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RESEARCH ARTICLE
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AN AWARENESS STUDY ON SAFE DISPOSAL OF UNUSED & EXPIRED MEDICINES FOR SAFEGUARDING THE ENVIRONMENT.

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Abstract
Improperly disposed medicines could adversely affect the environment and increase the riskof drug misuse or accidental poisoning. This survey evaluate the disposal practices of unusedandexpiredmedicinesamongthegeneralpopulationinAmravati,India.Thiswasadescriptivecross-sectional survey conducted among 192 respondents in Amravati, India. Data werecollectedthroughinterviewsusingapre-validatedstructuredquestionnaire.Descriptivestatistics were calculated using the Microsoft Excel® 2022. Ethics approval was obtained.General public knowledge and attitude regarding unused and expired medication disposalpractice is assessed. 72% Expired medicines and 38% Unused medicines were collected.Expired medicines comprises of29% NSAID ,20% Nutraceuticals, 21%Antibiotic, 9%Antacidandremaining31%medicinescomprisedofcategoriessuchasantiseptic,expectorant,anti-diarrheal, etc.Unused medicinescomprises of23% Antacid, 20% Nutraceutical,17%NSAID,11% Antibiotic,5% Antidiabeticandremaining24%areothermedicinescollectedandsorted.Themostcommondisposalmethodofunwantedmedicineswasthrowingaway in household garbage (26%). The current study has identified the need of propereducationondisposalofpharmaceuticalsthataccumulateinhouseholdsandalsotheneedforlaws and regulations to clearly and specifically describe how unused medications should beproperly disposed of. These findings call upon the strategies to strengthen the pharmaceuticalwastemanagement program.

Keywords: unused medicines, expired medicines, safe disposal, environment.

INTRODUCTION

The global consumption of medicines is rising daily, particularly in China and India.(Derksen J.G.et al.,2004)[(9)] The use of medications for both human and veterinarypurposes is growing constantly, and most customers at some point end up with someunused medications.(Rani N.V.et al.,2019)[(15)] Then, for municipal and environmentalhealth authorities, disposing of unused medications from families is also becoming abigger challenge.(Atinafu T.et al.,2014)[(5)] More focus is placed on the rational use

ofmedicine,sothatpatientsobtainthepropermedicationattherighttimeandutilisethemappropriately.(Abou A.H.S.,2003)[1] Our participant community lacks understandingabout how to dispose of unused, unwanted, and expired drugs. According to studiesconducted throughout the world, the majority of patients kept their prescriptions instoragebecausetheydidn'twanttothrowthemaway,nevercheckedtheexpirationdate,and didn't know how to properly and safely dispose of their medications, all of whichcould have unintended consequences or hazards.(Garey K.W.et al.,2004)[10] Improperdrug disposal could pose a serious risk to the environment, and prolonged exposure topharmaceuticalsintheenvironmentcouldhavenegativeimpacts,especiallyonvulnerablepopulationsincludingexpectantmothers,new-borns,andtoddlers.(DaughtonC.G.,2003)[8]
Moreover,whenkeptinthehome,unusedorundesired prescriptions are more likely to be misused and abused.(Beirens T.M.etal.,2006)[6] Studies carried out in Kenya and Nigeria revealed that flushing in the toiletwas followed by putting unneeded medications in the trash as the preferred method ofdisposal.(Angi'enda S.A.et al.,2016)[4]Some studies also identified that the unusedmedicineswerekeptinthehouseholdduetounawarenessofmethodstodisposethem.(Osei-Djarbeng S.N.et al.,2015)[11]

Disposalpracticeofunusedmedicineshasbecomeaworldwidechallengeforthepolicymakers,healthprofessionals,pharmaceuticalscompaniesandthecommunityingeneral.ManydevelopedcountrieslikeAustraliaandCanadahaveprogramssupportedby government and pharmaceutical industries aiming at disposal of unused medicineslike the"NationalReturnandDisposalofUnwantedMedicinesProject".UnitedKingdomandSwedenencouragesthedrugtake-backprograms.(TongA.Y.etal.,2011)
[20]Creatingawarenessamongmedicineusersaboutproperdisposalmethodwouldbea promising step to protect the environment from this kind of pharmaceutical waste.(Persson M.et al.,2009) [12] Evidence-based guidelines was published by the WorldHealth Organization (WHO) in 1996, 1999 and 2010 to and empower drug recipientsand control the practice of drug donations. As the quality of donated drugs cannot beguaranteed,theguidelinesclearlyprohibiteddonatingofdrugsthathavebeenissuedtopatientsandthenreturnedtoapharmacyorelsewhere,orweregiventohealthprofessionals as free samples. (Rani N.V.et al.,2019)[15]Another method of disposalsuggested by WHO was to return expired, unwanted, or unused medication to a localpharmacyandclinicortoahealthcareproviderforsafedisposal.Thoughsuchpracticesare in practice in some countries, patients are seldom aware of the existence of serviceastheyrarelyshowinteresttogetproperinformationonthesafeandappropriatewaysto disposemedications. (West L.M.et al.,2014)[22]

Ecopharmacovigilanceisofsignificantconcernastheadverseimpactofhumanpharmaceuticalsisontherise inenvironmentintherecentyearsespeciallyinsurfacewater. There is a dire need to address the challenges related to the improper disposal ofunusedandexpiredmedicinesimmediatelytominimizethehazardouseffectofimproper disposal of medicines on the environment. (Seehusen D.A.et al.,2006)
[17]Despitebeingamajorconsumerofmedicines,therearenostringentregulatorypoliciesfortheconsumerstowardssafedisposalofmedicinesinIndiaanddrugtake-backprograms are notfunctional/effective asinother
countries.TheNationalFormularyofIndia,specifiesguidelinesfortheproperdisposalofmedicines.However,mostofthepeopleinIndiaarenotawareofthesguidelinesandtheimportancetofollowthem.Thisisalsosubstantiatedbytherecommendationsgivenbyan Indianstudyontheknowledge,attitudeandbeliefofdental studentsaboutthedisposalmethodsofexpiredandleftovermedicinesontheneedtoimprovetheawarenessaboutsafeandjudiciousdisposalmethods.(AdityaS.etal.,2013)[2]Itis,thus,importanttoassesstheknowledge,attitudeandpracticeofconsumersofmedicinesaboutthedisposalofunusedand expired medicines.
Unused medication disposal is a topic of great interest and such a study has not beencarried out in

