

RESEARCH ARTICLE

Open Access

Severe strongyloidiasis: a systematic review of case reports

Dora Buonfrate^{1*}, Ana Requena-Mendez², Andrea Angheben¹, Jose Muñoz², Federico Gobbi¹, Jef Van Den Ende³ and Zeno Bisoffi¹

Abstract

Background: Strongyloidiasis is commonly a clinically unapparent, chronic infection, but immuno suppressed subjects can develop fatal disease. We carried out a review of literature on hyperinfection syndrome (HS) and disseminated strongyloidiasis (DS), in order to describe the most challenging aspects of severe strongyloidiasis.

Methods: We conducted a structured search using PubMed to collect case reports and short case series on HS/DS published from 1991 to 2011. We restricted search to papers in English, Spanish, Italian and French. Case reports were classified as HS/DS according to given definitions.

Results: Records screened were 821, and 311 were excluded through titles and abstract evaluation. Of 510 full-text articles assessed for eligibility, 213 were included in qualitative analysis. As some of them were short case series, eventually the number of cases analyzed was 244.

Steroids represented the main trigger predisposing to HS and DS (67% cases): they were mostly administered to treat underlying conditions (e.g. lymphomas, rheumatic diseases). However, sometimes steroids were empirically prescribed to treat signs and symptoms caused by unsuspected/unrecognized strongyloidiasis. Diagnosis was obtained by microscopy examination in 100% cases, while serology was done in a few cases (6.5%). Only in 3/29 cases of solid organ/bone marrow transplantation there is mention of pre-transplant serological screening. Therapeutic regimens were different in terms of drugs selection and combination, administration route and duration. Similar fatality rate was observed between patients with DS (68.5%) and HS (60%).

Conclusions: Proper screening (which must include serology) is mandatory in high - risk patients, for instance candidates to immunosuppressive medications, currently or previously living in endemic countries. In some cases, presumptive treatment might be justified. Ivermectin is the gold standard for treatment, although the optimal dosage is not clearly defined in case of HS/DS.

Keywords: Strongyloidiasis, *Strongyloides*, Hyperinfection, Disseminated strongyloidiasis, Review

Background

Strongyloidiasis is a neglected condition caused by *Strongyloides stercoralis*, a soil – transmitted helminth mainly diffused in tropical and subtropical regions, but also present in small areas of low endemicity in temperate climates [1]. Most infected individuals are asymptomatic or may present intermittent symptoms, mostly affecting intestine (from mild abdominal pain, intermittent or persistent diarrhea to more severe conditions

that can mimic inflammatory bowel disease), lungs (cough, wheezing and asthma, chronic bronchitis) and skin (pruritus, rash). Systemic symptoms such as weight loss and cachexia may also occur [2]. Immune suppressed subjects tend to develop hyperinfection syndrome (HS) and disseminated strongyloidiasis (DS), that are potentially fatal [3]. Therefore, it is mandatory to diagnose and treat the chronic infection, in order to prevent the life-threatening form. Unfortunately, the index of suspicion of health care providers seems to be low, especially in non-endemic countries [4]. Moreover, there are still gaps in knowledge regarding many aspects of the infection, such as diagnosis and treatment response [2].

* Correspondence: dora.buonfrate@sacrocuore.it

¹Centre for Tropical Diseases (CTD), Sacro Cuore Hospital, Negrar, Verona, Italy

Full list of author information is available at the end of the article

Our aim was to systematically review case reports of severe strongyloidiasis, in order to outline the main features of hyperinfection and disseminated strongyloidiasis and the difficulties in their management.

Methods

We carried out a systematic review of case reports/short case series published in PubMed from January 1991 to April 2011. We considered papers available in the following languages: English, Spanish, Italian, French.

The electronic search strategy was as follows: disease (strongyl*, anguillulose) AND severity of cases (disseminat*, hyperinfect*, severe, death, fatal, mortality) OR disease (strongyl*, anguillulose) AND associated conditions (tumor*, cancer, haematolog*, lymphom*, leukem*, leukaem*, neoplas*, malignan*, HTLV*, HIV, AIDS, hypogammaglobulinemia, rheumat*, "biological agents", diabet*, transplant*, COPD, steroid*, glucocorticoid*, Immunosuppression [MeSH], Immunocompromised Host [MeSH]) and limiting the search to humans. Search was done on March 20th 2011.

Definitions used for case - inclusion [5]: - Dissemination: larvae found in any organ, other than the respiratory and the gastrointestinal tracts. Hyperinfection: infection confined to lungs and gastrointestinal tract, but signs/symptoms of severe diseases in relation to elevated

number of larvae; in particular, necessity of intensive care, presence of sepsis/meningitis by enteric bacteria, death (without any other clear underlying cause).

