Use of Urinary Reagent Strips in Testing Cerebrospinal Fluid For Meningitis - A Review

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Abstract

Analysis of cerebrospinal fluid (CSF) is needed to make a meningitis diagnosis to assist in the proper management of patients. There is a good correlation between the results of reagent strip test and laboratory methods of CSF protein, sugar, and leukocyte estimation. CSF supplies nutrients to tissue in the nervous system. CSF eliminates waste products from cerebral metabolism. Cerebrospinal fluid has three main functions: CSF protects against trauma on the brain and spinal cord. Meningitis is a rare infection that affects the delicate membranes called meninges, which cover the brain and spinal cord. Index test was done for testing meningitis using urinary reagent strips. An intrusive outpatient procedure used to remove a sample of cerebrospinal fluid (CSF) from the spine's subarachnoid area is a lumbar puncture (LP), also called a spinal tap. A urinary test strip or dipstick is a simple medical tool used in normal urinalysis to assess abnormal differences in a patient's urine. There is a good correlation between the results of reagent strip test and laboratory methods of CSF protein, sugar, and leukocyte estimation. The review gives a clear view and knowledge about the usage of urinary reagent strips in measuring CSF for meningitis.

Keywords: *CSF; meningitis; urinary reagent strips; index test; definitive test; leukocyte.*

Introduction

Analysis of cerebrospinal fluid (CSF) is needed to render a diagnosis of meningitis to aid in the proper treatment of patients. There is a strong connection between the results of reagent strip test and laboratory methods of CSF protein, sugar and leukocyte estimation[1]. The estimation of CSF cell count is required while the estimation of sugar and protein levels requires appropriate laboratory help.Such services are often not accessible online[2].

Resource-limited environments, and the turnaround times are long even in environments where available. There are currently no prompt point-of -care tests available for meningitis diagnosis[3]. Using urinary reagent strips can be calculated the presence of glucose, fat, leukocytes, erythrocytes and pH in a body fluid[4]. In the past, CSF cellularity and chemistry were calculated using reagent strips, but the results were variable and the process did not gain popularity. Such strips can be an ideal test if proved effective to help clinicians make a simple bedside diagnosis of meningitis and start treatment[5]. This will greatly help health care workers who work in resource-limited environments[6].

We planned this analysis to evaluate whether urinary reagent strips are used to make a semi-quantitative assessment of Fat, glucose, and leukocyte esterase activity (as contrasted with CSF glucose, fat, and cell count) are sufficient to differentiate between normal and abnormal CSF samples[7]. This review has been done by

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a thorough literature search. Diagrams were made using brushes redux application.

URINARY MULTI REAGENT STRIPS IN CEREBROSPINAL FLUID ANALYSIS

Automatic urine test strip analysis using automated urine test strip analyzers is a well-established procedure in urinalysis of modern times[8]. Calcium, plasma, glucose, bilirubin, urobilinogen, ketones, leukocytes, creatinine, microalbumin, pH, ascorbic acid, and protein can be assessed[9].

Simply put one drop of your urine sample on a single chemical dipstick pad and wait for the time needed to measure the sample against the chart[10]. So proceed to the next strip check, and so forth[11]. Only be sure that the eyedropper, and any container used for urine collection, is sterile[12].

Using a collection jar to collect urine mid-stream, Then dip the strip into the sample for no more than 2 seconds and extract any excess by wiping the bottle side test strip and later write the results after 60 seconds (write after 90-120 seconds for checking for Leukocytes)[13]. Urine Reagent Strips (Figure 1) are strong plastic strips onto which are attached several different reagent area[14]. The test is designed to detect one or more of the following urine analytes: Leukocytes, Glucose, Ketone (Acetoacetic acid), Bilirubin, Blood, Specific Gravity, Protein, Urobilinogen, Nitrite, Ascorbic Acid, and Multiple Reactive Strips[15].

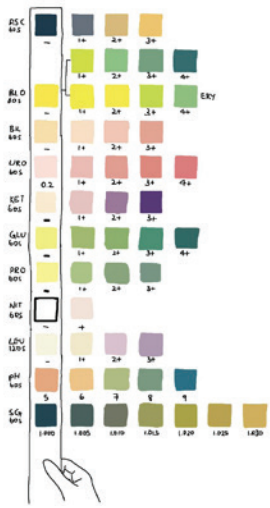

Figure 1: A model diagram of Urinary Reagent Strip. The diagram was made using brushes redux application.