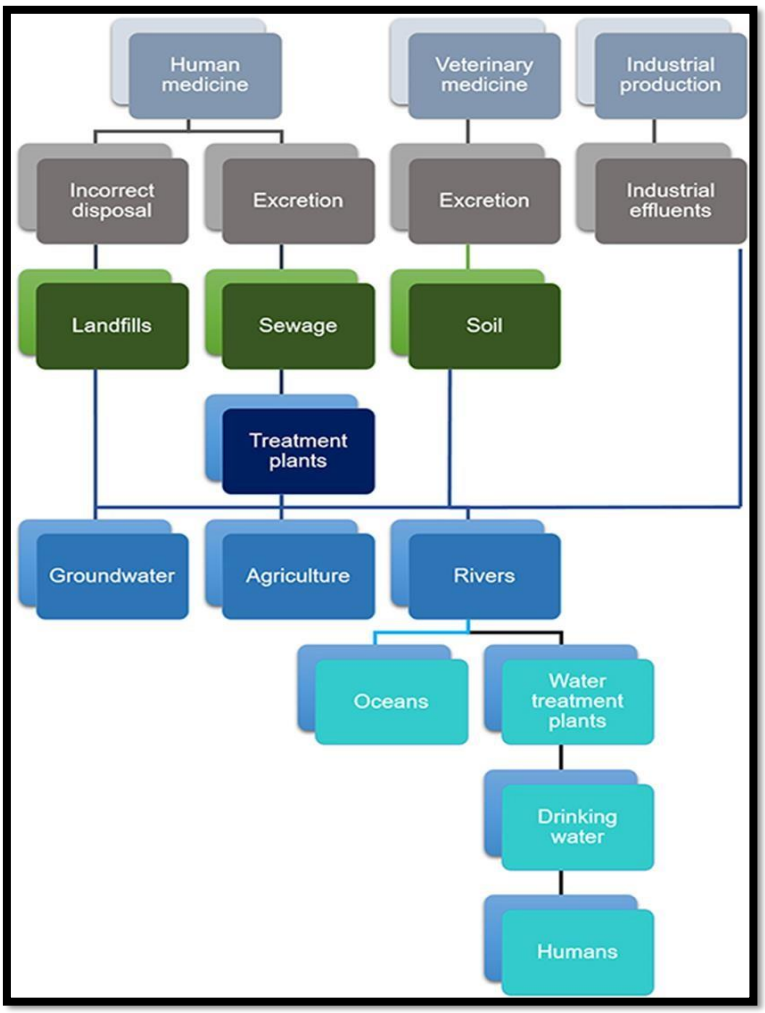
INDIA. Indeed, the knowledge on the factors which may affect howpatientsdisposeofandstoreunusedmedicationscancontributetotheestablishmentofformalizedprotocolsforthedisposalanddestructionofunusedor expiredmedicationsaroundtheworld.
Medications are chemical substances introduced into the body to cure a disease orpathological condition, relieve the symptoms of a specific illness, or simply to preventdisease (Cramer J. A.et al., 2008) [(7)]. Although medications play a considerable role inour daily lives, advancements in the medical field have contributed significantly to aremarkable increase in drug waste. This is attributable to the growing number ofpatientsandoverprescriptionbyhealthcareproviders.Theensuingdrugandmedication waste has resulted in biological maladies and ethical challenges, and it hasa negative impact on the environment (Sonowal M. K. D. S. et al., 2016) [(19)]. It isimportanttoraiseawarenessabouthowtodisposeofexpiredmedicationscorrectlyandwhatto do with unused medications.
Most homes in Saudi Arabia have medicine cabinets filled with medicines, some ofwhich have expired, and others that are not needed. Furthermore, most people disposeofmedicationsincorrectly.Forexample,somepeoplepourliquidmedicinesintotoiletsor bathtubs, which could cause pollution to our environment, especially by poisoningthe waterways, which harms marine life, negatively affects humans and animals, andmay spawn new diseases with a potentially dire impact on Saudi Arabian society(AlshehriD.etal.,2022)[(3)].Thereare alsopeoplewhodisposeofdrugsbythrowingthemin the trash (e.g., garbage cans), which also increases the hazard potential of thesechemicalswhentheyareexposedtothesunoreatenbyanimals,causingharm(Sonowal M. K. D. S.et al., 2016)[(19)]. Even when medicines are not disposed ofin anyof these ways, keeping unneeded medications at home is extremely unwise because itcould lead to accidental poisoning. When old drugs are not disposed of correctly andare instead kept in wardrobes or freezers, they are easily within reach of kids and pets,who may ingest them, leading to poisoning. In terms of economic impact,
medicinewastageconstitutesalargelossoffinancialresourcesexpendedbySaudiArabiaontheprovision of healthcarefor its citizens(Smale E.M., et al.,2021)[(18)].
Whenwetakemedication,aportionofitleavesourbodiesthroughexcrementorurineand travels a long way to the sewage system. Human Excretions travel via a treatmentfacility in the sewage system, where several contaminants are filtered out. Returningthis cleaner water to rivers allows it to eventually reach the sea. However, due to thelack of sewage system in many areas of the world, more pollution is produced whenhumanwaste is dumpedoutsideof building.

Other method via which medicine can enter the environment one possible route fordrugstoentertheenvironmentisthroughhumanexcretion.Additionallypharmaceuticalfirmsthatproducemedicinehavethepotentialtoreleasepollutionintothe environment that contains pharmaceutical. Veterinarians' medication used to treatanimalsmayalsowindupintheenvironment.Thesesubjectsaretooextensivetocoverinthisessay,sowe'llconcentrateonthecomponentsofmedicalpollutionthatareunderourcollectivecontrol.Unfortunately,alotpeoplestilldisposeoftheirunusedmedicationsby flushing them down thetoilet orthrowing them inthe trash

All waste that cannot be recycled has been disposed in landfills. Since landfills are notperfect, they need to be constantly monitored. When the trash at these locations beginstooverflow,itisburiedunderearthandcovered.Intheeventthatthebarrierenclosingthelandfillsfails, chemicalsfromtheburiedwaste,includingexpiredmedication,mayleachintotheground,contaminatingthesoilandgroundwater.Additionally,groundwater is used to create drinking water and irrigate crops. Once more,thismedicationthatremainsriskendangeringbothhumanandenvironmentalhealth.(Quadra G.R.et al.,2016) [(14)] Drug contamination of aquatic ecosystems can harm thespeciestherebyaffectingtheirgrowth,behaviourandevenreproduction.(RoyerT.V.etal.,2012)[(16)]

Oneinvestigationdiscoveredthataddingcertainquantitiesofanantidepressanttowatercould make male fish more aggressive, which increased the mortality of the femalesand decreased egg production. (Klaper R.etal.,2014)[21]

Theriseofbacteriathatareresistanttoantibodiesmayalsobecausedbyenvironmentalmedications. In order to treat bacterial infections like pneumonia, antibiotics werecreated.However,duetofactthatbacteriathatareresistanttotheeffectsofantibioticscan be extremely dangerous to humans and that we can no longer combat them withour more commonly used antibiotics, these substances need to be strictly controlled.(Pontes D.S.et al.,2009)[13]



FigureNo.1 Routesbywhichmedicinesgetintotheenvironment(QuadraG.R.etal.,2016)[14]

AIMOF STUDY

The aim of this study was to investigate the behaviors of individuals in P. R.Pote Patil Education Institute and Gajanan Township in the disposal of expiredandunused medications.
Weaimtoidentifythebestmethodstoeducatethepublicregardingappropriatesafedisposal of medications**.**
Theaimofsafedisposalofunusedandexpiredmedicinesistoprevente environmentalpollution and health hazards.