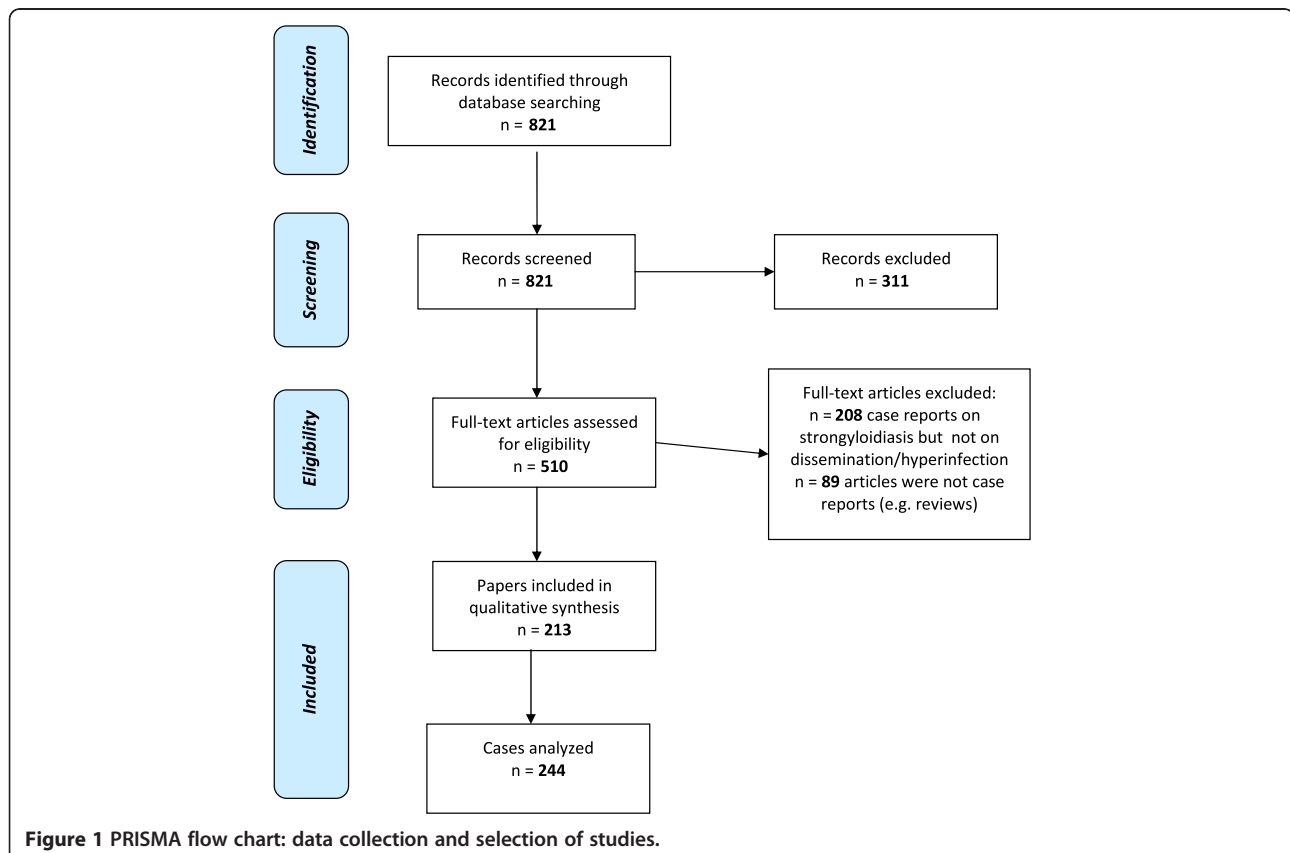
Results

Data synthesis

Our search strategy permitted to identify 821 papers, of which 311 were excluded by title and abstract evaluation. Full-text papers were then assessed for eligibility according to the criteria outlined above. Among the 213 papers included, some were small case series, eventually the number of cases analyzed was 244 (Figure 1).

Countries

Reports from highly endemic countries were 65/244 (27%), with India ([6–23]), Argentina ([24–28]), Brazil ([29–39]) and Peru ([40,41,42]) accounting for more than two thirds. Only four cases were reported from the whole of Africa [43–46], three of which in South Africa, a state where adequate diagnostic facilities are available. We collected 83/244 (34%) reports from North America (USA [47–109] and Canada [110–116]), 58/244 (24%) from Europe (Belgium [40,117], France [118–129], Germany [130,131], Greece [132–134], Italy [135–141], the Netherlands [142–145], Spain [146–155], Switzerland [156], UK [157–164]) and five (2%) from Oceania



(Australia [165–168] and New Zealand [169]). In these areas of low/no endemicity, half of the patients were immigrants (70/146, 48%), while a few subjects were veterans (5/146, 3%) who presumably acquired the infection during military service in an endemic country. Other areas of low endemicity where cases have been reported are in Eastern Asia (21 cases, mostly from Japan ([170–177]) and Taiwan ([178–182])), the Arabian peninsula (nine cases, mostly from Kuwait ([183,184]) and Qatar ([185,186])) and Israel ([187,188]) (three cases). Countries such as Iran ([189]), Turkey ([190]) and Venezuela ([191]) that might be presumed at medium to high prevalence, account for only one case each.