Uses Of Urinary Reagent Strips:

Diagnostic reagent strips are widely used in clinical urine and blood analysis, particularly for monitoring the concentration of glucose[16]. Tests are collected instrumentally or visually as quantitative thresholds and outputs. Dry reagents are used in a number of ways when producing strips[17]. A reagent strip is a thin sheet of paper that is impregnated with a reagent(= a material that induces a chemical reaction) of a particular substance contained in a body of fluid of test for that substance. Through urine, reagent strips react with protein and show its presence and level[18]. Doctors are calling for a urine test to help diagnose and treat a variety of disorders including kidney , liver, diabetes, and infections[19]. Urine may be tested for specific proteins, sugars, hormones, or other chemicals, some bacteria, and their acidity or alkalinity[20]. If the urine is alkaline, 1 ml of dilute acetic acid will help to dissolve phosphates that may obscure the elements that have formed. The two medical providers able to detect sexually transmitted diseases (STDs) using a urine test are chlamydia and gonorrhea. Most STDs or sexually transmitted infections (STIs) don't cause overt physical signs or symptoms, as healthcare providers often call them[21].

CerebroSpinal Fluid (CSF):

Cerebrospinal fluid has three main functions: CSF protects against trauma on the brain and spinal cord[22]. CSF supplies nutrients to tissue in the nervous system.CSF eliminates waste products from cerebral metabolism[23]. This is a continually generated and consumed watery fluid that flows throughout the brain and across the surface of the brain and spinal cord in the ventricles. The abbreviation is CSF[24]. The CSF obtained after a lumbar puncture is tested to diagnose disease. A combined cycle of diffusion, pinocytosis and active transfer produces the cerebrospinal fluid (CSF) from arterial blood into the choroid plexuses of the lateral and fourth ventricles. Ependymal cells produce a small amount too[25]. The ventricle volume is approximately 25 ml.

The concentration of proteins is lower in both cisternal and ventricular CSF.Normal CSF is composed of 0-5 mononuclear cells[26]. Measured at lumbar puncture (LP), the CSF pressure is 100-180 mm H2O (8-15 mm Hg) with the patient lying on the side and 200-300 mm

with the patient sitting up[27]. Cerebrospinal fluid has three main functions: CSF protects against trauma on the brain and spinal cord.CSF supplies nutrients to tissue in the nervous system. CSF prevents brain absorption of waste materials[28]. Although CSF's primary purpose is to protect the brain inside the skull and act as a shock absorber for the central nervous system, CSF also circulates blood-filtered nutrients and chemicals, and eliminates waste products from the brain.CSF is formed in the brain via the choroid plexus and then reabsorbed into your bloodstream[29]. A CSF sample is typically obtained by the operation of a lumbar puncture often known as a spinal tap[30]. A sample analysis involves calculating and testing for: the fluid strain. This test is performed for calculating pressure inside the CSF and for collecting a fluid sample for further research[31]. Testing of CSF may be used to identify some neurological conditions. This may involve infections (such as meningitis) and damage to the brain or spinal cord[32].

Meningitis:

Meningitis is a rare infection that affects the delicate membranes — called meninges— which cover the brain and spinal cord[33]. The first symptoms are usually fever, vomiting, headache and feeling unwell.Limb discomfort, pale skin, and cold hands and feet frequently manifest earlier than rash, neck stiffness, aversion to bright lights and uncertainty. Septicaemia can occur with meningitis or without it[34].

Actually there are five types of meningitis- bacterial, viral, parasitic, fungal and noninfectious— each categorized by disease origin[33]. Bacterial meningitis is serious, and can be fatal. Death can happen in as few hours[35]. Most people are recuperating from meningitis. However, the infection can cause permanent disabilities (such as brain injury, hearing loss, and learning disabilities [3,36].

