

# The need for providing pharmaceutical care in geriatrics: A case study of diagnostic errors leading to medication-related problems in a patient treatment plan

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## ABSTRACT

**Background:** Geriatric patients are more prone to suffer from medication related problems (MRPs). It may be due to comorbidity of chronic illnesses and/or number of medications prescribed to them as compared to other age groups. Illnesses are sometimes misdiagnosed or left undiagnosed due to aging. Pharmacists have the knowledge about the disease and medication therapy in geriatrics and can provide pharmaceutical care (PC) which can supplement decision making of physician, reduce MRPs and improve treatment outcomes.

**Introduction:** This case study highlights the need to provide PC to geriatrics. A diabetic patient presented with hypoglycemia and suspected electrolyte imbalance to the emergency room (ER) and was prescribed a treatment plan which had the potential to result in MRPs.

**Case Presentation:** An 80 years old male geriatric patient presented to ER with hypoglycemia. Past medical history revealed Type I DM and CABG. The treatment plan was more focused on resolving signs and symptoms for which no relevant laboratory and diagnostic tests were conducted. Medication therapy was prescribed to the patient on suspected diagnosis and more than one drug of the same therapeutic class was prescribed to the patient making him prone to suffer from MRPs.

**Conclusion:** Incorporating a pharmacist driven PC can help prescribers in establishing diagnosis, selecting rational therapies for co morbidities in geriatrics. It can eliminate unnecessary drug therapy, concomitant use of similar drugs and also reduce the chances of MRPs thereby improving treatment outcomes.

**Key words:** Geriatrics, medication-related problems, pharmaceutical care

## INTRODUCTION

Pharmaceutical care (PC) is a multifaceted dimension of pharmacy practice. It is provided by pharmacists and focuses on improving a patient's therapeutic plan in terms of effectiveness and safety. This practice

involves a number of different clinical skills and expertise which are aimed at achieving desired health outcomes in a patient and improving the overall quality of life.<sup>[1,2]</sup> Concurrently, it lowers the incidence of medication-related problems (MRPs). MRPs are

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unwanted events which a patient experiences during treatment, may be either due to prescribing and/or administering errors involving medications. These may include suffering from an adverse drug reaction or an adverse drug event (ADE), subtherapeutic response, drug interactions, etc.<sup>[3]</sup>

The MRPs can be caused by a number of reasons such as errors in the dosing regimen, which may be committed either by a health-care professional or patient, irrational prescribing and use of many drugs such as polypharmacy.<sup>[4]</sup> Defined as the use of more drugs than clinically indicated or simply use of many medications, polypharmacy is quite common in geriatrics as they are more prone to suffer from noncommunicable and chronic diseases than any other age group and are expected to have more number of medications in their prescription. It increases the probability of suffering from MRPs.<sup>[5,6]</sup>

A pharmacist-led PC can reduce the chances of experiencing MRPs by elderly patients.<sup>[7]</sup> Patient counseling by a pharmacist regarding drug use has resulted in improved compliance and diminished likelihood of misuse or abuse of drugs. PC has the potential to eliminate medication administering errors made by elderly patients during administering a medication. Educating the patient about the drugs prescribed is also very helpful. Apart from the patients, PC can also incorporate health-care professionals such as prescribers and nurses. Educating the prescribers about the drugs can reduce prescribing and dosing errors. Likewise, providing education to the nurse can decrease errors during the administration of medications to a patient. Altogether, PC is geared toward the patient benefit and a number of studies have reported a reduction in MRPs and improvement in therapy after provision of PC.<sup>[8,9]</sup>

This case study stresses on the need to provide PC to geriatric patients, a diabetic individual presented with hypoglycemia and electrolyte imbalance to the emergency room (ER) and was prescribed a treatment plan which had the potential to render the patient suffer from MRPs.

## CASE PRESENTATION

A male, geriatric patient aged 80 years weighing 65 kg and with a height of 177.8 cm presented to emergency ER. He had a medical history of insulin-dependent diabetes mellitus (DM) Type I, since last 50 years,

presented with hypoglycemia and suspected electrolyte imbalance.

Random blood sugar test was conducted and blood glucose levels were reported at 18 mg/dL or 1 mmol/L. Computed tomography scan of the brain was recommended to detect any damage to the central nervous system (CNS), pertaining to extremely low glucose levels. However, CNS activity was found to be normal. Patient's vitals were also measured and blood pressure was recorded at 150/80 mmHg. The respiratory rate was 20 and pulse rate was 88 beats/min. The clinician's note mentioned that the patient had electrolyte imbalance; however, no laboratory examination was conducted.

