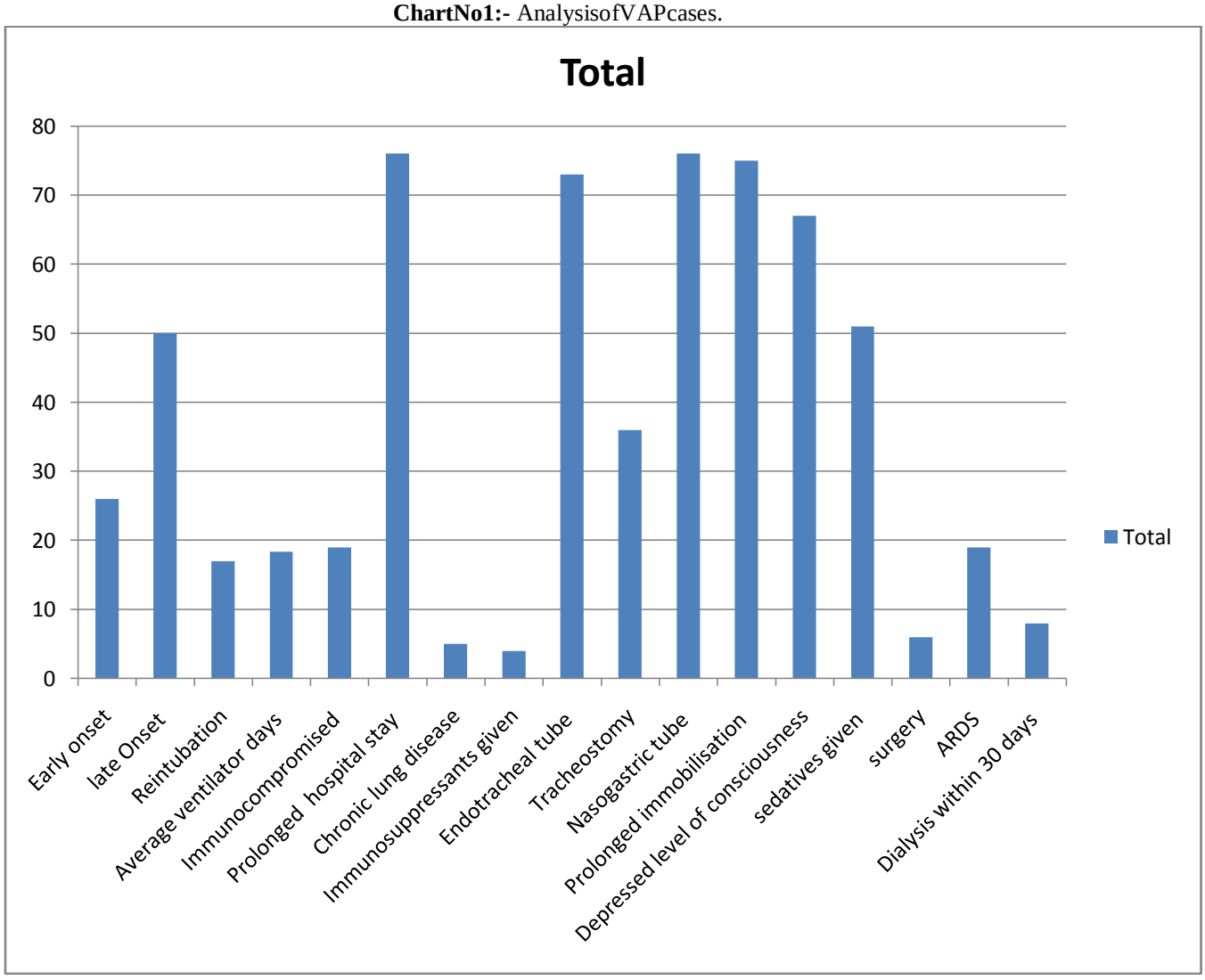
Medicalrecordsandbedsidechartswereusedtodocumenttheclinicaldataofthepatient Locationinformation,includingage,sex,DOE,thedateonwhichmechanicalventilationwasstartedandthemethodusedtoenterthepatient'sairway,suchasorotrachealintubationortracheostomy,numberofventilatordays,reintubation,surgeryetcwererecordedasperformatfordatacollection.Patients'positionwasroutinelyobserved.Areportofroutineinvestigationslikeradiologicalfindingsbeforeandaftermechanicalventilation,cultureandsensitivityofendotrachealsecretions&/trachealsecretionswasalsonoted.Inpresentstudy,76ventilator-associatedpneumoniapatientsintotalwereexamined.