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Index Test and definite tests:

Index research was performed by one of the investigators using urinary reagent strips that can detect ten parameters, including protein, glucose, and esterase leukocytes[39]. With the help of a pipette, 2–3 drops of undiluted CSF were applied to protein, glucose, and leukocyte esterase patches and the color change was reported and interpreted using the color grading provided by the manufacturer[40]. Leukocytes in cerebrospinal fluid:A standard CSF WBC count is < 5 cells / mm3, and the reagent strip requires at least 10 cells for detection and has an upper limit of 500 cells / mm3 for detection. The reaction does detect the presence of esterase on granulocytes, however.Using the color grading given by the manufacturer (less than 10 granulocytes / mm3, no colour; 10-75 granulocytes / mm3, 1 +; 75-500 granulocytes / mm3, 2+;>500 granulocytes / mm3, 3 +), we used undiluted CSF and interpreted the test result[41]. CSF glucose: A typical level of CSF glucose is 2/3 of the plasma glucose.CSF glucose levels dropped in bacterial meningitis and fungal meningitis. We calculated if CSF glucose was below or above 50 mg / dL, using the reagent strip. The interpretation of the findings on the reagent strip was no color change as less than 50 mg / dL and any color change as greater than 50 mg / dL[42]. CSF protein:Normal CSF proteins vary from 15 to 45 mg / dL; the strip protein detection range is between less than 30 mg / dL and 500 mg / dL.We decided if the CSF protein was < 30 mg / dL (normal), 30 to 100 mg / dL, or > 100 mg / dL.Total color definition on reagent stripes was as follows: less than 30 mg / dL, no color change; between 30 and 100 mg / dL, 1 +; between 100 and 500 mg / dL, 2 +; and more than 500 mg / dL, 3 +[43]. A definite test should be an objective blind investigator who has done conclusive research. The tests performed were cell count by Neubauer 's chamber followed by a differential count on two centrifuged smears: one stained with hematoxylin and eosin stain, and the other stained with Leishman stain along with an automated analyzer's protein and sugar estimate[44].

Urinary Reagent Strips In Measuring CSF:

It is commonly known as an index test. With the help of a pipette, 2–3 drops of undiluted CSF were applied to protein, glucose, and leukocyte esterase patches, and the color change was reported and interpreted using the color grading given by the manufacturer[45]. The reagent stripe is designed to detect the range of 15 to 500 cells / mm 3 leukocytes. A spinal tap is necessary to obtain

cerebrospinal fluid (CSF) for a definitive meningitis diagnosis. The CSF also indicates reduced sugar (glucose) levels in people with meningitis, along with an elevated white blood cell count and decreased protein[46]. CSF check up treats bacterial meningitis[47]. Typical findings include: increased opening pressure, high protein, and hypoglycorrhachia.The appearance of the fluid is sometimes blurry or turbid.bThe concentration of CSF leukocytes is normally elevated with pleocytosis of a neutrophilic nature.A red color occurs with fresh blood or brownish with old blood. The protein elevation is believed to be due to blood-brain barrier disruption and serum protein leakage into the CSF. In bacterial meningitis, CSF proteins are typically the largest, and can exceed 1,000 mg / dL.If the CSF appears blurry it may indicate that white blood cells or proteins are tainted or accumulation. If the CSF appears bloody or red it may be a sign of bleeding or inflammation of the spinal cord. Increased CSF pressure can be due to increased intracranial pressure (skull pressure)[48]. The concentration of proteins is lower in both cisternal and ventricular CSF.Normal CSF is composed of 0-5 mononuclear cells[49]. Measured at lumbar puncture (LP), the CSF pressure is 100-180 mm H2O (8-15 mm Hg) with the patient lying on the side and 200-300 mm with the patient sitting up. This test is identical to a blood test where a needle is inserted into the blood test artery[50].

Procedure For Testing CSF:

An intrusive outpatient procedure used to remove a sample of cerebrospinal fluid (CSF) from the spine's subarachnoid area is a lumbar puncture (LP), also called a spinal tap. Many techniques can also be used to extract CSF, but they are used mainly in people who have spine deformities or are unable to undergo a normal lumbar puncture.A needle can be inserted at the base of the brain under the occipital bone[51]. You can drill a hole directly into the skull too[52]. If appropriate CSF is obtained it will be sent to a laboratory[35].The laboratory technicians must position the CSF in medium cultured dishes. The plates are supervised for the development of infectious organisms.If no growth occurs, the test is considered average, or negative.The test is considered positive if the CSF detects bacteria , viruses or fungi[53]. CSF culture tests will help the health care provider decide what causes the symptoms.You may need more checking, such as: Blood crops, Total Blood Count (CBC), CT scanning or magnetic resonance imaging (MRI); Your health care provider will support you in drawing up a recovery plan to best address and relieve the symptoms you encounter[54]. Within the CSF a population of CSF is used to detect infectious species.The CNS is vulnerable to bacterial, viral and fungal infections. A culture of CSF can help to diagnose a variety of disorders including: Bacterial Meningitis or Infection, Mummy diseases, Bleeding in the brain[55](hemorrhage of the subarachnoid), Epilepsia, Multiple sclerosis, Lyme Borrelia, Syndrome of Guillain-Barré. CSF pressure can also be calculated concurrently with the execution of a CSF culture[56].