Triggers for development of HS/DS

According to the case definitions, 171 cases were classified as hyper infection and 73 cases as dissemination.

A high percentage of patients (67%: 164/244) were under corticosteroids: most of them presented clinical conditions causing immune suppression per-se or due to other related therapies (for instance leukemia, rheumatic conditions, transplant), as it is shown in Table 1. On the other hand, a few patients were taking steroids for eosinophilia and/or a specific symptoms caused by *S. stercoralis* itself (data reported in Table 1 too). A patient even underwent bone marrow transplant because of an unexplained eosinophilia misdiagnosed as “idiopathic hypereosinophilic syndrome” [81]; after receiving steroids and immunosuppressive therapy he developed HS (but only limited autopsy was performed, so we cannot rule out DS) and died.

Transplant is surely an event that poses the *Strongyloides* - infected patient at high risk of developing HS/DS. We collected 28/244 (11.5%) cases of HS/DS in transplant patients, of whom 19 (68%) died. A couple of patients

who developed hyper infection also had co infection with CMV [21,107]. All the surviving patients received ivermectin, either as single treatment (1 patient) or in combination with albendazole (7) or thiabendazole (1) [29,54,60,71,90,92,94,142,145,150].

HTLV-1 infection is a well known risk factor (sometimes in association with related haematological malignancies), of which we found 24/244 (10%) reports ([214,158,120,159,215,53,54,143,122,12,111,32,216,77,126,163,114,80,35,164,175,155,116]). Ten of the 24 patients (42%) died. One patient had HTLV-1-HIV co infection [122]; he developed an *E. coli* meningitis but successfully responded to ivermectin, two doses given some days (not specified how many) apart.

We found 38/244 (15%) reports on HIV-positive patients, 26 (68%) of whom died (Figure 2). Seven HIV patients were also receiving steroids for suspected *Pneumocystis jiroveci* pneumonia [24,26], immune reconstitution inflammatory syndrome [105], misdiagnosis of asthma [58], Wegener granulomatosis [36], toxoplasmosis encephalitis [36], cerebral TB with vasculitis [124]; six of them died.

A few reports/case series describe severe strongyloidiasis in patients with alcoholism [178,217] and malnutrition [27,171]. An apparently immunocompetent patient developed hyper infection and died two days after having started therapy with thiabendazole [149]. Unfortunately autopsy was denied.

Diagnosis

Eosinophilia was present in 55/244 cases (22.5%) overall, and only in 12/73 cases (16.4%) of dissemination. In all cases *S. stercoralis* was found at microscopy examination of biological samples. Serology was performed only in

Table 1 Patients under steroid treatment: reasons for prescription

Condition	N (%)	References
COPD/asthma/lung fibrosis	30 (18.3)	[48,49,52,57-59,68,99,101,118,121,123,128,137,146,153,180-183,185,187,188,192-196]
Leukemia/lymphoma	13 (7.9)	[9,17,23,25,37,47,56,98,111,126,162,186]
SLE	9 (5.5)	[41,64,66,86,151,176,197,198]
Rheumatoid arthritis	4 (2.4)	[83,103,199,200]
IBD	6 (3.6)	[59,147,148,164,177,201]
Sarcoidosis	2 (1.2)	[65,132]
Cancer	8 (4.8)	[30,54,93,97,112,160,169,202]
Organ/bone marrow transplant	25 (15.2)	[21,25,29,31,39,48,51,54,60,70,71,74,76,81,87,88,90,92,94,142,145,150,184]
Glomerulonephritis/CRI	6 (3.6)	[16,18,20,129,130,154]
“Idiopathic” eosinophilia	3 (1.8)	[7]
Multiple myeloma/myelodysplasia	6 (3.6)	[72,185,203-206]
Aspecific symptoms	2 (1.2)	[85,166]
Other clinical conditions	46 (28)	[17,22,34,36,54,59,66,84,89,100,102,110,113,124,125,127,133-135,140,155,159,171-174,207-213]
HIV-related opportunistic infections/IRIS	4 (2.4)	[24,26,36,105]

16/244 patients (6.5%) (Table 2). In a couple of organ transplant recipients, an ELISA test was negative pre-transplant, but resulted positive in the deceased donors (test performed retrospectively) [60,145]. In other two cases serology (ELISA) was negative: a HIV-infected person, who had larvae in stool and sputum [165] and a patient with dermatomyositis, under chronic treatment with prednisone and methotrexate, who died from disseminated strongyloidiasis (larvae found at autopsy in skin, lungs, small and large bowel, gall bladder, vessels of meninges and cervical spinal cord) [100].

Diagnosis was obtained post mortem in 29 cases (12%).

Therapy

Therapies given were very different in relation to the drugs used and the length of treatment.