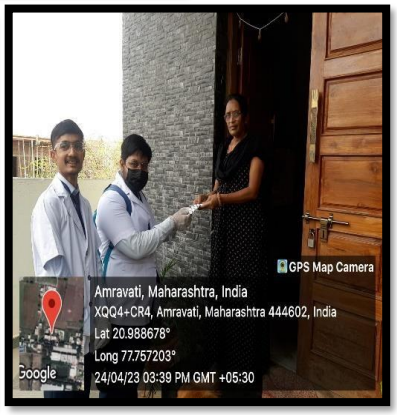
RESEARCHMETHODOLOGY

Studyarea:

Athree-daycampwasarrangedininstitute,atcampusofP.R.POTEPATILEDUCATIONAL INSTITUTE AMRAVATI, and at a residential area of GajananTownship, Amravati. on various days

respectively. The objective of the camp was tospread awareness about proper disposal of unused and expired medicine, also wecollectedunusedandexpiredmedicinesfromtheparticipantsparticipatedincamp.Themedicines collected were sorted, analysed and disposed off properly at biomedicalwaste management facility. The data collected from the camp was analysed and sortedaccordingto theirPharmacologicalclassification.

Figure No. 2 & 3 Awareness Camp (Day 1) at P.R. Pote Patil College of PharmacyAmravati.



FigureNo.4& 5 Awareness Camp (Day2)at GajananTownshipAmravati.

Figure No. 6 & 7 Awareness Camp (Day 3) at P.R.Pote Patil Educational InstitueAmravati.

Studydesign:

We have prepared a questionnaire to evaluate the knowledge, attitude of the studyparticipantsonsafedisposalmethodsofunusedandexpireddrugsandtheirpracticeofdrug disposal. The Questionnaire was shared and filled by participants using googleforms link (https://forms.gle/viCsSfc1uyjNdy3b7) and Quick response code.Thequestionnaire contains eight questions to obtain data on visit on physician, purchasingmedicinesprescribed,self–

medication,administrationmedicinesanddisposalofmedicines.
The 1st question is "How often do you visit physician in year?" and the responses arecategoriesthreeoption asonce, twice, thrice.
The 2nd question is "Do you purchase all the medicines prescribed by physician?" andtheresponses are categories intothree options asyes/no/may be.
The 3rd question is "how often do you self-medicate or take self -medication withoutvisiting a registered physician in a year?" and the responses are once, twice, and morethanthreetime.
The 4th question is "Do you use or administered all the medicine prescribed" and therespondingoption areyes or no.
The 5th question is "If you do not take all the medicines prescribed then how do youmanagethemedicineremaining"andtherespondingoptionarestoredthemtillexpired,throwthem in waste, giveback to pharmacists, donate them.
The6thquestionis"Ifyoustoredtheminyourhousethendoyouusethemagainornotandthe responding option areyes, no, may be.
The7th questionis"Ifyouhavestoredthemedicineandthey areofnoyoutoyouthenarewillingtocollectityourcollegeforanawarenessdriveandtherespondinganswers areyes, no.
The8thquestionisanysuggestionforproperwastemanagementofunusedandexpiredmedicinefor publicresidences?and theresponsesof participant arerecorded.
FigureNo.8 Quick ResponseCodeforGoogleformslink

SortingofMaterials:
Materials to be disposed off should be segregated. Different methods are employeddependingon
1) Typeofdosageforms-
   Tablets,Capsules,Powders,Injectables,Creams,Ointments,Liquids,Ampoules, Vials,IntravenousInfusionsetc.
2) Chemicalnatureofdrugse.g.,Antineoplastics/Anticancer,β-Lactams,Hormones, Steroids, Anti-infective, Narcotics, Antiseptics and Psychotropicsubstances etc. Tertiary (Printed/Labelled Corrugated Boxes) and Secondary(Printed Cartons/Paper box) packaging materials are removed and destroyedwiththehelpofheavy-dutypapershredder.Themethodsofdisposalofvariouspharmaceuticaldosage formsand that ofspecificcategory medicines.

MedicineCollectionBin:
Medicine collection bin is prepared by us to collect unused and expired medicineseparatelyand foreasy disposal and sorting.

FigureNo.9 Medicinecollection Bin

DataAnalysis:

We have reviewed previously reported disposal practices by the public around theworldtoobtainabettergrasponthegeneralawarenessregardingtheissueofimproperdisposalmethods. Databaseshavebeencollectedbyusingthekeywords“medicine”or“medication” or drugs” and “unused” or “wastage” or “disposal” or “management” indifferent combinations in the search bar in Google Scholar and PubMed up to 2022.Articles without an empirical investigation into disposal practices, through a publicsurvey,wereexcluded from reviewedarticles.

Data were entered in a Microsoft Excel®2022 sheet and analysed using descriptivestatistics.Soliddosageformswerecountedmanually,liquiddosageformsweremeasured using a calibrated measuring cylinder, dermatological preparations weremeasuredusingkitchenweighingscales,andinhalers whichhadacounter wererecorded as per value available on the counter. Unused inhalers without a counter, eyedrops,eardrops,nasaldrops,andnasalandoralsprayswerenotquantifiedaseffectiveentries,as their quantities could not besafely determined.

The cost of the medication returned was calculated using the retail price as per thepharmacy’spricelistissuedinApril2023.Thetwomainreasonsforchoosingtheretailprice were first, that this was the cost paid by the client, and secondly, retail prices inAmravati are standard across pharmacies and, unlike purchasing prices, do not varyaccording to special bonuses issued by pharmaceutical agents. For items for which apricecould not befound,e.g., medicines purchased from abroad,

The expirydate onthe packwasusedtoestimate the time, in months,thatthemedicationwasheldbeyondtheexpirydateattheclient’send.Itemswhichwerefoundinthep harmaceuticalbinbutwerenotyetexpiredwereclassifiedundertwocategories.Medicines which were not expired but had specific instructions on the packagingdetailinghowlongtheycouldbeusedafteropeningwereclassifiedasmedicineshaving“specific after opening instructions”. This was the case, for example, for eye droppreparations,certainliquidpreparations,andnasalsprays.Ontheotherhand,medicinesclassifiedas“n otyetexpired”consistedofmedicationsthatcouldstillbeutilizedatthetimeatwhichtheywerethrownaway. Whentheexpirydatewasnotvisibleonthepackorblister pack,thiswascategorizedas“expiry datenot visible”

FieldVisit(IncinerationPlant)Report:

The manager described us the method followed for segregation of bio-medical waste.Theyaresegregatedindifferentcolouredbagsasinred,yellow,blue.WastefromRedand yellow bags are transported to the treatment plant. The vehicle was painted withappropriate colour and symbols. Waste in yellow bags are mostly human anatomicalwasteandthisbagisnotopened.Theyellowbagisdirectlyputintoincineratorwithoutopening.