The chest examination circumflex revealed that the bilateral baseline crepitus was positive. Hence, the physician suspected acute pulmonary edema and respiratory tract infection (RTI).

The patient was accompanied by a family member and had no history of smoking or alcohol consumption. The patient's caregiver reported that he had two episodes of vomiting, i.e., one at night and the other in the following morning. The patient was afebrile but appeared disoriented and fell unconscious. Severe hypoglycemia along with vomiting led to disorientation and dehydration. Arterial blood gases were measured and it was reported that partial pressure of CO<sub>2</sub> and HCO<sub>3</sub> appeared lower than the normal range. The clinical findings are reported in Table 1.

The past medical history revealed that the patient suffered from ischemic heart disease (IHD), a macrovascular complication of DM and underwent

**Table 1: Clinical findings from the patient's medical record**

Clinical findings	Observed value	Normal range	Interpretation
pH	7.45	7.35-7.45	Normal
pCO <sub>2</sub>	28 mmHg	35-45 mmHg	Decreased
HCO <sub>3</sub>	19.1 mEq/L	22-28 mEq/L	Decreased
PO <sub>2</sub>	94 mmHg	85-100 mmHg	Normal
Respiratory rate	20	20-22	Normal
Pulse rate	88 beats/min	60-100 beats/min	Normal
Blood pressure	150/80 mmHg	120/80 mmHg	Hypertensive (Stage 1)*

\*Medical reference for HTN interpretation: Chobanian AV et al. Seventh report of the Joint National Committee on Prevention, Detection, Evaluation, and Treatment of High Blood Pressure=The complete JNC 7 report. Hypertension 2003;42:1206-52. HTN=Hypertension

coronary artery bypass grafting (CABG) surgery 10 years ago. During the stay at the hospital, the patient underwent an electrocardiogram (ECG) which was reported as normal. According to the clinician's note, the patient did not have any cardiac complication. Furthermore, the patient had a cough and appeared restless. In addition to this, the patient underwent a session of physiotherapy for his backache. The patient was further diagnosed with acute coronary syndrome (ACS) and RTI according to the consultant's medical notes.

## TREATMENT

The therapy provided to the patient was primarily aimed at restoring normal blood glucose level. For this purpose, 1000 ml of 25% dextrose water (D25W) was administered through intravenous (IV) infusion. The blood glucose level was raised and maintained at 125 mg/dL. Metformin 500 mg tablet bid and insulin 70/30 combination of short and intermediate acting IV were given in combination to prevent a sudden rise in blood glucose levels. The primary treatment was followed by maintenance therapy. The duration of the maintenance therapy was of 4 days. The primary goal of therapy was a reversal of severe hypoglycemia and to correct the electrolyte imbalance. The secondary goal was to manage RTI and ACS, and the patient was prescribed antibiotics, antiplatelets, cholesterol lowering medication, diuretics and nitrates. A detailed medication history of the patient is presented in Table 2.

## DISCUSSION

The goal of therapy in hypoglycemia is to achieve normal blood glucose level. Hypoglycemia is defined as blood glucose level of <50 mg/dL (2.8 mmol/L). Insufficient food intake, particularly carbohydrate-rich diet, excessive exercise, high doses of antiglycemic medication especially insulin, are primary causes of hypoglycemia in elderly patients with DM. According

to the American Association for Clinical Chemistry, peak postmeal level of glucose for a diabetic individual should be <140 mg/dL. *In lieu* of the patient's condition, dextrose water restored the blood glucose level to 125 mg/dL.<sup>[10]</sup> To prevent a future episode of hypoglycemia, a dietary plan of 6 small meals and 2-3 snacks/day are to be recommended to the patient.<sup>[11]</sup>