In Table 3 we summarize the drugs used. In the “other drugs” group we found mebendazole [9,17,44,48,131,137,181,218], cambendazole [35,36], levamisole [43,199], pyrantel pamoate [75,108], diethylcarbamazine [14].

Albendazole was used as a single drug even in recent case reports; since 2008 we found patients treated with albendazole only in reports from Pakistan [203], Romania [217], Taiwan [182], Israel [187], Kuwait [184], Argentina [25], Malaysia [207], Greece [133], Thailand [208].

In most cases the administration route was oral, but due to severe clinical conditions of patients, administration via nasogastric tube, subcutaneous injection (veterinary formulation) and retention enema were used, too.

A patient who developed disseminated strongyloidiasis after an empiric steroid treatment for pruritic rash was treated with albendazole [166]. Only one dose could be given, as the patient died. After his death, a review of his clinical records showed that he had been previously diagnosed with strongyloidiasis and treated with a 3-day course of albendazole; although serology persisted positive and eosinophilia was still present 6 and 12 months

Table 2 Patients tested with serology: chronic conditions and corticosteroids therapy

Year	Chronic condition	Corticosteroids	Serology	Ref.
1991	polychondritis	Yes	positive	[89]
1994	COPD	Yes	positive	[57]
1996	HIV	No	negative	[165]
2001	none	Yes	positive	[166]
2004	bronchogenic carcinoma	Yes	positive	[160]
2004	none	Yes	positive	[183]
2005	multiple myeloma	Yes	positive	[72]
2005	multiple myeloma	Yes	positive	[204]
2005	nephrotic syndrome	No	positive	[204]
2007	nephrotic syndrome	Yes	positive	[139]
2008	none	Yes	positive	[144]
2008	asthma	Yes	positive	[101]
2009	heart transplant	Yes	negative	[145]
2009	lung transplant	Yes	positive	[92]
2010	dermatomyositis	Yes	negative	[100]
2011	renal transplant	Yes	negative	[60]

after treatment, the patient did not receive any further therapy. Another patient who died from *Strongyloides* hyper infection had never been treated previously, despite a positive serology [101].

Outcome

The recorded deaths were 153/244 (62.7%). A similar fatality rate was observed in patients with dissemination (50/73 = 68.5%) and with hyperinfection (102/171 = 60%).

All 42 of 244 patients who did not receive any therapy died. Excluding patients treated with combination therapy, we observe that 25/34 (73%) patients treated with albendazole died, while deaths among patients treated with ivermectin and thiabendazole were 18/38 (47%) and 28/55 (51%), respectively.

Discussion

Considering that a considerable number of case reports are described in non endemic countries, we assume that fatal cases must be quite frequent in endemic countries, although they are not frequently published in the literature.

The main risk factors identified in this review have been reported previously, in particular steroids are frequently the trigger for developing severe strongyloidiasis. Unfortunately it was not possible to extract from the case reports the cumulative dosage and the duration of the corticosteroids treatment. Although the association with steroids should be well known, there are still papers

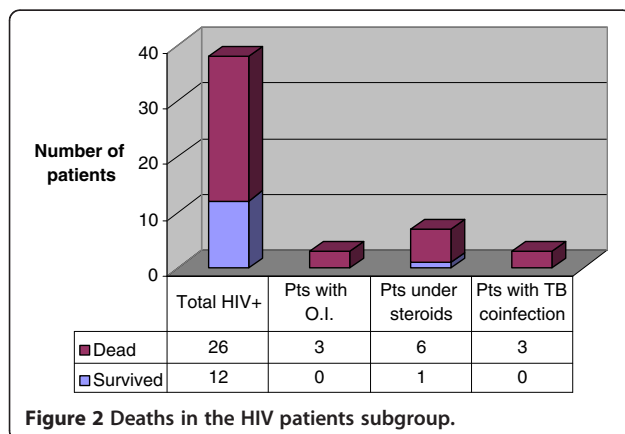


Table 3 Treatments

Drug	Albendazole	Ivermectin	Thiabendazole	Other drugs
Used as single treatment	34	38	55	6
Deaths among patients treated with single drug	25/34 (73%)	18/38 (47%)	28/55 (51%)	5/6 (83%)
Total of patients treated (including combination therapy)	48	79	60	14

reporting cases of patients under steroids who had not been previously screened for strongyloidiasis. Moreover, we found papers reporting severe strongyloidiasis in patients who were previously diagnosed with the infection but had not received a proper treatment. Once more, the lack of familiarity with strongyloidiasis by health care providers is the weak link in the chain; this is also highlighted by the fact that in 12% of cases the diagnosis was made post mortem. Eosinophil count is often normal in severe strongyloidiasis, hence this test has a limited excluding power.

Serology was not frequently performed. In fact, in case of hyperinfection and dissemination the diagnosis is easily made by direct examination of the biological samples. Serology would be most useful in chronic infections, before hyperinfection and/or dissemination occur, while in patients who are already immune suppressed its sensitivity is probably lower.

