World Journal of Gastroenterology

Online Submissions: http://www.wjgnet.com/1007-9327office
wjg@wjgnet.com
doi:10.3748/wjg.v17.i9.1091

World J Gastroenterol 2011 March 7; 17(9): 1091-1094
ISSN 1007-9327 (print) ISSN 2219-2840 (online)

EDITORIAL

Diagnosis of spontaneous bacterial peritonitis: An update on leucocyte esterase reagent strips

Anastasios Koulaouzidis

Anastasios Koulaouzidis, Centre for Liver and Digestive Disorders, Royal Infirmary of Edinburgh, 51 Little France Crescent, Edinburgh, EH164SA, United Kingdom
Author contributions: Koulaouzidis A solely contributed to this paper.
Correspondence to: Dr. Anastasios Koulaouzidis, MD, MRCP, MACG, FEBG, Centre for Liver and Digestive Disorders, Royal Infirmary of Edinburgh, 51 Little France Crescent, Edinburgh, EH164SA, United Kingdom. akoulaouzidis@hotmail.com
Telephone: + 44-131-2421126 Fax: +44-131-2421618
Received: November 10, 2010 Revised: January 18, 2011
Accepted: January 25, 2011
Published online: March 7, 2011

Key words: Peritonitis; Leukocytes; Esterases; Diagnosis; Reagent strips; Bacterial

Peer reviewer: Dr. Herwig R Cerwenka, Professor, Department of Surgery, Medical University of Graz, Auenbruggerplatz 29, A-8036 Graz, Austria

Koulaouzidis A. Diagnosis of spontaneous bacterial peritonitis: An update on leucocyte esterase reagent strips. *World J Gastroenterol* 2011; 17(9): 1091-1094 Available from: URL: http://www.wjgnet.com/1007-9327/full/v17/i9/1091.htm DOI: http://dx.doi.org/10.3748/wjg.v17.i9.1091

Abstract

Ascites remain the commonest complication of decompensated cirrhosis. Spontaneous bacterial peritonitis (SBP) is defined as the infection of ascitic fluid (AF) in the absence of a contiguous source of infection and/or an intra-abdominal inflammatory focus. An AF polymorphonuclear (PMN) leucocyte count $\geqslant$ 250/mm^3 -irrespective of the AF culture result- is universally accepted nowadays as the best surrogate marker for diagnosing SBP. Frequently the results of the manual or automated PMN count do not reach the hands of the responsible medical personnel in a timely manner. However, this is a crucial step in SBP management. Since 2000, 26 studies (most of them published as full papers) have checked the validity of using leukocyte esterase reagent strips (LERS) in SBP diagnosis. LERS appear to have low sensitivity for SBP, some LERS types more than others. On the other hand, though, LERS have consistently given a high negative predictive value (> 95% in the majority of the studies) and this supports the use of LERS as a preliminary screening tool for SBP diagnosis. Finally, an AF-tailored dipstick has been developed. Within the proper setting, it is set to become the mainstream process for handling AF samples.

INTRODUCTION

Ascites remains the commonest of the three major complications of advanced or decompensated cirrhosis (along with hepatic encephalopathy and variceal haemorrhage). Cirrhotics with ascites have, over a one-year period, 10% probability of developing the first episode of spontaneous bacterial peritonitis (SBP)[1]. Conn first introduced the term SBP, publishing his clinical findings just one year after Kerr *et al* described (in 1963) 11 cases of seemingly unexplained infection of the ascitic fluid (AF)[2].

SBP is defined as the infection of AF in the absence of a contiguous source of infection and/or an intra-abdominal (and potentially surgically treated) inflammatory focus. Depending on the patient population examined (outpatients or hospitalised), the prevalence of SBP varies from 3.5% and 30%[3]. Around 50% of SBP episodes are present at the time of hospital admission, whilst the remainder are acquired during the hospitalisation period[2]. The mortality of untreated SBP remains high (> 80%), and a satisfactory patient course and clinical outcome is based on an aggressive approach aiming to rapid diagnosis and prompt initiation of antibiotic therapy.