Patientsonventilatorwereregularlymonitoredforventilatorassociatedpneumonia.IncidenceofVAPcasewasgeneratedbyclinicians/residentsfromvariousICUs.Also,patientsonventilatorwereregularlymonitoredforventilatorassociatedpneumoniabyinfectioncontrolnursingstaff.Relevantpatientdataincludingthenoofventilatordaysandvariousriskfactorswascollectedbyinfectioncontrolnursingstaff.Datawasverifiedbytheinfectionpreventionandcontrolteamtoconfirm VAPcase.Allrelevantclinicalandlaboratorydatawasanalysed.

Result:-

Outofthe76cases,50(65.78%)wereclassifiedashavingalateonsetand26(34.21%)ashavinganearlyonsetVAP.Males53(69.73%)hadahigherfrequencyofVAPthandidfemales23(30.26%)andinvariousagegroups,patientshadthehighestprevalenceofVAPinagegroupof51-60years19(25%).MaximumpatientsofVAPwerefromMICUfollowedbyMCRIICUandSICU.

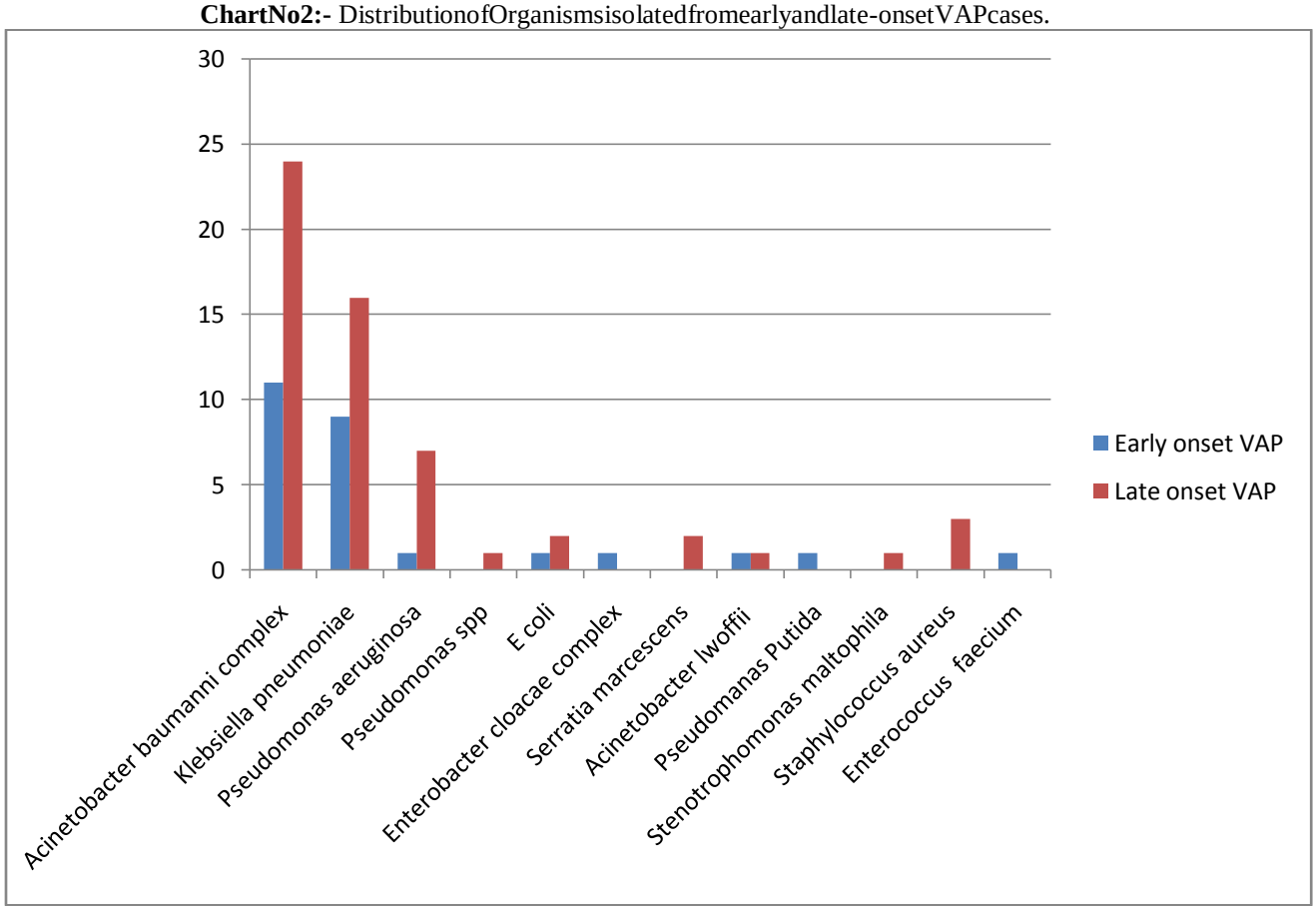
ChartNo1:- AnalysisofVAPcases.