Limits in our results are due to incomplete information in the case descriptions. Moreover, cases in which autopsy was not performed sometimes couldn't allow a proper classification. Actually, in the 65 cases we classified as hyper infections, autopsy was not done, hence it is not possible to rule out dissemination. Moreover, we found the same fatality rate for patients with hyper infection and with dissemination, but a misclassification might have played a role. In fact, we think that from a clinical, practical point of view the distinction between hyper infection and dissemination is not essential, because they're both severe conditions requiring immediate assessment and care.

In general, the best drug to treat strongyloidiasis is ivermectin which is effective and well tolerated. There are still some concerns about the treatment schedule of the chronic infection, and this is even more debated in case of hyper infection/dissemination. In fact there are no specific guidelines and the case reports we collected outline a Babylon of different therapeutic schemes. Subcutaneous ivermectin (veterinary formulation) has been used on an empiric basis, when intestinal absorption is decreased or the patient cannot swallow tablets. On the other hand, albendazole is still used even as a single drug, although it has been proved to be poorly effective. In some cases, this might be due to the scarce availability of ivermectin in many countries.

Conclusions

The first step to be done to guarantee an adequate management of infected patients is to avoid a delayed diagnosis. Unfortunately, lack of familiarity with strongyloidiasis by health care providers still seems to be the main cause of delay. A better diffusion of the available information is badly needed, and collaboration among different specialists (oncologists, rheumatologists. . .) is desirable in order to provide common and adequate protocols for screening and treatment of at – risk patients.

It is mandatory to treat patients in the chronic phase, before HS/DS develop. Patients with possible, previous exposure to the parasite should be screened with serology before corticosteroid treatment, chemotherapy or transplant. Considering the high tolerability of ivermectin, it would be probably worth treating high – risk patients irrespective of the result of the screening test, in order to avoid the potential consequences of a possible false negative result.

Ivermectin is currently the gold standard for treatment of strongyloidiasis, so it is simply no more ethical to use any other drug. Moreover, ivermectin is in the WHO model lists of essential medicines [219], so it should be registered and made available everywhere, particularly in endemic countries.

Competing interests

The authors declare that they have no competing interests.

Authors' contributions

DB searched PubMed, analyzed the data and wrote the manuscript. ARM analyzed the data and critically reviewed the manuscript. AA created the search strategy and analyzed the data. JM, FG and JVDE gave intellectual content and critically reviewed the manuscript. ZB conceptualized the review and critically reviewed the manuscript. All authors read and approved the final manuscript.

Authors' information

Cohemi project study group: Maurizio Bonati, Francesca Severino, Valeria Confalonieri, Chiara Pandolfini, Zeno Bisoffi, Dora Buonfrate, Andrea Angheben, Marco Albonico, Alessandro Bartoloni, Marianne Strohmeyer, Lorenzo Zammarchi, Jose Muñoz, Robert Pool, Ana Requena-Mendez, Maria Roura, Anita Hardon, Christopher Pell, Peter Chiodini, Juan Moreira, Roberto Sempértegui, Mariella Anselmi, Eduardo Gotuzzo, Maria Alejandra Mena, Hector H. Garcia, Javier Bustos, Saul Santiva, Faustino Torrico, Daniel Lozano, Guido Chumiray Rojas, Teresa Hinojosa Cabrera, Javier Ochoa Morón, Ignacio Abapori Cuellar, Jaime Amorós Suarez, Gianni Tognoni, Alessandra Nicoletti, Elisa Bruno

Acknowledgements

This work has been supported by the EC within the 7th Framework Program under grant agreement FP7-GA-261495.

Author details

¹Centre for Tropical Diseases (CTD), Sacro Cuore Hospital, Negrar, Verona, Italy. ²Barcelona Centre for International Health Research (CRESIB) Hospital Clinic, Barcelona, Spain. ³Department of Clinical sciences, Institute of Tropical Medicine, Antwerp, Belgium.