On the other hand, the red bag contains gloves, tubing and plastics etc as itcannot be burnt, nor it can be buried according to the rules laid by pollution controlboard.Hence,theyareautoclavedandthensentforshredding.Inordertopreventreuseof rubber or plastic material after autoclaving of the material, shredding is done. Theplasticand rubber material areshreddedinto small pieces.

These small pieces are sent for recycling. Blue contains sharps like broken bottles,vials and ampoules etc. these are sent for chemical treatment. Sharps like needles arenot put into blue bags. However, needles are put into white tamper proof or punctureproof containers containing 10% hypochlorite solution and water to disinfect it andonce the container is full then hospital send it to the Bio Medical Waste plant. Laterthesesharpsareputintosharppits.Wewereinformedthatmanyatimessegregationisnot done as per the Bio Medical Waste guidelines. As in waste coconut shell, paper,fruit peels, etc. are also put into wrong-colored bags. It is the duty of the doctor or theconcernedhospitalforpropersegregationofthewasteandsendittothetreatmentplant.Black is provided to the hospital to discard general waste in it and send it to municipalcorporation.

Incineration Process Incineration is a high temperature thermal process employingcombustionofthewasteundercontrolledconditionforconvertingitintoinertmaterialand gases. Incinerators is oil fired in this case 35 liters of diesel are required per hour.Incinerators have primary and secondary combustion chambers toensure optimalcombustion. In the incinerator, solid phase combustion takes place in the primarychamber whereas the secondary chamber is for gas phase combustion. These arereferredtoasexcessairincineratorsbecauseexcessairispresentinboththechambers.Thus,thewasteisin cineratedintwostagesi.e.,theprimarychamberwheretemperature isashighas850°C.around35litresofdieselisrequiredforburningthewaste.Oncethetemperaturereaches85 0°Cthentheburnergoesofftilltemperaturestartstodrop.

The secondary combustion chamber which are positioned adjacent to the primarychamber.Thefluegasesthenpasstosecondarychamberwherethetemperatureisabout1050°Canda reletouttoatmosphereviaIDfanand100fthighchimney.Thenremaininggasesandparticlesaresentthrough thehighpressuredropVenturiScrubber,droplet separator. The Primary Combustion Chamber operates under near pyrolyticconditionwhereinthewastesaredecomposed&allvolatilesarereleased.Thesubstrateremaining gets converted into sterile ash. The volatiles released from the PrimaryCombustionChamberarethencompletelyburntintheSecondaryCombustionChamber under high temperature and excess air. Incinerator runs for 7.5 hours a dayandaround150 kg ofwaste is burntevery day.

Autoclaving Process: An autoclave is a specialized piece of equipment designed todeliverheatunderpressuretoachamber,withthegoalofdecontaminatingorsterilizingthe contents of the chamber. Content of the red bags are sent for autoclaving and thenfor shredding. Shredding Process: Shredding is a process by which wastes are de-shapedorcutintosmallerpiecestomakethewastesunrecognizable.Shredderhasnon-corrosivesharpblades capableforshredding ofplasticwastes,sharps,bottles,needles,tubing's, and other general wastes. The low speed two shaft systems are effective forshreddinghardand solid wastes.

WaterRecyclinginProcess:

The water discharged from the process of wet scrubbing of fuel gas generated byincinerator will be collected in the seal pit below ground level. The treated water isreused in the venturi scrubber. The Ashes and sludge formed by the bio-medical wasteplantarefurthersenttohazardousmaterialtreatmentplantsituatedinButibori,Nagpur.Outcome ofthe visit:

Studentswereeducatedaboutnewreformsinthebiomedicalwastemanagementrules.They could understand in detail how the biomedical waste generated from hospital issegregated and treated. Three major treatment procedures were explained in detail i.e.,incineration,autoclavingand

shredding.

FigureNo.11 FieldVisitatGlobalEcoSaveSystemBadnera, AmravatiMaharashtra

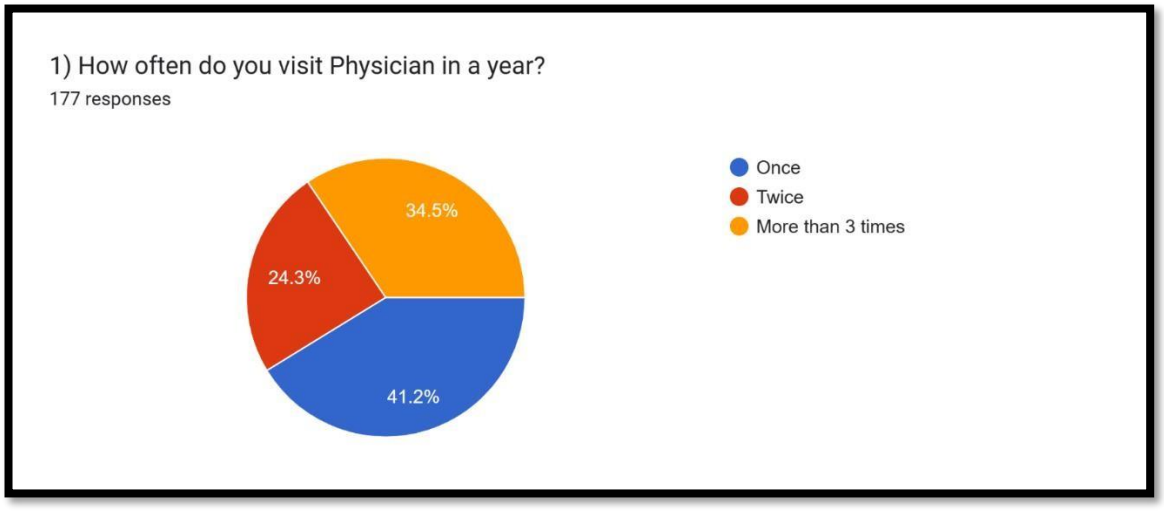
RESULT

ThetotalstudypopulationwaS192participantsofP.R.PotePatilEducationalInstituteandGajananTownshipinAmravatiofIndiacomprisingFemaleandMales.Respondent'sagerangedfrom 18to 60years withameanageofyears.