Advantages and Disadvantages of measuring CSF for diagnosing meningitis:

Although CSF's primary purpose is to protect the brain inside the skull and act as a shock absorber for the central nervous system, CSF also circulates blood-filtered nutrients and chemicals, and eliminates waste products from the brain[57]. Urinary strips in testing of CSF for meningitis helps in biochemical analysis of CSF, whether the levels of glucose and protein are altered or maintained. This can be an ancillary method to confirm the biochemical parameters. However it shows the biochemical status of the CSF, the reagent strips will give only semi quantitative levels of the glucose and protein value. The cell count is not possible with the strips even though the leukocytes count is in urine. The CSF culture is not harmful while there are risks in the selection of CSF.Risks of puncture to the lumbar include: Inconvenience or pain during treatment,Bleeding of the spinal cord, particularly in people with low platelet count or blood thinners (thrombocytopenia), Headache[58] following leakage of CSF, Infection of Virus, Shock to the nerves. Lumbar punctures usually should not be performed on someone with a brain tumor or cyst.The operation can cause brain damage in these cases, and even death[59]. By avoiding strenuous activities on the day of the operation and remaining well hydrated you will reduce the risk of headache. A non-prescription medication, like acetaminophen (Tylenol), can help relieve back pain or headache[60].

Conclusion

The analysis offers strong insight and information on the use of urinary reagent strips in the calculation of CSF for meningitis. The principle of the chemical reactions

and colour reactions will be maintained both in the urine sample and cerebrospinal fluid sample. These concepts kindled the researchers in the field of neuropathology and made them to analyse the use of reagent strips in CSF analysis. Many successful results were obtained with a few limitations which were mentioned in this article.

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Conflict of Interest:

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References

1. Parmar RC, Warke S, Sira P, Kamat JR. Rapid diagnosis of meningitis using reagent strips. Indian J Med Sci [Internet]. 2004 Feb;58(2):62–6. Available from: https://www.ncbi.nlm.nih.gov/pubmed/14993718
2. Mamani M, Hashemi S, Niayesh A, Jamal-Omidi S. P112 Rapid diagnosis of acute meningitis using reagent strips [Internet]. Vol. 34, International Journal of Antimicrobial Agents. 2009. p. S62. Available from: http://dx.doi.org/10.1016/s0924-8579(09)70331-0
3. Abdelmotaleb GS, Abdo MK, Behiry EG, Mahmoud MI. Evaluation of using urine reagent strips in the diagnosis of childhood meningitis [Internet]. Vol. 15, Medical Research Journal. 2016. p. 42–7. Available from: http://dx.doi.org/10.1097/01.mjx.0000511316.35322.38
4. Romanelli RMC, Thome EE, Duarte FMC, Gomes RS, Camargos PAM, Freire HBM. Diagnosis of meningitis with reagent strips [Internet]. Vol. 77, Jornal de Pediatria. 2001. p. 203–8. Available from: http://dx.doi.org/10.2223/jped.207
5. Bokadia GS, Sneha. Bokadia G, Brundha MP, Ariga P. Current knowledge about lung cancer amongmiddleaged non medical males a questionnaire based survey [Internet]. Vol. 11, Research Journal of Pharmacy and Technology. 2018. p. 2565. Available from: http://dx.doi.org/10.5958/0974-360x.2018.00474.2
6. Jeong JY, Park SK. Usability of Urinary Reagent Strips in Diagnosis of Meningitis [Internet]. Vol. 4, Korean Journal of Pediatric Infectious Diseases. 1997. p. 265. Available from: http://dx.doi.org/10.14776/kjpid.1997.4.2.265
7. Moosa A, Ibrahim MD, Quortum HA. Rapid diagnosis of bacterial meningitis with reagent strips [Internet]. Vol. 345, The Lancet. 1995. p. 1290–1. Available from: http://dx.doi.org/10.1016/s0140-6736(95)90931-1
8. Buch A, D. Y. Patil Medical College, Hospital and Research Center, Patil Vidyapeeth DY, Pune. A Study of Cerebrospinal Fluid Examination using Urine Reagent Strips for Diagnosis of Meningitis [Internet]. Vol. 5, Recent Advances in Pathology & Laboratory Medicine. 2020. p. 1–6. Available from: http://dx.doi.org/10.24321/2454.8642.201919
9. Brundha MP, Nallaswamy D. Hide and seek in pathology-A research on game-based histopathology learning. International Journal of Research [Internet]. 2019; Available from: https://www.pharmascope.org/index.php/ijrps/article/view/606
10. Heckmann JG, Engelhardt A, Druschky A, Blum HE, Neundörfer B. Hepatitis-C-assoziierte vaskulitische Mononeuritis multiplex [Internet]. Vol. 122, DMW - Deutsche Medizinische Wochenschrift. 2008. p. 259–62. Available from: http://dx.doi.org/10.1055/s-2007-1024211
11. Shreya S, Brundha MP. Alteration of Haemoglobin Value in Relation to Age, Sex and Dental Diseases-A Retrospective Correlation Study. J Pharm Res [Internet]. 2017; Available from: http://www.indianjournals.com /ijor.aspx?target=ijor:rjpt&volume=10&issue=5&article=016
12. Ravichandran H, Brundha MP. Awareness about personal protective equipments in hospital workers (sweepers and cleaners). International Journal of Pharmaceutical Sciences Review and Research. 2016;40(1):28–9.
13. Boutin J, Colombies B, Berard A, Dabernat S, Rucheton B. Diagnosis of subarachnoid

haemorrhage using heam pigment detection in cerebrospinal fluid: Focus on urine test strips [Internet]. Vol. 493, Clinica Chimica Acta. 2019. p. S612–3. Available from: http://dx.doi.org/10.1016/j.cca.2019.03.1283