Received: 29 May 2012 Accepted: 19 January 2013

Published: 8 February 2013

References

1. WHO: *Strongyloidiasis*. http://www.who.int/neglected_diseases/diseases/strongyloidiasis/en/.
2. Olsen A, Van Lieshout L, Marti H, Polderman T, Polman K, Steinmann P, Stothard R, Thybo S, Verweij JJ, Magnussen P: **Strongyloidiasis—the most neglected of the neglected tropical diseases? *Trans R Soc Trop Med Hyg* 2009, **103**(10):967–972.**
3. Marcos LA, Terashima A, Canales M, Gotuzzo E: **Update on Strongyloidiasis in the immunocompromised host. *Curr Infect Dis Rep* 2011, **13**:35–46.**
4. Boulware DR, Stauffer WM, Hendel-Paterson BR, Rocha JL, Seet RC, Sumner AP, Nield LS, Supparatpinyo K, Chaiwarith R, Walker PF: **Maltreatment of Strongyloides infection: case series and worldwide physicians-in-training survey. *Am J Med* 2007, **120**(6):545. e541–548.**
5. Keiser PB, Nutman TB: **Strongyloides stercoralis in the immunocompromised population. *Clin Microbiol Rev* 2004, **17**(1):208–217.**
6. Agrawal V, Agarwal T, Ghoshal UC: **Intestinal strongyloidiasis: a diagnosis frequently missed in the tropics. *Trans R Soc Trop Med Hyg* 2009, **103**(3):242–246.**
7. Ghosh K: **Strongyloides stercoralis septicaemia following steroid therapy for eosinophilia: report of three cases. *T Roy Soc Trop Med H* 2007, **101**(11):1163–1165.**
8. Das P, Raghu P, Amit Kumar D, Garg P: **Strongyloides hyperinfection in rheumatoid arthritis. *Int J Surg Pathol* 2007, **15**(4):391–392.**
9. Ghoshal UC, Saha J, Ghoshal U, Ray BK, Santra A, Naik S, Mazumder DN: **Pigmented nails and Strongyloides stercoralis infestation causing clinical worsening in a patient treated for immunoproliferative small intestinal disease: two unusual observations. *J Diarrhoeal Dis Res* 1999, **17**(1):43–45.**
10. Ghoshal UC, Ghoshal U, Jain M, Kumar A, Aggarwal R, Misra A, Ayyagari A, Naik SR: **Strongyloides stercoralis infestation associated with septicemia due to intestinal transmural migration of bacteria. *J Gastroenterol Hepatol* 2002, **17**(12):1331–1333.**
11. Ghoshal UC, Alexander G, Ghoshal U, Tripathi S, Krishnani N: **Strongyloides stercoralis infestation in a patient with severe ulcerative colitis. *Indian J Med Sci* 2006, **60**(3):106–110.**
12. Jayamani R, Joseph AJ, Chacko A: **Severe and treatment resistant strongyloidiasis—indicator of HTLV-I infection. *Trop Gastroenterol* 2007, **28**(4):176–177.**
13. Murali A, Rajendiran G, Ranganathan K, Shanthakumari S: **Disseminated infection with Strongyloides stercoralis in a diabetic patient. *Indian J Med Microbiol* 2010, **28**(4):407–408.**
14. Patil PL, Salkar HR, Ghodeswar SS, Gawande JP: **Parasites (filaria & strongyloides) in malignant pleural effusion. *Indian J Med Sci* 2005, **59**(10):455–456.**
15. Premanand R, Prasad GV, Mohan A, Gururajkumar A, Reddy MK: **Eosinophilic pleural effusion and presence of filariform larva of Strongyloides stercoralis in a patient with metastatic squamous cell carcinoma deposits in the pleura. *Indian J Chest Dis Allied Sci* 2003, **45**(2):121–124.**
16. Rajapurkar M, Hegde U, Rokhade M, Gang S, Gohel K: **Respiratory hyperinfection with Strongyloides stercoralis in a patient with renal failure. *Nat Clin Pract Nephrol* 2007, **3**(10):573–577.**
17. Reddy IS, Swarnalata G: **Fatal disseminated strongyloidiasis in patients on immunosuppressive therapy: report of two cases. *Indian J Dermatol Venereol Leprol* 2005, **71**(1):38–40.**
18. Sathe PA, Madiwale CV: **Strongyloidiasis hyperinfection in a patient with membranoproliferative glomerulonephritis. *J Postgrad Med* 2006, **52**(3):221–222.**
19. Satyanarayana S, Nema S, Kalghatgi AT, Mehta SR, Rai R, Duggal R, Bhardwaj JR: **Disseminated Strongyloides stercoralis in AIDS: a report from India. *Indian J Pathol Microbiol* 2005, **48**(4):472–474.**
20. Sekhar U, Madan M, Ranjitham M, Abraham G, Eapen G: **Strongyloides hyperinfection syndrome—an unappreciated opportunistic infection. *J Assoc Physicians India* 2000, **48**(10):1017–1019.**
21. Soman R, Vaideeswar P, Shah H, Almeida AF: **A 34-year-old renal transplant recipient with high-grade fever and progressive shortness of breath. *J Postgrad Med* 2002, **48**(3):191–196.**