### Renal function not assessed

Concurrently, insulin and metformin were used in combination to achieve better blood glucose control. However, the renal function test is imperative when metformin is prescribed to an elderly patient.<sup>[12]</sup> This will aid in determining the renal function and dose is adjusted accordingly, but no tests were done for the patient. Elevated blood sugar levels lead to proteinuria and decline in glomerular filtration rate (GFR). Kidneys filter more blood than normal which damages the filters thereby allowing the protein to pass into urine and impedes GFR. Hence for diabetic patients, selection of medicine also takes the renal function of the patient into consideration at the time of treatment decisions.<sup>[13]</sup> Physiological and pathological structure alterations in various parts of the nephron are observable in geriatrics. Pathological alterations such as glomerulosclerosis and nephrosclerosis reduces renal blood flow, and GFR by 40-50% in healthy population by the age of 80 years. DM accelerates the process; the glomerular function is compromised due to morphological alterations and high blood glucose. GFR decreases and kidney loses its ability to eliminate drugs in urine leading to building up of potentially toxic metabolites. Impaired kidney function combined with slower metabolism in geriatrics makes it imperative to be cautious with the amount of drug administered. Adequate laboratory tests such as GFR and albumin to creatinine ratio ACR are recommended to determine the state of kidney function and decide upon the most suitable dose of a drug to prevent ADEs.<sup>[14,15]</sup>

**Table 2: Medication history of the patient for maintenance therapy**

Medication	Drug class	Strength	Dosage form	Frequency
Ceftriaxone	Cephalosporin antibiotic (third generation)	2 g	Injection	OD
Ipratropium bromide	Bronchodilator	0.025%	Oral inhalation solution	Not mentioned
Aspirin	Antiplatelet	75 mg	Tablet	OD
Clopidogrel	Antiplatelet	75 mg	Tablet	OD
Rosuvastatin	Cholesterol-lowering drug	20 mg	Tablet	OD
Atorvastatin	Cholesterol-lowering drug	20 mg	Tablet	Not mentioned
Spironolactone and furosemide	Diuretics	40 mg	Tablet	OD
Furosemide	Diuretics	40 mg	Intravenous	BD
Isosorbide-5-mononitrate	Nitrates	60 mg	Capsule	Not mentioned
Isosorbide dinitrate	Nitrates	10 mg/ml	Intravenous	Not mentioned

### Incomplete diagnosis of electrolyte imbalance and a case of needed drug therapy

The patient had vomited twice before the treatment started. A mere empiric diagnosis of electrolyte imbalance was made since he vomited and lost fluids. Moreover, he was too disoriented. The patient eventually recovered from the loss of electrolytes but did not receive any salt colloids to restore electrolyte balance as a part of the treatment plan. It could have reverted to normal following administration of 1–2 L of salt crystalloid such as normal saline.<sup>[11]</sup> However, the treatment plan is devoid of any instruction for normal saline to be administered. National Institute for Health and Care Excellence (NICE) algorithm for IV fluid therapy in adults stipulates a comprehensive set of pathways to be followed to replenish the fluid loss in a patient. Assessment of whether the patient is hypovolemic and needs fluid resuscitation is conducted using the airway, breathing, circulation, disability, and exposure approach. In this particular case, the patient needed fluid and electrolyte which could not be administered orally since the patient was unconscious. An IV administration of 25–30 ml/kg/day of water, 1 mmol/kg/day of sodium, potassium and chloride, and 50–100 g/day glucose are recommended.<sup>[16]</sup>

### Use of wrong drugs

The geriatric patient was diabetic with a history of IHD and had a systolic pressure of 150 mmHg. He could have been prescribed thiazide-like diuretics and not loop diuretics. According to NICE guidelines for hypertension (HTN) in adults, if diuretic treatment is to be initiated or changed, offer a thiazide-like diuretic, such as chlorthalidone (12.5 mg–25 mg once daily) or indapamide (1.5 mg modified release OD or 2.5 mg OD) in preference to a conventional thiazide diuretic such as bendroflumethiazide or hydrochlorothiazide.<sup>[11,17,18]</sup> Combination of spironolactone and furosemide is indicated for mild to moderate essential HTN, edema, ascites of congestive heart failure (CHF), and cirrhosis of liver, but none of the indications were present in the patient at the time of prescribing.<sup>[19]</sup> Furosemide is a loop diuretic, increasing excretion of sodium and potassium from the body, which is indicated for cardiac, pulmonary, cerebral, and peripheral edema, which the patient did not present with. Hence, the diuretics were prescribed irrationally; in fact, they should be used with caution for diabetic patients and in electrolyte imbalance.<sup>[18,20]</sup>