DIAGNOSIS OF SBP

The clinical manifestations of SBP can be subtle and in-

sidious, and its diagnosis requires a high index of clinical suspicion. Abdominal paracentesis is considered necessary for all patients with ascites on hospital admission, in-patient cirrhotics with ascites who develop clinical signs of sepsis, hepatic encephalopathy, (sudden or unexplained) renal impairment and/or all cirrhotics who develop GI bleeding[4]. Unfortunately, a clinical diagnosis of infected AF without a paracentesis is not adequate[1].

An AF polymorphonuclear (PMN) leukocyte count $\geqslant$ 250/mm^3, irrespective of the AF culture result, is universally accepted nowadays as the best surrogate marker for diagnosing SBP[5]. The presence of positive AF cultures is confirmatory, but by no means a necessary prerequisite for instigation of antibiotic therapy. In fact, it is considered a "fatal" mistake to wait 48 h for culture results before initiating therapy, where it is indicated.

Frequently the results of the manual PMN count do not reach the hands of the responsible medical personnel in a timely manner[6]. Such situations include busy night or weekend shifts, small hospitals with off-site laboratory facilities, or units with limited case-load and liver disease expertise. We have recently showed that the mean delay from paracentesis to a validated PMN result out-of-hours was more than 4 h[7]. Furthermore, manual AF PMN counting is laborious and costly. The use of automated cell counters has now been backed-up by sufficient published evidence to become the common practice[5,8].

However, even automated cell counts suffer generally from similar constraints to those described above for manual techniques. Therefore, any alternative test that may provide or, more importantly, exclude a diagnosis of SBP at the bedside and reduce the "tap-to-first shot" time is considered welcome. The leukocyte esterase reagent strips (LERS), commonly used in every day practice for the rapid diagnosis of urinary tract infections (UTIs), were certainly featuring as a promising candidate.

LERS IN SBP

LERS had already been successfully evaluated in the diagnosis of infection in other sterile body fluids i.e. synovial, pleural, cerebrospinal fluid and peritoneal dialysate[9-11]. The LERS test is based on the esterase activity of the leucocytes. A pyrrole, esterified with an amino-acid is used as the substrate; hydrolysis of the ester (mediated by the esterase) releases the pyrrole which in turn reacts with a diazonium salt yielding a violet or purple azo dye in the relevant pad of the strip[11]. LERS are not specific for PMNs and the interpretation of the colorimetric reaction is inherently subjective, therefore the method is considered qualitative or semi-quantitative at best. Butani *et al*[12] were the first to present their results on the use of LERS in SBP diagnosis as an abstract in DDW 2000.

Since then, 26 publications followed (23 as full, peer-reviewed papers and 3 as either an abstract or a letter to Editor; of them, 22 are in English, 2 in French, 1 in Chinese & 1 in Korean), with the first full paper that of Vanbiervliet *et al*[13] validating the Multistix ®8SG.

Their results were very encouraging. Thus, various LERS were eventually validated in what were mostly single or two-centre studies (Table 1), with one notable exception in the French multicentre study (Nousbaum *et al*[28], 70 centres) published initially as an abstract and later as a full paper in 2007. It is important to note here that the grading is different for each dipstick, and therefore the cut-off leucocyte count should be used instead, in order to draw meaningful conclusions.

The French multicentre study pointed out the weakness of Multistix ®8SG and, to a certain extent, of the concept of using dipstick in SBP diagnosis overall. Furthermore, 2 systematic reviews[9,10] have been published in 2008, both pointing out that the heterogeneity in the number of patients included in each study, the AF samples tested and SBP episodes observed, as well as in all measures of LERS performance, did not allow pooling of the results via meta-analysis. Overall, the Aution® and Combur® dipsticks have performed better[38] (in regards to the negative predictive value) than the Multistix®. The spectrophotometric analyser Clinitek® 50, compatible with the Multistix® dipstick, was used in only 6 studies.