22. Sreenivas DV, Kumar A, Kumar YR, Bharavi C, Sundaram C, Gayathri K: **Intestinal strongyloidiasis—a rare opportunistic infection. *Indian J Gastroenterol: J Indian Soc Gastroenterol* 1997, **16**(3):105–106.**
23. Vigg A, Mantri S, Reddy VA, Biyani V: **Acute respiratory distress syndrome due to Strongyloides stercoralis in non-Hodgkin's lymphoma. *Indian J Chest Dis Allied Sci* 2006, **48**(1):67–69.**
24. Bava AJ, Troncoso AR: **Strongyloides stercoralis hyperinfection in a patient with AIDS. *J Int Assoc Physicians AIDS Care (Chic)* 2009, **8**(4):235–238.**
25. Galimberti R, Ponton A, Zaputovich FA, Velasquez L, Galimberti G, Torre A, Kowalczyk A: **Disseminated strongyloidiasis in immunocompromised patients—report of three cases. *Int J Dermatol* 2009, **48**(9):975–978.**
26. Rivero FD, Kremer LE, Allende L, Casero RD: **[Strongyloides stercoralis and HIV: a case report of an indigenous disseminated infection from non-endemic area]. *Rev Argent Microbiol* 2006, **38**(3):137–139.**
27. Taranto NJ: **[Strongyloides stercoralis. Report of a case and review of the literature]. *Acta Gastroenterol Latinoam* 1995, **25**(2):113–120.**
28. Trione N, Corti M, Castello T, Abuin JC, Bellegarde E: **[Disseminated infection due to strongyloides stercoralis in AIDS patients. A report of 2 cases]. *Acta Gastroenterol Latinoam* 2001, **31**(5):399–402.**
29. Dullely FL, Costa S, Cosentino R, Gamba C, Saboya R: **Strongyloides stercoralis hyperinfection after allogeneic stem cell transplantation. *Bone Marrow Transplant* 2009, **43**(9):741–742.**
30. Salluh JJ, Feres GA, Velasco E, Holanda GS, Toscano L, Soares M: **Successful use of parenteral ivermectin in an immunosuppressed patient with disseminated strongyloidiasis and septic shock. *Intensive Care Med* 2005, **31**(9):1292.**
31. German JC, Flores JH, Chiesura G, Ruiz EM, Flores SS, Laudanna AA: **[Fatal strongyloidiasis in an immunodepressed patient following renal transplantation]. *Revista do Hospital das Clinicas* 1992, **47**(1):31–33.**
32. Lambertucci JR, Leao FC, Barbosa AJ: **Gastric strongyloidiasis and infection by the human T cell lymphotropic virus type 1 (HTLV-1). *Rev Soc Bras Med Trop* 2003, **36**(4):541–542.**
33. Lambertucci JR, Westin MR, Barbosa AJ: **Severe gastrointestinal strongyloidiasis. *Rev Soc Bras Med Trop* 2005, **38**(4):365–366.**
34. Rodrigues MA, Froes RC, Anefalos A, Kobayasi S: **Invasive enteritis by Strongyloides stercoralis presenting as acute abdominal distress under corticosteroid therapy. *Revista do Hospital das Clinicas* 2001, **56**(4):103–106.**
35. Porto MA, Alcantara LM, Leal M, Castro N, Carvalho EM: **Atypical clinical presentation of strongyloidiasis in a patient co-infected with human T cell lymphotropic virus type I. *Am J Trop Med H* 2005, **72**(2):124–125.**
36. Siciliano RF, Mascheretti M, Ho YL, Gryscek RC: **Severe strongyloidiasis in AIDS: is steroid therapy guilty again? *J Acquir Immune Defic Syndr* 2008, **49**(3):333–334.**
37. Tabacof J, Feher O, Katz A, Simon SD, Gansl RC: **Strongyloides hyperinfection in two patients with lymphoma, purulent meningitis, and sepsis. *Cancer* 1991, **68**(8):1821–1823.**
38. Takayanagui OM, Lofrano MM, Araugo MB, Chimelli L: **Detection of Strongyloides stercoralis in the cerebrospinal fluid of a patient with acquired immunodeficiency syndrome. *Neurology* 1995, **45**(1):193–194.**
39. Vilela EG, Clemente WT, Mira RR, Torres HO, Veloso LF, Fonseca LP, De Carvalho EFLR, Franca MC, Lima AS: **Strongyloides stercoralis hyperinfection syndrome after liver transplantation: case report and literature review. *Transplant Inf Dis: J Transplant Soc* 2009, **11**(2):132–136.**
40. De Goede E, Martens M, Van Rooy S, VanMoerkerke I: **A case of systemic strongyloidiasis in an ex-coal miner with idiopathic colitis. *European J Gastroenterol Hepatol* 1995, **7**(8):807–809.**
41. Mora CS, Segami MI, Hidalgo JA: **Strongyloides stercoralis hyperinfection in systemic lupus erythematosus and the antiphospholipid syndrome. *Semin Arthritis Rheu* 2006, **36**(3):135–143.**