### Unnecessary drug therapy with ipratropium bromide

Ipratropium bromide is a bronchodilator which is indicated for chronic bronchitis and chronic reversible

airway obstruction, i.e., asthma. According to the patient medical records, there were no symptoms of asthma. The Scottish Intercollegiate Guidelines Network guidelines recommend a tenacious list of symptoms of asthma, to be diagnosed as an asthmatic patient and relevant treatment with inhalers to be initiated.<sup>[21]</sup> Moreover, the patient had no chronic bronchitis. Hence, a bronchodilator was unnecessarily prescribed to the patient. In such cases, hypoglycemia can cause anxiety attack, leading to hyperventilation. This was evident as the patient suffered from respiratory alkalosis. Therefore, referral to a respiratory therapist would have been effective. These health-care professionals would have helped the patient breathe with ease by suggesting breathing exercises. Giving bronchodilators is not rational in such conditions. Shortness of breath can be dealt with, without medicines.

### Misdiagnosis of respiratory tract infection and unnecessary antibiotic drug therapy

Physical chest examination of the patient revealed positive bilateral basal crepitus. The physician suspected acute pulmonary edema and RTI due to CHF. However, the classic signs and symptoms of CHF were not reported by the patient.<sup>[22]</sup> A routine test to evaluate CHF such as ECG was recorded as normal. Incomprehensive physical and laboratory examination of the patient led to an array of irrationally prescribed medicines to treat CHF and RTI. Previous studies reveal that positive crepitus needs to be recognized closely in elderly patients to prevent interference with the therapeutic management. Hence, prescribing ceftriaxone to treat RTI can be accounted as an irrational decision.<sup>[23]</sup>

### No culture sensitivity test performed before prescribing cephalosporin

If at all, there was a chance of RTI, the NICE guideline for RTI stipulates that for a geriatric patient with an acute cough and Type I DM, infection in the lower respiratory tract is to be treated with amoxicillin or doxycycline.<sup>[24]</sup> In this particular instance, ceftriaxone, a third generation cephalosporin antibiotic was prescribed but no culture sensitivity test (CST) was conducted. Only sputum results may account for alternative antibiotics to be used. Prescribing antibiotics without CST and an appropriate indication has become a common practice.<sup>[25]</sup>

### Unnecessary combination drug therapy of aspirin with clopidogrel

Before admission and during the course of stay in hospital, the patient did not suffer from myocardial

infarction, stroke, or peripheral arterial disease. There were no complains of chest pain. Since the patient underwent CABG in the past, he was administered antiplatelet as indicated in guidelines.<sup>[26]</sup> Clopidogrel was prescribed along with aspirin. The interaction between clopidogrel and aspirin would result in potentiated antiplatelet action and increased chances of bleeding. It is not in accordance with the therapy plan. It has to be either aspirin or clopidogrel if given concomitantly due to high risk of cardiac disease. It needs to be monitored closely and can be only given for a span of 4 months post operation. In this case, the patient did not have any cardiac complications at the time of admission to the hospital or during his stay. Therefore, given the patient's medical history either aspirin or clopidogrel can be given.<sup>[27]</sup>

### Misdiagnosis of stable angina leading to unnecessary drug therapy of two antianginal drugs

Patient medical records reported CABG; however, no episode of angina pectoris was reported after surgery. Yet, physician suspected ACS and initiated treatment with two antianginal drugs, i.e., isosorbide-5-mononitrate and isosorbide dinitrate, to prevent an episode of angina pectoris. NICE guidelines recommend cardiac troponin levels to be evaluated and ECG to be performed, for differential diagnosis of ACS based on signs and symptoms, laboratory tests, and calculation of risk factors for cardiovascular diseases. Patient's ECG was reported to be normal. Moreover, there were no complains of chest pain which is a hallmark sign of angina pectoris. Antianginal drugs develop tolerance in patients, therefore  $\beta$  blockers or calcium  $Ca^{+2}$  channel blockers are indicated for long-term treatment in patients of angina. For a post-CABG patient, they can be prescribed one or a combination of antianginal drugs (one short acting and another long acting) depending upon severity to prevent future episode of angina or if there is an established recurrence of angina. However, tolerance develops within 24–48 h after using nitrates and hence it is recommended to have intervals between doses. For a geriatric patient, a low dose antianginal drug can be prescribed if the diagnosis establishes the need concretely. Moreover, data reported from randomized controlled trials RCTs regarding the use of nitrates in post-CABG patients are not supportive.<sup>[26,28]</sup>