The rather intense research on the field has brought up important details on the limitations of LERS. First, the results seem to be influenced by the number of PMNs in the AF, LERS performing less well if the PMN count < 1000/μL[39]. Second, all LERS validated in the SBP studies were initially designed for use in the diagnosis of UTIs; in infected urine though, both the number of leucocytes and the protein content are quite different, the first being significantly higher than in most SBP[39], while the latter does not exceed the 1 g/L level[35]. The above 2 factors are considered significant for the observed low sensitivity of some LERS. I need to mention again here that, aside the fact there is significant inter-study variability in terms of the LERS brands used, as well as to the cut-off level examined, LERS are not specific for PMNs and the interchangeable use of PMNs and leucocytes (seen in the majority of the studies) is confusing to the reader. Finally, LERS are not suitable for the few cases of chylous ascites or peritoneal tuberculosis.

On the other hand, LERS have consistently given a high negative predictive value (NPV) of above 95% in the majority of the studies and, as in SBP, a false positive result (which might eventually lead to the 'adverse' administration of a single dose of an overall well-tolerated antibiotic[28]) is considered ethically and medically acceptable advocating the use of LERS as a preliminary screening tool for SBP diagnosis. In addition, Castelote *et al*[33] only recently showed that LERS, despite their qualitative nature, could be well used in the clinical management of SBP. The low cost of the strips can only be considered a significant advantage.

Only one study has checked the combine use of the LERS with the relevant pad for nitrites. There was no additional advantage by combining the two results. Finally, despite clear evidence to support its use[5], no study has validated the combination results of LER pad with that of the pH[3].

CONCLUSION

In conclusion, there is reasonable amount of evidence

Table 1 Studies, patients included, ascitic fluid samples tested, inpatients/outpatients, type of leukocyte esterase reagent strips used, leukocyte esterase reagent strips cut-off grade of the study with Sens, Spec, PPV and NPV