14. Druschky A, Heckmann J, Engelhardt A, Neundörfer B. Myositis - eine seltene Komplikation des M. Crohn [Internet]. Vol. 64, Fortschritte der Neurologie · Psychiatrie. 1996. p. 422–4. Available from: http://dx.doi.org/10.1055/s-2007-996586
15. Heckmann JG, Kraus J, Niedermeier W, Erbguth F, Druschky A, Schoerner C, et al. Nosokomiale Pneumonien auf einer neurologischen Intensivstation [Internet]. Vol. 124, DMW - Deutsche Medizinische Wochenschrift. 2008. p. 919–24. Available from: http://dx.doi.org/10.1055/s-2007-1024452
16. Swetha S, Brundha MP. Analysis of knowledge about the hospital warning symbols among the postgraduate dental students-A comparative study [Internet]. Vol. 10, Research Journal of Pharmacy and Technology. 2017. p. 975. Available from: http://dx.doi.org/10.5958/0974-360x.2017.00177.9
17. Taj A, Jamil N. Cerebrospinal Fluid Concentrations of Biogenic Amines: Potential Biomarkers for Diagnosis of Bacterial and Viral Meningitis [Internet]. Vol. 7, Pathogens. 2018. p. 39. Available from: http://dx.doi.org/10.3390/pathogens7020039
18. Vogel U, Steinmetz I, Frosch M. Avoiding artifacts in the infant rat model for bacterial meningitis: use of Sangur test strips for the rapid quantification of blood contamination in cerebrospinal fluid [Internet]. Vol. 185, Medical Microbiology and Immunology. 1996. p. 27–30. Available from: http://dx.doi.org/10.1007/s004300050011
19. John DA, Brundha MP. Awareness of Vitamin A Deficiency among Middle Aged Men-Research. Vitamins & Minerals [Internet]. 2016;5(2):144. Available from: https://pdfs.semanticscholar.org/6450/b7a951ea17ed64c0f699315fe1e3e5d5f1bc.pdf
20. Mahoney WM, Mark Mahoney W. Cerebrospinal fluid c-reactive protein measurement: A bedside test in the rapid diagnosis of bacterial meningitis [Internet]. Vol. 20, Annals of Emergency Medicine. 1991. p. 211–2. Available from: http://dx.doi.org/10.1016/s0196-0644(05)81231-4
21. Gaul C, Heckmann JG, Druschky A, Schöcklmann H, Neundörfer B, Erbguth F. Renale tubuläre Azidose mit schwerer hypokaliämischer Tetraparese nach Ibuprofeneinnahme [Internet]. Vol. 124, DMW - Deutsche Medizinische Wochenschrift. 2008. p. 483–6. Available from: http://dx.doi.org/10.1055/s-2007-1024347
22. Prashaanthi N, Brundha MP. A Comparative Study between Popplet Notes and Conventional Notes for Learning Pathology [Internet]. Vol. 11, Research Journal of Pharmacy and Technology. 2018. p. 175. Available from: http://dx.doi.org/10.5958/0974-360x.2018.00032.x
23. Neundörfer B, Engelhardt A, Druschky K. Polyneuropathien bei HIV-Infektion [Internet]. Vol. 57, Fortschritte der Neurologie · Psychiatrie. 1989. p. 127–31. Available from: http://dx.doi.org/10.1055/s-2007-1000753
24. Santer R, Sievers E, Schaub J. Cerebrospinal fluid concentrations of leukotriene B4in bacterial meningitis [Internet]. Vol. 85, Acta Paediatrica. 1996. p. 902–5. Available from: http://dx.doi.org/10.1111/j.1651-2227.1996.tb14181.x
25. Balaji S, Brundha MP, Path DNB. Awareness of About Breast Cancer among Dental Surgeons. Res J Pharm Biol Chem Sci [Internet]. 2016;8(8):797. Available from: https://pdfs.semanticscholar.org/63f4/4173d90b35bffa33eed0aeb52ac547ef1567.pdf
26. Harsha L, Brundha MP. Prevalence of dental developmental anomalies among men and women and its psychological effect in a given population. Res J Pharm Biol Chem Sci [Internet]. 2017;9(6):869. Available from: http://search.proquest.com/openview/1f488cc6e377096f44a87e509aceab79/1? pq-origsite= gscholar&cbl=54977
27. Kölmel HW. Bacterial Meningitis [Internet]. Atlas of Cerebrospinal Fluid Cells. 1977. p. 41–7. Available from: http://dx.doi.org/10.1007/978-3-642-66623-0_6
28. Balagopal SK, Sainu A, Thomas V. Evaluation of leucocyte esterase reagent strip test for the rapid bedside diagnosis of spontaneous bacterial peritonitis [Internet]. Vol. 29, Indian Journal of

Gastroenterology. 2010. p. 74–7. Available from: http://dx.doi.org/10.1007/s12664-010-0017-0