### Medication-related problems (concomitant use of two statins)

Cholesterol lowering agents such as 3-hydroxy-3-methylglutaryl-coenzyme A (HMG-CoA) reductase

inhibitors, more commonly known as statins are indicated as adjunct along with dietary modification in hyperlipidemia, a condition in which elevated levels of low-density lipoproteins are present in the blood. It can lead to coronary artery diseases if left untreated.<sup>[29,30]</sup> The diagnosis of hyperlipidemia is established after a complete investigation of the lipid profile of the patient. In this case, lipid profile was not examined. It is impossible to prescribe statins without investigating the lipid profile.<sup>[31]</sup> Though, the patient's past medical history has provision for prescription of a statin and atorvastatin can be prescribed.<sup>[32]</sup> Concomitant use of two statins can precipitate rhabdomyolysis.<sup>[33]</sup> It is a condition in which muscle tissue breaks down due to muscle injury and releases intracellular content into the blood such as a protein myoglobin. It can precipitate in glomerular filtrate, rendering injury to kidney structures causing renal tubular obstruction and acute kidney injury.<sup>[34]</sup> However, continuing the practice of irrational prescribing, the patient was prescribed rosuvastatin and atorvastatin concomitantly which makes the patient prone to liver toxicity and myopathy.<sup>[35]</sup>

According to the World Health Organization, more than half of the medicines are inappropriately prescribed and dispensed. They are mainly caused by polypharmacy (too many medicines), failure to prescribe according to clinical guidelines and overuse of injections and antibiotics.<sup>[31]</sup> The patient was inadequately treated for the present condition and was irrationally prescribed medications, which leads to decreased compliance of the patient to receive treatment.

## RECOMMENDATIONS

Correct treatment needs proper identification and prioritization of patient complains. The patient had a number of complains such as hypoglycemia, suspected electrolyte imbalance, suspected RTI, suspected ACS, suspected stable angina, Type I DM, HTN, and was post-CABG. Active complains included all except CABG which the patient underwent 10 years ago.

Hypoglycemia was treated with priority and 1000 ml D25W IV infusion since it can lead to sudden increase blood glucose level, the patient was given insulin 70/30 IV in combination with metformin 500 mg to maintain an optimal level of blood glucose. Since the patient is geriatric, it is recommended to assess renal functions as it is of prime importance. Second, it is necessary to conduct laboratory and

chemical examination of the patient to identify and establish diagnosis of electrolyte imbalance before administering the subsequent therapy.

Pharmacotherapy of comorbidity of DM and HTN includes the use of diuretics and angiotensin-converting-enzyme inhibitors (ACEIs) as the first-line therapy.<sup>[17]</sup> The patient was prescribed a combination of loop diuretics which promotes Na<sup>+</sup> and K<sup>+</sup> loss. Considering the overall condition of the patient, i.e. DM, electrolyte imbalance, difficulty in breathing. Loop diuretics and ACEIs may not be a good choice.  $\beta$ -blockers are not the first choice in DM patients. Therefore, as per NICE recommendation, diuretic therapy can commence using a thiazide-like diuretic and ARBs can be used as a replacement of ACEIs.

There is a need to establish a diagnosis for RTI in the first place. Using the third generation cephalosporin antibiotic without CST and an accurate diagnosis of RTI is mere irrational.

For post-CABG patients, pharmacotherapy for secondary prevention includes the use of aspirin and a statin. Nitrates can be used to prevent an episode of angina. Using a combination of nitrates in a geriatric patient with no established diagnosis of angina is of no benefit. In fact, it can adversely affect the patient by precipitating a heart sinking effect and shortness of breath. Using a combination of two antiplatelet drugs can lead to severe bleeding. In addition, two statins can also lead to rhabdomyolysis; hence, the recommended treatment for such patient is to use an HMG-CoA reductase inhibitor and aspirin only. Nitrate can be given only if the clinician judges the need to prescribe. After managing the patient, a proper investigation must be conducted to confirm or rule out ACS or stable angina. Blood testing, coronary angiography, and ECG are recommended.

Incorporating a pharmacist driven PC can help prescribers in selecting rational therapies, for comorbidities in this age group and reduce the chances of MRPs, thereby improving treatment outcomes.

## CONCLUSION

Geriatric patients are more susceptible to MRPs and studies report that illnesses in this age group are often misdiagnosed or ignored.<sup>[36]</sup> The present case study also reported numerous diagnostic errors and MRPs in a geriatric inpatient. PC in the elderly can promote medication optimization and have the

potential to reduce MRPs since pharmacist is better equipped with knowledge about disease and drugs affecting the geriatrics. PC can improve patient outcomes by reducing MRPs. Moreover, a pharmacist can provide specialized clinical pharmacy services by offering guidance in prescribing of drugs for comorbid conditions normally seen in geriatrics and help prescribers choose optimal pharmacotherapy.