Study	Patients	Samples	In/Out	M/F	SBP	LERS	LERS cut-off	Sens (%)	Spec (%)	PPV (%)	NPV (%)
Vanbiervliet *et al*[13]	72	78	72/0	44/28	9	Multistix8®SG	70 leuc/μL-G2	100	100	100	100
Castelote *et al*[14]	128	228	128/0	91/37	52	Aution® sticks	75 leuc/μL-G2	96	89	74	99
Thévenot *et al*[15]	31	100	23/8	13/18	9	Multistix8®SG	125 leuc/μL-G3	89	100	100	99
						Combur2LN®	75 leuc/μL-G2	89	100	100	99
Butani *et al*[16]	75	136	n/s	n/s	12	Multistix10®SG	70 leuc/μL-G2	83	99	91	98
Sapey *et al*[11]	34 (s-group)	55 (s-group)	n/s	51/15	13	Multistix10®SG	25 leuc/μL-G1	83/100	96/100	83/100	96/100
	76	184				Nephur-test®	25 leuc/μL-G1	86/100	92.5/100	75/100	99/100
Sapey *et al*[17]	51	245	9/42		17	Multistix10®SG	25 leuc/μL-G1	64.7	99.6	91.7	97.4
						Nephur-test®	25 leuc/μL-G1	88.2	99.6	93.8	99.1
Kim *et al*[18]	257	257	257/0	187/70	79	UriSCAN®	75 leuc/μL-G2	100	99	98	100
Kim *et al*[19]	53	75	53/0	36/17	18	Multistix10®SG	75 leuc/μL-G2	50	100	100	87
						UriSCAN®	75 leuc/μL-G2	100	100	100	100
Sarwar *et al*[20]	214	214	214/0	116/98	38	Combur10®	75 leuc/μL-G2	95	92	72	99
Wisniewski *et al*[21]	47	90	47/0	27/20	6	Multistix8®SG	15 leuc/μL-G1	83	83	42	97
Braga *et al*[22]	42	100	35/7	10/32	9	Combur® UX	75 leuc/μL-G2	100	98.9	92.3	100
Rerknimitr *et al*[23]	127	200	106/21	75/52	42	Combur10M®	25 leuc/μL-G1	88	81	55	96
Campillo *et al*[24]	116	443	n/s	76/40	33	Multistix8®SG	70 leuc/μL-G2	45.7	98	75	93.3
						Combur2LN®	75 leuc/μL-G2	63	99.2	91	92.9
Li *et al*[25]	84	84	84/0	47/37	25	Multistix10®SG	15 leuc/μL-G1	92.8	84.7	71.8	96.1
Ribeiro *et al*[26]	106	200	80/26	82/24	11	Multistix10®SG	15 leuc/μL-G1	86	96	60	99
Gaya *et al*[27]	105	173	71/34	71/34	17	Multistix10®SG	15 leuc/μL-G1	100	91	50	100
Nousbaum *et al*[28]	1041	2123	686/355	748/293	117	Multistix8®SG	70 leuc/μL-G2	45.3	99.2	77.9	96.9
Torun *et al*[29]	63	63	63/0	38/25	15	Aution® sticks	75 leuc/μL-G2	93	100	100	98
Nobre *et al*[30]	55	109	55/0	33/22	9	H-T Combina®	75 leuc/μL-G2	78	88	37	98
de Araujo *et al*[31]	71	155	43/28	57/24	17	Multistix10®SG	15 leuc/μL-G1	80	98.5	90.9	96.2
		159				Choiceline 10®	75 leuc/μL-G2	76.9	97.7	87	95.6
Balagopal *et al*[32]	175	n/f	n/f	146/29	n/f	Magistik10®	125 leuc/μL-n/f	92	100	n/f	n/f
Castellote *et al*[33]	51	n/s	51	n/s	53	Aution® sticks	75 leuc/μL-G2	89	86	62	97
Rerknimitr *et al*[34]	143	250	n/s	91/52	30	Multistix10®SG	?25 leuc/μL-G1	80	94.5	66.7	97.2
						Aution® sticks	?250 leuc/μL-G3	90	93.2	64.3	98.6
						Combur10®	?75 leuc/μL-G2	90	93.2	64.3	98.6
[letter]Gülberg *et al*[35]	n/s	194	n/s	n/s	16	Multistix10®SG	n/s	31	n/s	n/s	n/s
						Combur®	n/s	44	n/s	n/s	n/s
[letter]Farmer *et al*[36]	256	311	n/s	161/95	59	Multistix8®SG	70 leuc/μL-G2	96	96.5	90.7	99.4
[abstract] Delaunay-Tardy *et al*[37]	n/f	n/f	n/f	n/f	n/f	Multistix8®SG	n/f	60	n/f	n/f	n/f

Sens: Sensitivity; Spec: Specificity; PPV: Positive predictive value; NPV: Negative predictive value; LERS: Leukocyte esterase reagent strips; SBP: Spontaneous bacterial peritonitis; n/s : Not stated; n/f : Not found; G : Grade (as per LERS); In/out: Inpatients/outpatients; M/F : Male/female; s-group: subgroup

to support the use of LERS in the work-up of patients suspected of having SBP. The PMN count (be it manual or automated) is not to be abolished from SBP diagnostic algorithm. Remote hospitals, less affluent health systems and busy junior clinicians should realise the benefit of LERS and incorporate them in their AF handling routine. A "new kid on the block" has just appeared[40] in the race against SBP; if further validation studies worldwide are supportive, it is set to become the mainstream process for handling AF samples[41].