29. Mirzaei A, Khorsand A, Hajibemani A, Sharifiyazdi H. Evaluation of leukocyte esterase test strips for rapid diagnosis of subclinical mastitis in dairy cows [Internet]. Vol. 28, Comparative Clinical Pathology. 2019. p. 151–6. Available from: http://dx.doi.org/10.1007/s00580-018-2808-0
30. Saivignesh S, Brundha MP. Myeloid sarcoma. International Journal of Clinicopathological Correlation [Internet]. 2019 Jul 1 [cited 2020 Jun 10];3(2):41. Available from: http://www.ijcpc.org/article.asp?issn=2589-1731; year=2019;volume=3;issue=2;spage=41; epage=43; aulast=Saivignesh;type=0
31. Hannah R, Ramani P, Brundha MP, Herald. J. Sherlin, Ranjith G, Ramasubramanian A, et al. Liquid Paraffin as a Rehydrant for Air Dried Buccal Smear [Internet]. Vol. 12, Research Journal of Pharmacy and Technology. 2019. p. 1197. Available from: http://dx.doi.org/10.5958/0974-360x.2019.00199.9
32. Castellote J. Can leukocyte esterase reagent strips be used for the diagnosis of spontaneous bacterial peritonitis? [Internet]. Vol. 2, Nature Clinical Practice Gastroenterology & Hepatology. 2005. p. 566–7. Available from: http://dx.doi.org/10.1038/ncpgasthep0340
33. Panjarathinam R, Shah RK. Pyogenic meningitis in Ahmedabad [Internet]. Vol. 60, The Indian Journal of Pediatrics. 1993. p. 669–73. Available from: http://dx.doi.org/10.1007/bf02821730
34. Haritha PS, Brundha MP. Awareness of dengue fever among the parents of children coming to the dental outpatient department – A questionnaire study. International Journal of Clinicopathological Correlation [Internet]. 2019 Jul 1 [cited 2020 Jun 10];3(2):60. Available from: http://www.ijcpc.org/article.asp?issn=2589-1731;year=2019;volume=3;issue=2;spage=60;epage=63;aulast=Haritha
35. Kumar MDA, Ashok Kumar MD, Brundha MP. Awareness about nocturia-A questionnaire survey [Internet]. Vol. 9, Research Journal of Pharmacy and Technology. 2016. p. 1707. Available from: http://dx.doi.org/10.5958/0974-360x.2016.00344.9
36. Mirdha BR, Gupta U, Bhujwala RA. Latex agglutination test: An adjunct to the laboratory diagnosis of pyogenic bacterial meningitis [Internet]. Vol. 58, The Indian Journal of Pediatrics. 1991. p. 521–4. Available from: http://dx.doi.org/10.1007/bf02750934
37. Koulaouzidis A. Diagnosis of spontaneous bacterial peritonitis: An update on leucocyte esterase reagent strips [Internet]. Vol. 17, World Journal of Gastroenterology. 2011. p. 1091. Available from: http://dx.doi.org/10.3748/wjg.v17.i9.1091
38. Preethikaa S, Brundha MP. Awareness of diabetes mellitus among general population. Research Journal of Pharmacy and Technology [Internet]. 2018;11(5):1825–9. Available from: http://www.indianjournals.com/ijor.aspx?target=ijor:rjpt&volume=11&issue= 5& article=024
39. Shenoy PB, Brundha MP. Awareness of polycystic ovarian disease among females of age group 18-30 years. Res J Pharm Biol Chem Sci [Internet]. 2016;8(8):813. Available from: http://search.proquest.com/openview/a8a09e7b2e9d2f967bf3fee479c7018a/1?pq-origsite=gscholar&cbl=54977
40. Molyneux E, Walsh A. Caution in the use of reagent strips to diagnose acute bacterial meningitis. Lancet [Internet]. 1996 Oct 26;348(9035):1170–1. Available from: http://dx.doi.org/10.1016/S0140-6736(05)65304-4
41. Molyneux E, Walsh A, Phiri A, Molyneux M. Acute bacterial meningitis in children admitted to the Queen Elizabeth Central Hospital, Blantyre, Malawi in 1996–97 [Internet]. Vol. 3, Tropical Medicine & International Health. 1998. p. 610–8. Available from: http://dx.doi.org/10.1046/j.1365-3156.1998.00278.x
42. McKendrick MW, Kennedy N, Green ST, Partridge S, Read RC. Management of acute bacterial meningitis [Internet]. Vol. 347, The Lancet. 1996. p. 903. Available from: http://dx.doi.org/10.1016/s0140-6736(96)91384-7
43. Obaro SK. Dexamethasone in acute bacterial meningitis [Internet]. Vol. 360, The Lancet. 2002. p. 1609–10. Available from: http://dx.doi.org/10.1016/s0140-6736(02)11553-4
44. Bhat A, Roy R, Umashankar T, Jayaprakash CS. Rapid Diagnosis of Bacterial Meningitis by Urine [Internet]. Vol. 04, Journal of Medical Sciences

and Health. 2018. p. 15–7. Available from: http://dx.doi.org/10.46347/jmsh.2018.v04i01.003