AnalysisofVAPcasesisshowninchartNo1.Outof76patients17requiredreintubation.Inourstudyaveragedaysofmechanicalventilationwas18.39days.Outof76patientsofVAPendotrachealintubationwasrequiredin73patients[96.05%]andtracheostomyin36patients[47.36%];19[25%]patientswereimmunocompromised,fivepatients[6.57%]weresufferingfromchroniclungdisease.Depressedlevelofconsciousnesswaspresentin67cases[88.15%],sixpatientsgavehistoryof[Head,neckorthoracic]surgery.

Outof76cases26[34.21%]hadearlyonsetVAPand50[65.78%]developedlateonsetVAP.InbothlateandearlyonsetVAPpredominantpathogenswereAcinetobacterbaumannicomplexfollowedbyKlebsiellapneumoniae.Total83organismswereisolatedfromVAPcases;outofwhichpredominantisolatewasAcinetobacterbaumannicomplex35(42.16%)followedby25(30.12%)Klebsiellapneumoniaeand8(9.6%)Pseudomonasaeruginosa.[SeeChartNo2]

ChartNo2:- DistributionofOrganismsisolatedfromearlyandlate-onsetVAPcases.



AllisolatesofAcinetobacterbaumannicomplexfromVAPcaseswereresistanttoCefepime,Ceftazidime,Ciprofloxacin,Doripenem,Imipenem,Meropenem&Piperacillin/Tazobactam.

BettersusceptibilitywasfoundonlyagainstColistin[100%]followedbyMinocycline[63.64%]Trimethoprim+Sulfamethoxazole[35.3%],Cefoperazone+Sulbactam[24.75%]&Levofloxacin[8%]&Gentamicin[3.04%].

OutofKlebsiellapneumoniaeisolates[96%]wereresistanttoCiprofloxacinfollowedbyCefuroxime[95.45%],Ceftriaxone[95.45%],Meropenem[93.33%],Cefepime[92%]Amoxicillin+Clavulanicacid[88%],Ertapenem[86.36%]Cefoperazone+Sulbactam[80%]Imipenem[81.81%]&Trimethoprim+Sulfamethoxazole[80%].

KlebsiellapneumoniaeisolatesweresusceptibletoColistin[90.09%]followedbyPiperacillin/Tazobactam[57.14%],Gentamicin[40%],Amikacin[40%]andTigecycline[36.36%].

Discussion:-

InICUpatients,afrequenthospital-acquiredillnessknownasventilator-associatedpneumonia(VAP)islinkedtoincreasedmortalityandmorbidity.[1,2,3]

TheVAPbundleincluded30^0–45^{0}headelevation,sedationbreakseachday,evaluationsofextubationreadiness,prophylaxisfordeepveinthrombosis,pepticulcerdisease,suctionfromendotrachealtubestokeepventilatorcircuitsdryandtwicedailyuseof2%chlorhexidinetwiceadayorasperrequirementandhandhygieneguidelinesareimplementedinourhospitaltopreventVAPinfection.

AtotalofadultVAPpatientsintotalwereassessed.VAPratewasobservedtobemoreprevalentinamongmales53(69.73%)andmeanagegroupwas51-60yrs.

InastudycarriedoutbyUzzwaletal52%ofthepatientswereVAPwithearlyonset,while48%wereVAPwithlateonset.[7]Inours tudyoutof76cases50(65.78%)acquiredlate-onsetVAP,while26(34.21%)hadearly–onsetVAPwhichmaybeduetodifferencesinstudyperiod&populationstudied.

Endotrachealintubationisasignificantriskfactorthatcanleadtosecretionstricklingaroundthecuff,thedevelopmentofabact erialbiofilm,microaspirationduringtheintubationprocessandimpairedmucociliaryclearanceofsecretions.Replacemento fnormalflorabypathogensandtheventilator'spositivepressurehelpsforwardmovementofbacterium-enrichedmaterial.[8]Inpresentstudyendotrachealintubationrequiredin73patients[96.05%].Riskishigherinpatientsoftrache ostomyasmanipulationoftheairwaymaypredisposetoaspirationfollowedbyVAP.Inourstudy36(47.36%)patientsrequire dtracheostomy.

ReintubationisoneoftheriskfactorsfortheemergenceofVAP.Aspirationriskmaybeincreasedasaresultofslowedreflexesbr oughtonbyprolongedintubationoralteredlevelsofconsciousness.[1,4]Inourstudy17patientsrequiredreintubation.

Patientswithconsciousnessissueshadconsiderablylongerhospitalstaysandlongerperiodsonmechanicalventilation,which exposedthemtomoremicroorganismsandincreasedtheirriskofdevelopingVAP.[11]Inpresentstudydepressedlevelofconsci ousnesswaspresentin67[88.15%]patients.