REFERENCES

1 **Amini M**, Runyon BA. Alcoholic hepatitis 2010: a clinician's guide to diagnosis and therapy. *World J Gastroenterol* 2010; **16**: 4905-4912

2 **Ribeiro TC**, Chebli JM, Kondo M, Gaburri PD, Chebli LA, Feldner AC. Spontaneous bacterial peritonitis: How to deal with this life-threatening cirrhosis complication? *Ther Clin Risk Manag* 2008; **4**: 919-925

3 **Koulaouzidis A**, Bhat S, Saeed AA. Spontaneous bacterial peritonitis. *World J Gastroenterol* 2009; **15**: 1042-1049

4 **Rimola A**, García-Tsao G, Navasa M, Piddock LJ, Planas R, Bernard B, Inadomi JM. Diagnosis, treatment and prophylaxis of spontaneous bacterial peritonitis: a consensus document. International Ascites Club. *J Hepatol* 2000; **32**: 142-153

5 **Wong CL**, Holroyd-Leduc J, Thorpe KE, Straus SE. Does this patient have bacterial peritonitis or portal hypertension? How do I perform a paracentesis and analyze the results? *JAMA* 2008; **299**: 1166-1178

6 **Runyon BA**. Strips and tubes: improving the diagnosis of spontaneous bacterial peritonitis. *Hepatology* 2003; **37**: 745-747

7 **Koulaouzidis A**, Said E, Saeed AA. Use of Urine Dipsticks in Spontaneous Bacterial Peritonitis (SBP): Benefit for the Busy Junior Physician [abstract]. *Endoscopy* 2006; **38**: 1187

8 **Riggio O**, Angeloni S. Ascitic fluid analysis for diagnosis and monitoring of spontaneous bacterial peritonitis. *World J Gastroenterol* 2009; **15**: 3845-3850

9 **Koulaouzidis A**, Leontiadis GI, Abdullah M, Moschos J, Gasem J, Tharakan J, Maltezos E, Saeed AA. Leucocyte esterase reagent strips for the diagnosis of spontaneous bacterial peritonitis: a systematic review. *Eur J Gastroenterol Hepatol* 2008; **20**: 1055-1060

10 **Nguyen-Khac E**, Cadranel JF, Thevenot T, Nousbaum JB. Review article: the utility of reagent strips in the diagnosis of infected ascites in cirrhotic patients. *Aliment Pharmacol Ther* 2008; **28**: 282-288