45. Mazumder S, Ramya BS, Biligi DS. Utility of urine reagent strips in cerebrospinal fluid analysis: An aid to bedside diagnosis of meningitis. Indian J Pathol Microbiol [Internet]. 2018 Jul;61(3):356–9. Available from: http://dx.doi.org/10.4103/IJPM.IJPM_821_16
46. Goswami K, Parvizi J, Maxwell Courtney P. Current Recommendations for the Diagnosis of Acute and Chronic PJI for Hip and Knee—Cell Counts, Alpha-Defensin, Leukocyte Esterase, Next-generation Sequencing [Internet]. Vol. 11, Current Reviews in Musculoskeletal Medicine. 2018. p. 428–38. Available from: http://dx.doi.org/10.1007/s12178-018-9513-0
47. Timothy CN, Samyuktha PS, Brundha MP. Dental pulp Stem Cells in Regenerative Medicine – A Literature Review [Internet]. Vol. 12, Research Journal of Pharmacy and Technology. 2019. p. 4052. Available from: http://dx.doi.org/10.5958/0974-360x.2019.00698.x
48. Coppens A, Speeckaert M, Delanghe J. THE PRE-ANALYTICAL CHALLENGES OF ROUTINE URINALYSIS [Internet]. Vol. 65, Acta Clinica Belgica. 2010. p. 182–9. Available from: http://dx.doi.org/10.1179/acb.2010.038
49. Brundha MP, Pathmashri VP, Sundari S. Quantitative Changes of Red Blood cells in Cancer Patients under Palliative Radiotherapy-A Retrospective Study [Internet]. Vol. 12, Research Journal of Pharmacy and Technology. 2019. p. 687. Available from: http://dx.doi.org/10.5958/0974-360x.2019.00122.7
50. Oyaert M, Delanghe J. Progress in Automated Urinalysis [Internet]. Vol. 39, Annals of Laboratory Medicine. 2019. p. 15. Available from: http://dx.doi.org/10.3343/alm.2019.39.1.15
51. Swetha G, Rani SL, Brundha MP. Awareness of the side effects of vaccination among general public. Drug Invention Today. 2020;14(3).
52. Conly JM, Ronald AR. Cerebrospinal fluid as a diagnostic body fluid [Internet]. Vol. 75, The American Journal of Medicine. 1983. p. 102–8. Available from: http://dx.doi.org/10.1016/0002-9343(83)90080-3
53. Rao SP, Brown IAK. 660 RECURRENT PNEUMOCOCCAL MENINGITIS IN INFANTS UNDER OOU 15 MONTHS WITH SICKLE CELL DISEASE [Internet]. Vol. 12, Pediatric Research. 1978. p. 473–473. Available from: http://dx.doi.org/10.1203/00006450-197804001-00665
54. Parving H-H, Oxenbøll B, Aa. Svendsen P, Sandahl Christiansen J, Andersen AR. Early detection of patients at risk of developing diabetic nephropathy. A longitudinal study of urinary albumin excretion [Internet]. Vol. 100, Acta Endocrinologica. 1982. p. 550–5. Available from: http://dx.doi.org/10.1530/acta.0.1000550
55. Kalaiselvi R, Brundha MP. Prevalence of hysterectomy in South Indian population [Internet]. Vol. 9, Research Journal of Pharmacy and Technology. 2016. p. 1941. Available from: http://dx.doi.org/10.5958/0974-360x.2016.00398.x
56. Brundha MP. A Comparative Study-The Role of Skin and Nerve Biopsy in Hansen's Disease. Journal of Pharmaceutical Sciences and Research. 2015;7(10):837–44.
57. Penders J, Fiers T, Delanghe JR. Quantitative Evaluation of Urinalysis Test Strips [Internet]. Vol. 48, Clinical Chemistry. 2002. p. 2236–41. Available from: http://dx.doi.org/10.1093/clinchem/48.12.2236
58. Ferdioz J, Brundha MP. Awareness of stye. International Journal of Pharmaceutical Sciences Review and Research [Internet]. 2016 Jan 1 [cited 2020 Jun 8];40(1):30–2. Available from: http://dx.doi.org/
59. Penders J, Fiers T, Giri M, Wuyts B, Ysewyn L, Delanghe JR. Quantitative measurement of ketone bodies in urine using reflectometry [Internet]. Vol. 43, Clinical Chemistry and Laboratory Medicine (CCLM). 2005. Available from: http://dx.doi.org/10.1515/cclm.2005.123
60. Penders J, Fiers T, Everaert K, Barth J, Dhondt AW, Delanghe JR. Diagnostic performance of combined specific urinary proteins and urinary flow cytometry in urinary tract pathology [Internet]. Vol. 45, Clinical Chemical Laboratory Medicine. 2007. Available from: http://dx.doi.org/10.1515/cclm.2007.090