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## Statement of consent

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## Conflicts of interest

There are no conflicts of interest.

## REFERENCES

1. Khan MH, Abbas A. The importance of clinical pharmacists in health care system. *Med Sci* 2014;11:80-1.
2. The Role of the Pharmacist in the Health Care System. Report of a WHO Meeting Tokyo, Japan; 31 August-3 September, 1993.
3. Wolstenholme B. Medication-related problems in geriatric pharmacology. *Aging Well* 2011;4:8.
4. Andrezza RS, Silveira De Castro M, Sippel Köche P, Heineck I. Causes of drug-related problems in the emergency room of a hospital in Southern Brazil. *Gac Sanit* 2011;25:501-6.
5. Naqvi AA, McGarry K. Polypharmacy in Pakistan. 1<sup>st</sup> ed. Saarbrücken, Germany: LAP Lambert Academic Publishing Corporation; 2014. p. 1-105.
6. Viktil KK, Blix HS, Moger TA, Reikvam A. Polypharmacy as commonly defined is an indicator of limited value in the assessment of drug-related problems. *Br J Clin Pharmacol* 2007;63:187-95.
7. Vinks TH, Egberts TC, de Lange TM, de Koning FH. Pharmacist-based medication review reduces potential drug-related problems in the elderly: The SMOG