Characteristics	Parameter	RespondentsN(192)
Gender	MaleFemale	69.27%30.72%
Age(Years)	18-25 26-35 36-60	90.62% 5.72% 3.64%

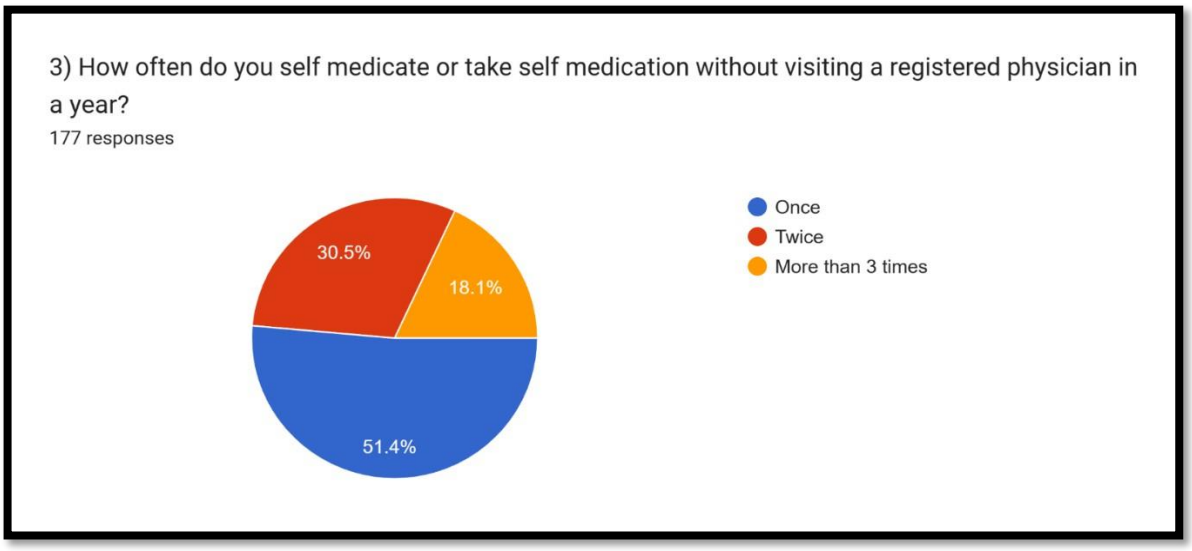
Table.1 Socio-DemographicCharacteristicsofrespondents(n=192)

41.2%ofrespondentssaidtheyvisitaphysicianinaonceyear,24.3%twiceayearand34.5%morethan threetimes ayear.



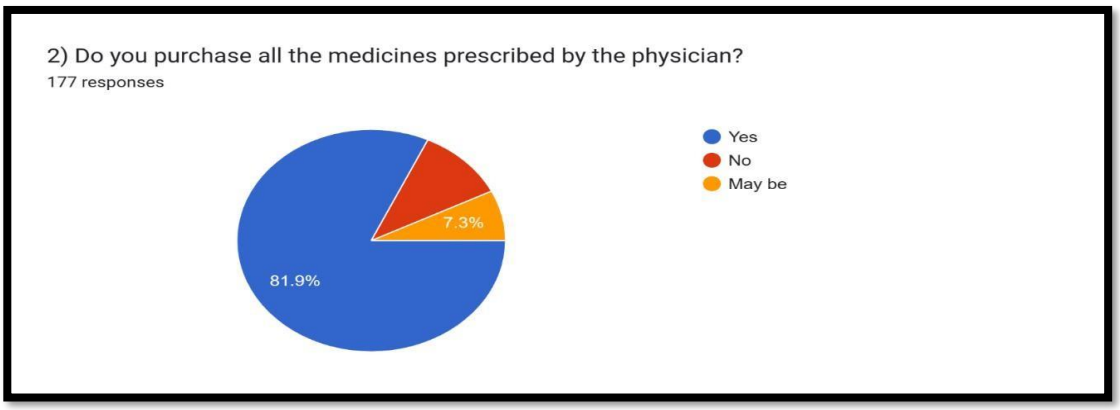
FigureNo.12 Responsesonthe Questionno.1ofquestionnaire.

81.9% respondents purchase all the medicines prescribed by the physician,10.7% donot buy all the medicines prescribed and 7.3% are not sure about purchasing allmedicinesprescribed.



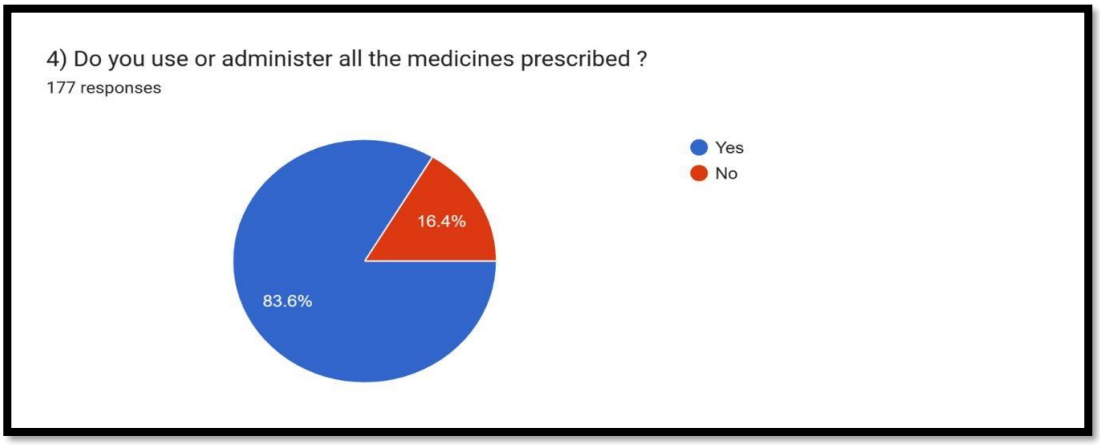
FigureNo.13 Responsesonthe Questionno.2ofquestionnaire.

51.4%respondents self-medicatewithoutconsultingaphysicianonceinayear,30.5%self-medicate twice a year and 18.1% respondents self-medicate more than three timesayear.