Outof76patients19[25%]wereimmunocompromised,5(6.57%)patientsweresufferingfromchroniclungdisease,06[7.89 %]gavehistoryofhead,neckorthoracicsurgery.

PredominantpathogensinbothlateandearlyonsetVAPwereAcinetobacterbaumannicomplexfollowedbyKlebsiellapneu moniae

ThedurationofmechanicalventilationtypicallyaffectstheVAPcausingagent.EarlyVAPistypicallycausedbyinfectionstha trespondwelltoantibiotics,butlateonsetVAPiscausedbyorganismsthataremulti-drugresistant.[8]However,inourstudybothlate–onsetandearly–onsetVAPwereassociatedwithMDRinfectionthismaybebecauseofprolongedhospitalizationandpriorantibiotictherapy. OurfindingsareinconcordancewithstudybyBenLakhalHetalinwhichtherearenodiscernibledistinctionsbetweenMDRpat hogenslinkedtoearly-onsetorlate-onsetVAPintheirpatternsofresistance.[12]BenLakhalHetalreportedA.baumannii(53%),P.aeruginosa(37%)andEnterobacterales(28%),whichincludedK.pneum oniae,Enterobactercloacaecomplex,E.coli,Proteusmirabilis,ProvidenciastuartiiandSerratiamarcescenswerethemostfre quentlyisolatedorganismsfromVAPcases.[12]InastudyatBangalore;Pseudomonasaeruginosa,E.coliandAcinetobacterbau maniiwerefoundinbothearlyonsetandlateonsetVAPisolates.[13]

InourstudyAcinetobacterbaumannicomplexwasthemostcommonpathogenfoundinpatientswithlate-onsetandearly-onsetVAPfollowedbyKlebsiellapneumoniae.

AllisolatesofAcinetobacterbaumannicomplexfromVAPcaseswereresistanttocefepime ,ceftazidime , ciprofloxacin, doripenem , imipenem ,meropenem&pipercillin / tazobactam.AllisolatesofAcinetobacterbaumannicomplexweresusceptibletocolistin[100%]

OutofKlebsiellapneumoniaeisolates[96%]were resistant to ciprofloxacin followed by cefuroxime [95.45%], ceftriaxone [95.45%], meropenem[93.33 %], cefepime [92%] amoxicillin + clavulanic acid [88 %], ertapenem [86.36%] , cefoperazone +sulbactam[80%]imipenem [81.81 %] &trimethoprim+ sulfamethoxazole [80 %]. better susceptibility was found only against colistin [90.09%] followed by piperacillin / tazobactam [57.14%].

Manyclinicianstreatcriticallyillpatientsempiricallywithamixofbroad-spectrumantibioticsduetorisingantimicrobialresistancerates,whichcanexacerbatethedevelopmentofresistance.[14]Ration aluseofappropriateantibioticsandunnecessaryprolongedhospitalizationmayreducepatientcolonizationandsubsequentde velopmentofVAPwithMDRpathogens.

TreatmentforVAPbroughtonbymultidrug-resistantA.baumanniicanbeaccomplishedwithintravenouslyadministeredcolistin.[15]Onlyafterallothertestedantibi oticshavefailedcolistin and polymixinBcanbegiven.[16]

AccordingtoourfindingscolistinshouldbekeptasreserveddrugtotreattheseMDRinfections.Programsforawarenessamongstclinicianstoreduceunnecessaryantibioticprescription,propertrainingofstaffoninfectionprevention&controlpractices,prudentuseofantibioticsiscrucialinpreventingMDRinfectionsinVAPpatients

Conclusion:-

InpresentstudybothearlyandlateonsetVAPoccurredin34.21%and65.78%ofpatients,respectively.Prolongedmechanicalventilation,reintubation,tracheostomyanddepressedlevelofconsciousnesswereimportantriskfactors.PatientswithbothlateandearlyonsetVAPwereinfectedwithmultidrugresistantbacteria.AcinetobacterbaumannicomplexfollowedbyKlebsiellapneumoniaeWhenselectingthebestempiricalantibiotictherapy,theideaofdifferentiatingpathogensbasedonearlyandlateVAPmaynolongerbeapplicable.Westronglyrecommendtofolloweasyinfectionpreventionmethodslikehandhygiene,transmissionbasedprecautions,programsforawarenessamongstclinicianstolowertherateofneedlessantibioticprescription,decreasereintubationratesbypropertrainingofstaffandfollowaseptictechniquesthatwillpreventspreadofinfection.Also,Antibioticusageshouldbedonecarefullytoavoid MDRinfectionsbroughtonbyVAP.

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Conflictofinterest

Nonedeclared.

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