- controlled trial. *Drugs Aging* 2009;26:123-33.
8. Fu AZ, Liu GG, Christensen DB. Inappropriate medication use and health outcomes in the elderly. *J Am Geriatr Soc* 2004;52:1934-9.
  9. Abbas A, Khan N. Clinical trials involving pharmacists in Pakistan's healthcare system: A leap from paper to practice. *Pharmacy* 2014;2:244-7.
  10. American Association for Clinical Chemistry AACC. Available from: <https://www.labtestsonline.org/understanding/conditions/diabetes/start/3>. [Last accessed on 2016 Mar 20].
  11. DiPiro JT, Talbert RL. *Pharmacotherapy: A Pathophysiologic Approach*. USA: McGraw-Hill Education; 2014.
  12. Metformin. *Drugs.com*. Available from: <http://www.drugs.com/pro/metformin.html#ID20>. [Last accessed on 2016 Mar 21].
  13. Cleveland Clinic. Centre for Continuing Education. Disease Management. Diabetic Nephropathy; 2010. Available from: <http://www.clevelandclinicmeded.com/medicalpubs/diseasemanagement/nephrology/diabetic-nephropathy/>. [Last accessed on 2016 Mar 21].
  14. Alsaad KO, Herzenberg AM. Distinguishing diabetic nephropathy from other causes of glomerulosclerosis: An update. *J Clin Pathol* 2007;60:18-26.
  15. Qian Y, Feldman E, Pennathur S, Kretzler M, Brosius FC 3<sup>rd</sup>. From fibrosis to sclerosis: Mechanisms of glomerulosclerosis in diabetic nephropathy. *Diabetes* 2008;57:1439-45.
  16. National Institute of Health and Clinical Excellence NICE. Algorithms for IV Fluid Therapy in Adults. Available from: <https://www.nice.org.uk/guidance/cg174/resources/intravenous-fluid-therapy-in-adults-in-hospital-algorithm-poster-set-191627821>. [Last accessed on 2016 Mar 22].
  17. National Institute for Health and Care Excellence NICE. Hypertension in Adults: Diagnosis and Management. NICE Guidelines [CG127]. Available from: <https://www.nice.org.uk/guidance/cg127/chapter/1-Guidance#choosing-antihypertensive-drug-treatment-2>. [Last accessed on 2016 Mar 22].
  18. National Institute for Health and Care Excellence NICE. Type 1 Diabetes in Adults: Diagnosis and Management. NICE Guidelines [NG17]; 2015. Available from: <http://www.nice.org.uk/guidance/ng17/chapter/1-Recommendations#insulin-therapy-2>. [Last accessed on 2016 Mar 22].
  19. Spiromide. SEARL. Available from: <http://www.searlecompany.com/spiromide.html>. [Last accessed on 2016 Mar 22].
  20. Furosemide. Dosing and Uses. *Medscape*. Available from: <http://www.reference.medscape.com/drug/lasix-furosemide-342423#0>. [Last accessed on 2016 Mar 22].
  21. Scottish Intercollegiate Guidelines Network SIGN. Managing Asthma in Adults; 2014. Available from: [http://www.sign.ac.uk/pdf/pat141\\_adults.pdf](http://www.sign.ac.uk/pdf/pat141_adults.pdf). [Last accessed on 2016 Mar 22].
  22. Pulmonary Edema. National Institutes of Health U.S. National Library of Medicine. Available from: <https://www.nlm.nih.gov/medlineplus/ency/article/000140.htm>. [Last accessed on 2016 Mar 22].
  23. Kataoka H, Matsuno O. Age-related pulmonary crackles (rales) in asymptomatic cardiovascular patients. *Ann Fam Med* 2008;6:239-45.
  24. National Institute for Health and Care Excellence NICE. Antibiotic Prescribing For Respiratory Tract Infections. NICE Guideline 69; 2013. Available from: [https://www.networks.nhs.uk/nhs-networks/nhs-cumbria-ccg/medicines-management/guidelines-and-other-publications/detail-aids/RTI%20abbreviated%20Antibiotic%20guidance%20Aug%202013%20update%20vs3.pdf/at\\_download/file](https://www.networks.nhs.uk/nhs-networks/nhs-cumbria-ccg/medicines-management/guidelines-and-other-publications/detail-aids/RTI%20abbreviated%20Antibiotic%20guidance%20Aug%202013%20update%20vs3.pdf/at_download/file). [Last accessed on 2016 Mar 22].
  25. National Institute for Health and Care Excellence NICE. Antibiotic Prescribing For Respiratory Tract Infections. NICE Guideline 69; 2012. Available from: <https://www.nice.org.uk/guidance/cg69>. [Last accessed on 2016 Mar 23].
  26. Hlatky MA, Solomon MD, Shilane D, Leong TK, Brindis R, Go AS. Use of medications for secondary prevention after coronary bypass surgery compared with percutaneous coronary intervention. *J Am Coll Cardiol* 2013;61:295-301.
  27. Scottish Intercollegiate Guidelines Network SIGN. Heart Disease. Quick Reference Guide; 2012. Available from: <http://www.sign.ac.uk/pdf/qrgchd.pdf>. [Last accessed on 2016 Mar 23].
  28. Okrainec K, Platt R, Pilote L, Eisenberg MJ. Cardiac medical therapy in patients after undergoing coronary artery bypass graft surgery: A review of randomized controlled trials. *J Am Coll Cardiol* 2005;45:177-84.
  29. Abbas A. Hypertriglyceridemia: What is it and how it is managed – A review. *Int J Pharmacother* 2014;4:32-5.
  30. Abbas A. The association of dyslipidemia with osteoporosis: A case report. *El Med J* 2013;1:3.
  31. Ravi SP. Medicines use in primary care in developing and transitional countries: Fact book summarizing results from studies reported between 1990 and 2006. *Bull World Health Organ* 2009;87:804.
  32. National Institute for Health and Care Excellence NICE. Lipid Modification Therapy for Preventing Cardiovascular Disease. Available from: <http://www.pathways.nice.org.uk/pathways/cardiovascular-disease-prevention/lipid-modification-therapy-for-preventing-cardiovascular-disease#content=view-node%3Anodes-secondary->

- prevention. [Last accessed on 2016 Mar 24].
33. Radcliffe KA, Campbell WW. Statin myopathy. *Curr Neurol Neurosci Rep* 2008;8:66-72.
  34. Torres PA, Helmstetter JA, Kaye AM, Kaye AD. Rhabdomyolysis: Pathogenesis, diagnosis, and treatment. *Ochsner J* 2015;15:58-69.
  35. Athyros VG, Papageorgiou AA, Dimitriadis DS, Kontopoulos AG. Atorvastatin plus pravastatin for the treatment of heterozygous familial hypercholesterolaemia – A pilot study. *Curr Med Res Opin* 2001;17:267-72.
  36. Roy V, Varsha R. Pharmacist in geriatric care: A challenging service. *Health Adm* 2006;XIX: 76-82.
  37. Abbas A. Evidence based improvements in clinical pharmacy clerkship program in undergraduate pharmacy education: The evidence based improvement (EBI) initiative. *Pharmacy* 2014;2:270-5.



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