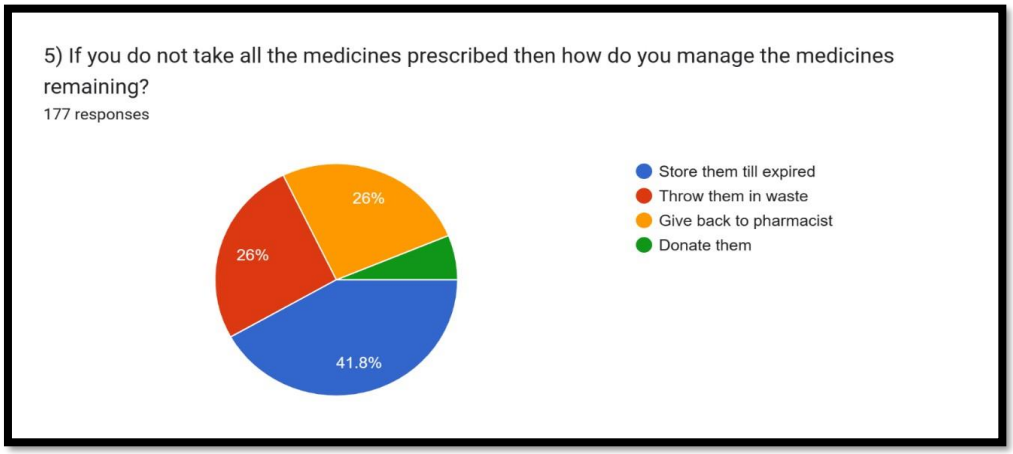
FigureNo.14 Responsesonthe Questionno.3ofquestionnaire.

83.6%respondentsadministerallthemedicinesprescribedand16.4%donotadministerall the medicines prescribed.



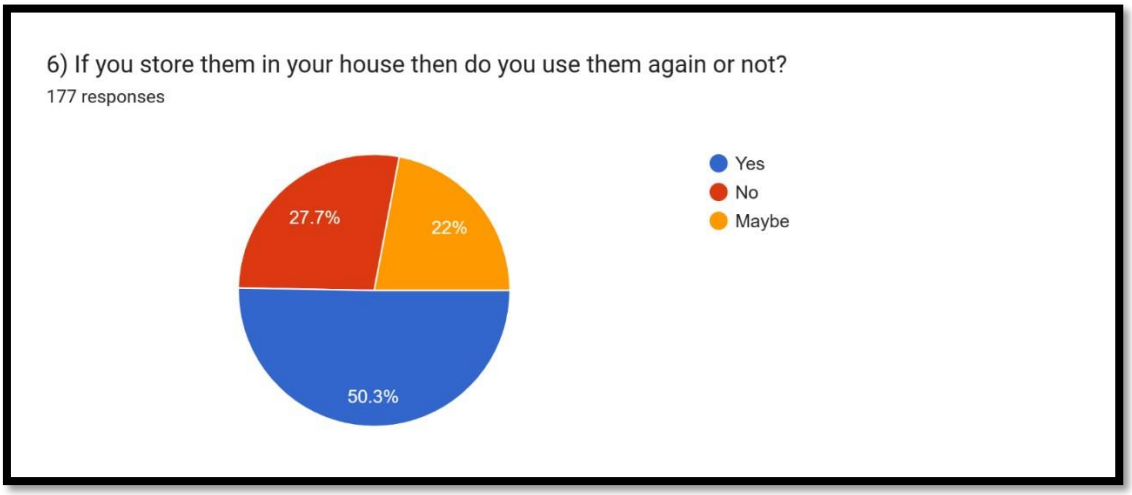
FigureNo.15 Responsesonthe Questionno.4ofquestionnaire.

41.8%respondentsstorethemedicinestillexpiryiftheydonotconsumeallprescribedmedicines, 26% respondents throw the medicines in waste, 26% give back them topharmacistand 6.2%donate themedicines.



FigureNo.16 Responses ontheQuestion no.5ofquestionnaire.

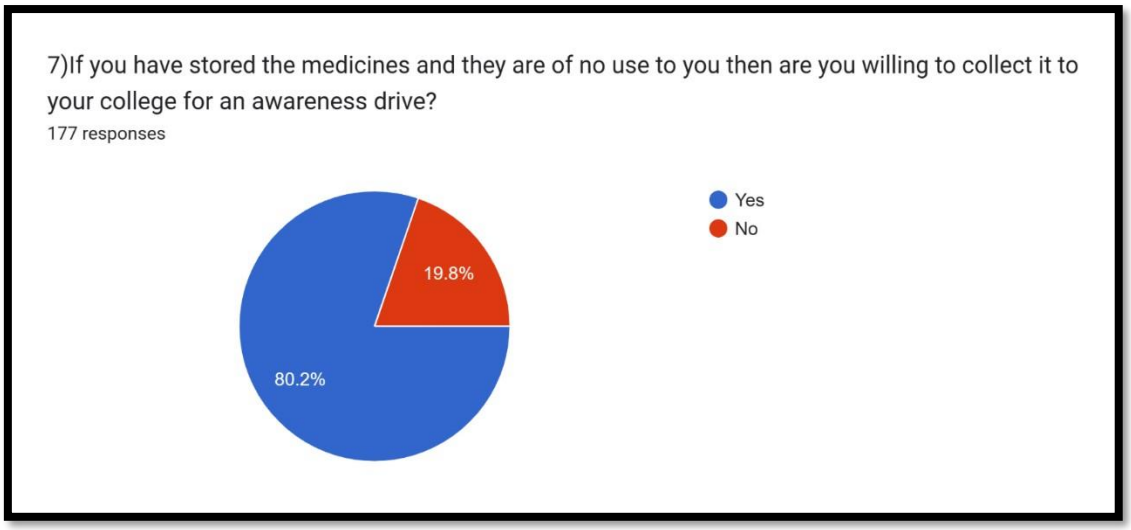
50.3% respondents use the medicines stored in their house, 27.7% do not use themedicinesand22%arenotsureabout theuseof medicinesafterstoringthemathome.



FigureNo.17 Responses ontheQuestion no.6ofquestionnaire.

%respondentsarewillingtocollectthestoredunusedorexpiredmedicinestocollegeoratawarenesscampw