11 **Sapey T**, Mena E, Fort E, Laurin C, Kabissa D, Runyon BA, Mendler MH. Rapid diagnosis of spontaneous bacterial peritonitis with leukocyte esterase reagent strips in a European and in an American center. *J Gastroenterol Hepatol* 2005; **20**: 187-192
12 **Butani RC**, Shaffer RT, Szyjkowski RD, Weeks BE, Speights LG, Kadakia SC. Use of Multistix® leukocyte esterase dipstick testing for ascitic fluid infection [abstract]. *Gastroenterology* 2000; **118** (Suppl): 1089
13 **Vanbiervliet G**, Rakotoarisoa C, Filippi J, Guérin O, Calle G, Hastier P, Mariné-Barjoan E, Schneider S, Piche T, Broussard JF, Dor JF, Benzaken S, Hébuterne X, Rampal P, Tran A. Diagnostic accuracy of a rapid urine-screening test (Multistix8SG) in cirrhotic patients with spontaneous bacterial peritonitis. *Eur J Gastroenterol Hepatol* 2002; **14**: 1257-1260
14 **Castellote J**, López C, Gornals J, Tremosa G, Fariña ER, Baliellas C, Domingo A, Xiol X. Rapid diagnosis of spontaneous bacterial peritonitis by use of reagent strips. *Hepatology* 2003; **37**: 893-896
15 **Thévenot T**, Cadranel JF, Nguyen-Khac E, Tilmant L, Tiry C, Welty S, Merzoug N. Diagnosis of spontaneous bacterial peritonitis in cirrhotic patients by use of two reagent strips. *Eur J Gastroenterol Hepatol* 2004; **16**: 579-583
16 **Butani RC**, Shaffer RT, Szyjkowski RD, Weeks BE, Speights LG, Kadakia SC. Rapid diagnosis of infected ascitic fluid using leukocyte esterase dipstick testing. *Am J Gastroenterol* 2004; **99**: 532-537
17 **Sapey T**, Kabissa D, Fort E, Laurin C, Mendler MH. Instant diagnosis of spontaneous bacterial peritonitis using leukocyte esterase reagent strips: Nephur-Test vs. MultistixSG. *Liver Int* 2005; **25**: 343-348
18 **Kim DK**, Suh DJ, Kim GD, Choi WB, Kim SH, Lim YS, Lee HC, Chung YH, Lee YS. [Usefulness of reagent strips for the diagnosis of spontaneous bacterial peritonitis]. *Korean J Hepatol* 2005; **11**: 243-249
19 **Kim DY**, Kim JH, Chon CY, Han KH, Ahn SH, Kim JK, Paik YH, Lee KS, Moon YM. Usefulness of urine strip test in the rapid diagnosis of spontaneous bacterial peritonitis. *Liver Int* 2005; **25**: 1197-1201
20 **Sarwar S**, Alam A, Izhar M, Khan AA, Butt AK, Shafqat F, Malik K, Ahmed I, Niazi AK. Bedside diagnosis of spontaneous bacterial peritonitis using reagent strips. *J Coll Physicians Surg Pak* 2005; **15**: 418-421
21 **Wisniewski B**, Rautou PE, Al Sirafi Y, Lambare-Narcy B, Drouhin F, Constantini D, Fischer D, Labayle D, Denis J. [Diagnosis of spontaneous ascites infection in patients with cirrhosis: reagent strips]. *Presse Med* 2005; **34**: 997-1000
22 **Braga LL**, Souza MH, Barbosa AM, Furtado FM, Campelo PA, Araújo Filho AH. Diagnosis of spontaneous bacterial peritonitis in cirrhotic patients in northeastern Brazil by use of rapid urine-screening test. *Sao Paulo Med J* 2006; **124**: 141-144
23 **Rerknimitr R**, Rungsangmanoon W, Kongkam P, Kullavanijaya P. Efficacy of leukocyte esterase dipstick test as a rapid test in diagnosis of spontaneous bacterial peritonitis. *World J Gastroenterol* 2006; **12**: 7183-7187
24 **Campillo B**, Richardet JP, Dupeyron C. Diagnostic value of two reagent strips (Multistix 8 SG and Combur 2 LN) in cirrhotic patients with spontaneous bacterial peritonitis and symptomatic bacterascites. *Gastroenterol Clin Biol* 2006; **30**: 446-452
25 **Li J**, Pan Y, Bao WG, Niu JQ, Wang F. [Multistix10SG urine test in diagnosing spontaneous bacterial peritonitis]. *Zhonghua Ganzangbing Zazhi* 2006; **14**: 784-785
26 **Ribeiro TC**, Kondo M, Amaral AC, Parise ER, Bragagnolo Júnior MA, Souza AF. Evaluation of reagent strips for ascitic fluid leukocyte determination: is it a possible alternative for spontaneous bacterial peritonitis rapid diagnosis? *Braz J Infect Dis* 2007; **11**: 70-74
27 **Gaya DR**, David B Lyon T, Clarke J, Jamdar S, Inverarity D, Forrest EH, John Morris A, Stanley AJ. Bedside leucocyte esterase reagent strips with spectrophotometric analysis to rapidly exclude spontaneous bacterial peritonitis: a pilot study. *Eur J Gastroenterol Hepatol* 2007; **19**: 289-295
28 **Nousbaum JB**, Cadranel JF, Nahon P, Khac EN, Moreau R, Thévenot T, Silvain C, Bureau C, Nouel O, Pilette C, Paupard T, Vanbiervliet G, Oberti F, Davion T, Jouannaud V, Roche B, Bernard PH, Beaulieu S, Danne O, Thabut D, Chagneau-Derrode C, de Lédinghen V, Mathurin P, Pauwels A, Bronowicki JP, Habersetzer F, Abergel A, Audigier JC, Sapey T, Grangé JD, Tran A. Diagnostic accuracy of the Multistix 8 SG reagent strip in diagnosis of spontaneous bacterial peritonitis. *Hepatology* 2007; **45**: 1275-1281
29 **Torun S**, Dolar E, Yilmaz Y, Keskin M, Kiyici M, Sinirtas M, Sarandol E, Gurel S, Nak SG, Gulten M. Evaluation of leukocyte esterase and nitrite strip tests to detect spontaneous bacterial peritonitis in cirrhotic patients. *World J Gastroenterol* 2007; **13**: 6027-6030
30 **Nobre SR**, Cabral JE, Sofia C, Leitão MC. Value of reagent strips in the rapid diagnosis of spontaneous bacterial peritonitis. *Hepatogastroenterology* 2008; **55**: 1020-1023
31 **de Araujo A**, de Barros Lopes A, Trucollo Michalczuk M, Stifft J, Nardelli E, Escobar G, Rossi G, Alvares-da-Silva MR. Is there yet any place for reagent strips in diagnosing spontaneous bacterial peritonitis in cirrhotic patients? An accuracy and cost-effectiveness study in Brazil. *J Gastroenterol Hepatol* 2008; **23**: 1895-1900
32 **Balagopal SK**, Sainu A, Thomas V. Evaluation of leucocyte esterase reagent strip test for the rapid bedside diagnosis of spontaneous bacterial peritonitis. *Indian J Gastroenterol* 2010; **29**: 74-77
33 **Castellote J**, Girbau A, Ariza X, Salord S, Vazquez X, Lobatón T, Rota R, Xiol X. Usefulness of reagent strips for checking cure in spontaneous bacterial peritonitis after short-course treatment. *Aliment Pharmacol Ther* 2010; **31**: 125-130
34 **Rerknimitr R**, Limmathurotsakul D, Bhokaisawan N, Kongkam P, Treeprasertsuk S, Kullavanijaya P. A comparison of diagnostic efficacies among different reagent strips and automated cell count in spontaneous bacterial peritonitis. *J Gastroenterol Hepatol* 2010; **25**: 946-950
35 **Gülberg V**, Gerbes AL, Sauerbruch T, Appenrodt B. Insufficient sensitivity of reagent strips for spontaneous bacterial peritonitis. *Hepatology* 2007; **46**: 1669; author reply 1669-1670
36 **Farmer AD**, Cook MJ, Bruckner Holt CE, Syn WK, Lewis MJ. Leucocyte esterase reagent strips for the diagnosis of spontaneous bacterial peritonitis: a systematic review by Koulaouzidis et al. *Eur J Gastroenterol Hepatol* 2009; **21**: 1102
37 **Delaunay-Tardy K**, Cottier M, Patouillard B, Audigier JC. [Early diagnosis of spontaneous bacterial peritonitis by Multistix® strips with spectrophotometric reading device: a poor sensitivity]. *Gastroenterol Clin Biol* 2003; **27**: A166
38 **Castellote J**, Xiol X. Reagent strips and spontaneous bacterial peritonitis. *Aliment Pharmacol Ther* 2008; **28**: 660; author reply 661
39 **Nousbaum JB**, Cadranel JF. [Are reagent strips useful for the diagnosis of spontaneous bacterial peritonitis?]. *Gastroenterol Clin Biol* 2006; **30**: 439-441
40 **Mendler MH**, Agarwal A, Trimzi M, Madrigal E, Tsushima M, Joo E, Santiago M, Flores E, David G, Workman A, Runyon B. A new highly sensitive point of care screen for spontaneous bacterial peritonitis using the leukocyte esterase method. *J Hepatol* 2010; **53**: 477-483
41 **Koulaouzidis A**, El-Ramli R, Gasem J, Saeed AA. Leukocyte esterase reagent strips for spontaneous bacterial peritonitis: what now? *Ann Hepatol* 2008; **7**: 255-256

S- Editor Sun H **L- Editor** Rutherford A **E- Editor** Ma WH