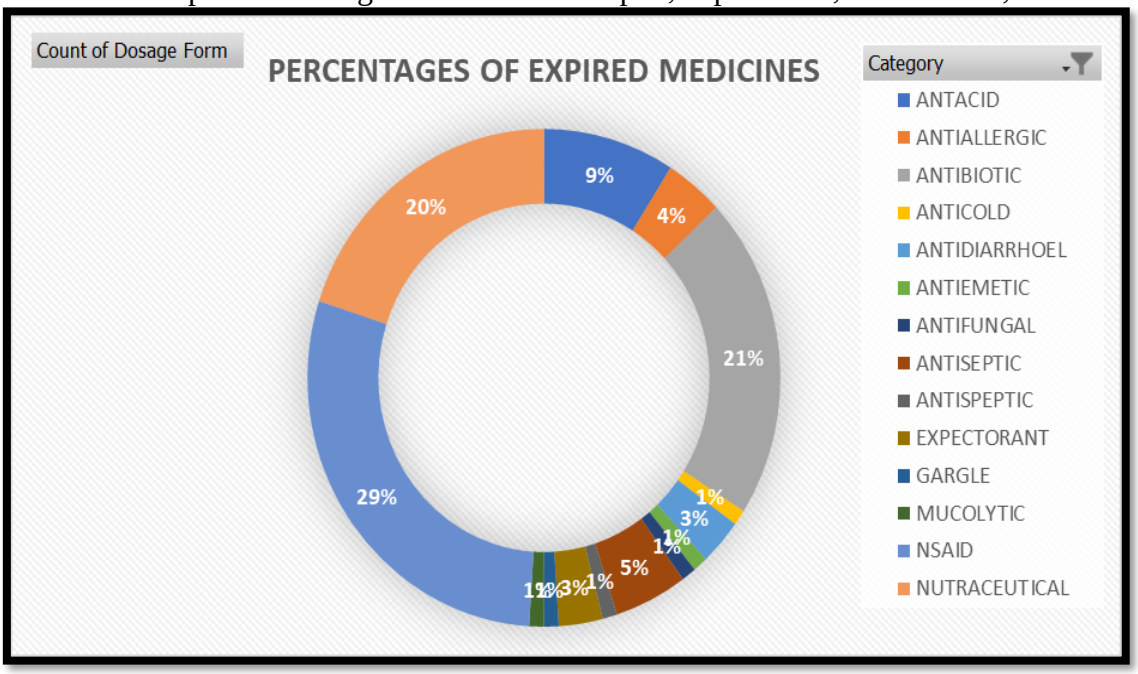
hile19.8%arenotwillingto collectthemedicines.



FigureNo.18 Responses ontheQuestion no.7ofquestionnaire.

Somerelevantsuggestionswerealsocollected fromtherespondentsasfollows
- ❖ HandlingthemedicinestoMunicipalCorporationortothebiomedicalwastedepartment.
- ❖ MoreAwarenesscampsshouldbearranged.
- ❖ TakeBackprogramsshouldbearranged.

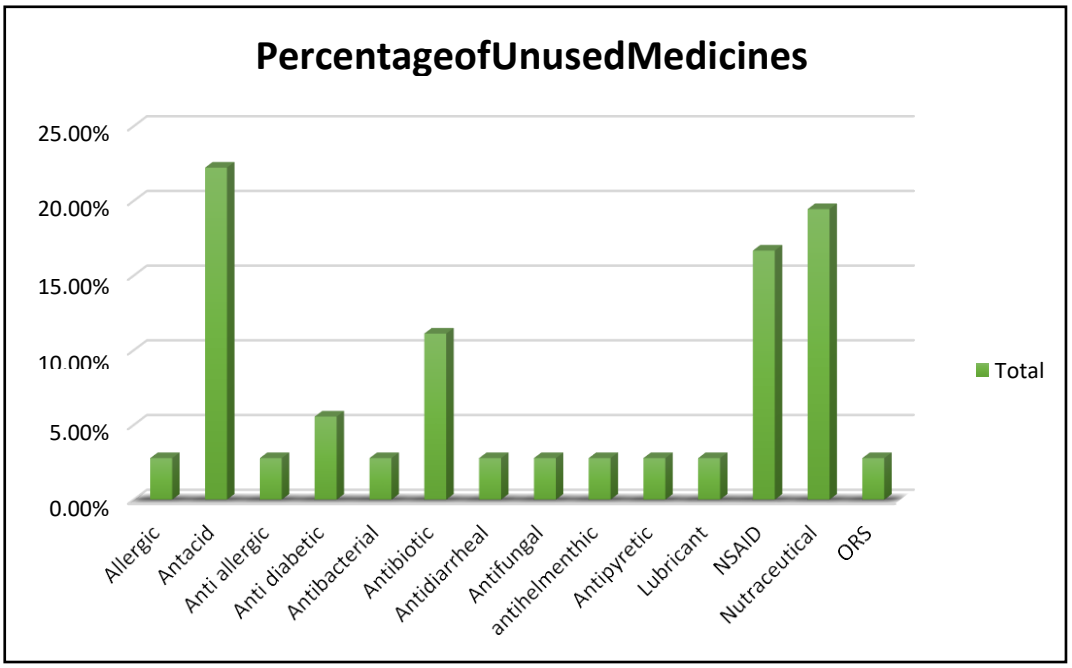
Mostoftherespondentsdonothaveanyopinionsonproperandsafedisposalofunusedandexpired medicines.
Respondentsalsocollectedunusedandexpiredmedicinesattheawarenesscampinthe MedicineCollection Bin prepared.
72%Expiredmedicines and38%Unusedmedicineswerecollected.
In expired medicines 29% NSAID ,20% Nutraceuticals, 21%Antibiotic, 9% Antacidand remaining 31% medicines comprises of categories such as antiseptic, expectorant,antidiarrheal,etc.



FigureNo.19 PercentageofExpiredMedicines

In Unused medicines 23% Antacid, 20% Nutraceutical, 17%NSAID, 11%

Antibiotic,5%Antidiabeticand remaining 24%areother medicinescollectedand sorted.



FigureNo.20 Percentageof UnusedMedicinesEstimatedcostofExpiredmedicinescollectedis₹11283.62andcostofunusedmedicine s is₹ 3254.52.

DISCUSSIONS

The study aimed to investigate the patterns of medication use and storage among thepopulationofP.R.PotePatilEducationalInstituteAndGajananTownshipinAmravati,India. The study sample consisted of 192 participants, both male and female, with awideagerangeof 18-60years.

Thestudyfoundthatthemajorityofrespondentsvisitedaphysicianatleastonceayear,with over a third visiting more than three times a year. Most respondents (81.9%)purchased all the medicines prescribed by their physician, and a significant proportion(51.4%)self-medicatedwithout consultingaphysician at leastonceayear.

Regardingthestorageanddisposalofmedicines,thestudyfoundthatmostrespondentsadministeredallthe medicinesprescribedbytheirphysician,butonly41.8%storedthemedicines until expiry. Instead, a similar proportion (26%) threw the medicines in thewaste,and26%gavethem backto thepharmacist. Only6.2%donated the medicines.

Interestingly, half of the respondents reported using the medicines stored in theirhomes, while 27.7% did not use them. Also, a significant proportion (80.2%) of therespondentswerewillingtocollectthestoredunusedorexpiredmedicinestoacollegeorawarenesscamp. The study also collected suggestions from the respondents, including handling themedicines to Municipal Corporation or to the biomedical waste department, arrangingmoreawareness camps, and take-back programs.

Finally,thestudyfoundthatattheawarenesscamp,72%ofexpiredmedicinesand38%of unused medicines were collected. The expired medicines were mostly NSAIDs,nutraceuticals,antibiotics, and antacids,while the unused medicines were mainlyantacids,nutraceuticals,NSAIDs, andantibiotics.

SUGGESTIONS

- Take Back programs should be carried out by educational institute with thealliance of Government bodies such as Municipal Corporations or PollutionControlBoards.
- AwarenessCamptoawarepublicshould becarriedout.
- A medicines collection bin should be use at community pharmacy and retailpharmacies.
- Self-Medicationsshouldbeassessedbyphysicianandpercentageofself-medications should

bedecreased.

Adopting Practices of Disposal of Pharmaceutical Dosage Forms by NationalFormularyofIndia, Edition4th, 2011(23)asperfollowing:

Tablets/Capsules:

At Household Level: Up to 50 tablets or capsules soak in about 100 ml of water andcollect the same in a polyethylene bag containing used Tea/Coffee grind. Seal the bagandput in trash.

At Commercial Level: Pulverize using heavy duty crusher. Collect in a poly bag andseal.Disposeitinhightemperatureincinerator(Temp.850ºCto1200ºC)/approvedsiteforsolid waste disposal by the PollutionControl Board ofthe State.

Injectables-ampoules/vials:

At Household Level: Up to 50 Ampoules/Vials (up to 10 ml)-break ampoules/ openvials and collect liquid in a polyethylene bag containing used Tea/Coffee grind. Sealthebag and put in trash.

At Commercial Level: Use heavy duty crusher to separate liquid and dilute it withwater and transfer it to Effluent Treatment Plant (ETP) of the manufacturing unit.Brokenglass/vials(afterremovaloflabel),rubberstoppersandsealsshouldbedisposedoffasscrap.Po wderInjectables(inVials/Ampoules)tobedisposedoffinanincineratorasindicated above.

OralliquidsandIntravenousfluids:

AtHousehold Level: Dilutethe liquidwith waterand drainit.

At Commercial Level: Dilute collected liquid with water and transfer it to ETP of themanufacturingunit.Liquidswithhighsolidcontentstobedisposedoffinanincineratorasindicated above.

Semisolids:

At Household Level: Mix it with used Tea/Coffee grind in a polyethylene bag. Sealthe bag and put in a trash. Deshape the containers/remove the label and discard thecontainers.

AtCommercialLevel: Semisolidsinbiggerquantitytobedisposedoffinanincinerator mentioned earlier. Containers - Tubes to be deshaped and remove the labelfromglass/plastic container beforedisposal asascrap.

Specificcategories:

Anti-infectives-β-lactams:

At Household Level: Small quantity of all β-lactam antibiotics to be destroyed bysoaking in 1N Sodium Hydroxide for 30 mins or 1% Hydroxylamine in Water for 10minsand trash.

At Commercial Level: Bigger quantity to be disposed off in an incinerator (Temp.850ºCto 1200ºC) indicated above.

Anti-infectives -others:

At Household Level: Tetracyclines- Small quantity to be soaked in 10% of CalciumHydroxide/anyotherCalciumsaltinWaterfor30minsandtrash.Macrolides-(Erythromycin,Clarithromycinetc.)-Smallquantity,soakin 1NHydrochloricAcidandtrash.Aminoglycosides(Gentamycin,Amikacinetc.)-Smallquantitydilutewithlargevolumeof water and drain it.

AtCommercialLevel: Biggerquantityofalltheaboveanti-infectiveshouldbedisposedof in an incinerator as mentioned above.

Steroids:

AtHousehold Level: Soakin1NSodiumHydroxidefor30minsandtrash.

AtCommercialLevel: Alldosageforms(takenoutfromtheprimarypackingmaterials)to be incinerated atthetemperature rangeindicatedabove.

Hormones:
AtHouseholdLevel: AqueoussolutiontobeexposedtoUVfor20minutesandtrash.Estrogens- small quantity in aqueous solution should be exposed to ultrasound at 0.6and2 kw in asonicatorfor 60mins. and trash.
At Commercial Level: All solid dosage forms (taken out from primary packagingmaterials)to be incinerated as indicatedabove.

Disinfectants:
AtHousehold Level: Useit.
At Commercial Level: Not more than 50L. Dilute with enough quantity of water toensuredilution with loss of activity and drain itin ETP.

Controlledsubstances:
AtHouseholdLevel: Flush downthetoilet toavoid misuse.
At Commercial Level: All dosage forms (take out from primary packaging material)to be incinerated as mentioned above. Disposal by incineration is preferred overchemicalinactivation forall dosageforms/APIs.

CONCLUSION

Thestudyhasshownthatmanyhouseholdsacquiremedicationsfromlocalpharmaciesandhospitals.Patient smostlyfailtocompletethefulldosagegiventothemoncethereisanimprovementintheirmedicalcondition, experiencesideeffectofthemedications,or when a prescriber changes their medications; and these lead to unused or expiredmedicinesinthehomes.Suchmedicationsarenormallydisposedofbythrowingthemaway in the trash or rubbish, flushing them down the toilet, sink or gutter; and otherkeepsthem forfutureuse.
Thecurrentstudyhasidentifiedtheneedofpropereducationondisposalofpharmaceuticalsthataccumulatei nhouseholdsandalsotheneedforlawsandregulations to clearly and specifically describe how unused medications should beproperlydisposed of.

1) Strict Legal Framework, well organized, cost – effective and easily accessiblestate-run disposal systems are necessary in order to enable the general public toreduce negative pharmaceutical impacts on the environment by returning unusedpharmaceuticalsto collection schemes forproper disposal.
2) The major challenges on disposal practices of expired and unused medicationsrevealedinthecourseofthisstudywithpooreducationandlowlevelofawarenesson the standard protocols in the management of expired pharmaceuticals, limiteddocumentation on the issue, inadequate law enforcement strategies and protocolinvolvedin returning expired drugs.

LIST OFABBREVIATIONS

API:ActivePharmaceuticalIngrediente.g.:exempligratia
etc:Et cetera
ETP:EffluentTreatmentPlantgm:gram
L:litre
ml:millilitreN:normal
NSAID:Non-SteroidalAnti-inflammatoryDrugUV:ultra violet
WHO:WorldHealthOrganisation

FUTURERESEARCH

As discussed above, further research needs to be carried out in a larger sample ofcommunitypharmacies,aswellasinothersettings,suchashospitalpharmacies,wards,schools and educational institutes. Rather than just quantifying waste, this should bepresented in line with the amount of medication that was supplied and reasons forwastedmedication.Focusgroupsorinterviewswithclientscouldgiveabetterunderstandingoftheirpract

icesandbeliefsaboutmedicationstorageanddisposal,andtheroleofthecommunitypharmacistinallthis.Futureresearchcouldalsoexploretheimpactof publiceducational campaignson themedication wastagephenomenon.

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