42. Zavala J, Sanchez L, Carillo L, Cueva A, Balbin G, Quispe V: [Atypical presentations of strongyloidiasis: a report of 8 cases]. *Rev Gastroenterol Peru* 1994, **14**(1):15–21.
43. Adetiloye VA: A case of fatal gastrointestinal strongyloidiasis in an otherwise healthy Nigerian, masquerading as gastric outlet obstruction. *Trop Geogr Med* 1992, **44**(1–2):60–62.
44. Coovadia YM, Rajput MC, Bhana RH: Disseminated strongyloidiasis in a diabetic patient. *Trop Geogr Med* 1993, **45**(4):179–180.
45. Daubenton JD, Buys HA, Hartley PS: Disseminated strongyloidiasis in a child with lymphoblastic lymphoma. *J Pediatr Hematol Oncol: Am Soc Pediatr Hematol Oncol* 1998, **20**(3):260–263.
46. Haddow LJ, Mahlakwane MS, Ramdial PK, Moosa MY: Histopathology of Strongyloides stercoralis hyperinfection during immune reconstitution in an HIV-infected patient. *AIDS* 2009, **23**(12):1609–1611.
47. Jamil SA, Hilton E: The Strongyloides hyperinfection syndrome. *New York State J* 1992, **92**(2):67–68.
48. Purvis RS, Beightler EL, Diven DG, Sanchez RL, Tyring SK: Strongyloides hyperinfection presenting with petechiae and purpura. *Nt J Dermatol* 1992, **31**(3):169–171.
49. Boken DJ, Leoni PA, Preheim LC: Treatment of Strongyloides stercoralis hyperinfection syndrome with thiabendazole administered per rectum. *Clin Infect Dis: Infect Dis Soc Am* 1993, **16**(1):123–126.
50. Celedon JC, Mathur-Wagh U, Fox J, Garcia R, Wiest PM: Systemic strongyloidiasis in patients infected with the human immunodeficiency virus. A report of 3 cases and review of the literature. *Medicine* 1994, **73**(5):256–263.
51. El Masry HZ, O'Donnell J: Fatal strongyloides hyperinfection in heart transplantation. *J Heart Lung Transpl: Int Soc Heart Transpl* 2005, **24**(11):1980–1983.
52. Foreman EB, Abraham PJ, Garland JL: Not your typical strongyloides infection: a literature review and case study. *South Med J* 2006, **99**(8):847–852.
53. Friedenber F, Wongpraparut N, Fischer RA, Gubernick J, Zaeri N, Eiger G, Ozden Z: Duodenal obstruction caused by Strongyloides stercoralis enteritis in an HTLV-1-infected host. *Digest Dis Sci* 1999, **44**(6):1184–1188.
54. Fusco DN, Downs JA, Satlin MJ, Pahuja M, Ramos L, Barie PS, Fleckenstein L, Murray HW: Non-oral treatment with ivermectin for disseminated strongyloidiasis. *Am J Trop Med Hyg* 2010, **83**(4):879–883.
55. Nomura J, Rekrut K: Strongyloides stercoralis hyperinfection syndrome in a patient with AIDS: diagnosis by fluorescent microscopy. *Clin inf dis: Inf Dis Soc Am* 1996, **22**(4):736.
56. Goldman DE, Grier JF, Ball BE, Abreo F, Abreo KD: A 72-year-old woman with non-Hodgkin's lymphoma, dyspnea, vomiting, diarrhea, and eosinophilia. *J La State Med Soc: Louisiana State Med Soc* 1995, **147**(6):243–250.
57. Gordon SM, Gal AA, Solomon AR, Bryan JA: Disseminated strongyloidiasis with cutaneous manifestations in an immunocompromised host. *J Am Acad Dermatol* 1994, **31**(2 Pt 1):255–259.
58. Gulick RM: Reappearance of a remotely acquired infection. *AIDS Clin Care* 1997, **9**(9):70.
59. Gutierrez Y, Bhatia P, Garbadawala ST, Dobson JR, Wallace TM, Carey TE: Strongyloides stercoralis eosinophilic granulomatous enterocolitis. *Am J Surg Pathol* 1996, **20**(5):603–612.
60. Hamilton KW, Abt PL, Rosenbach MA, Bleicher MB, Levine MS, Mehta J, Montgomery SP, Hasz RD, Bono BR, Tetzlaff MT, et al: Donor-derived Strongyloides stercoralis infections in renal transplant recipients. *Transplantation* 2011, **91**(9):1019–1024.
61. Hong IS, Zaidi SY, McEvoy P, Neafie RC: Diagnosis of Strongyloides stercoralis in a peritoneal effusion from an HIV-seropositive man. A case report. *Acta Cytol* 2004, **48**(2):211–214.
62. Jain AK, Agarwal SK, El-Sadr W: Streptococcus bovis bacteremia and meningitis associated with Strongyloides stercoralis colitis in a patient infected with human immunodeficiency virus. *Clin inf dis: Inf Dis Soc Am* 1994, **18**(2):253–254.
63. Kao D, Murakawa GJ, Kerschmann R, Berger T: Disseminated strongyloidiasis in a patient with acquired immunodeficiency syndrome. *Arch Dermatol* 1996, **132**(8):977–978.
64. Kothary NN, Muskie JM, Mathur SC: Strongyloides stercoralis hyperinfection. *Radiographics: Radiological Soc North Am Inc* 1999, **19**(4):1077–1081.
65. Lambroza A, Dannenberg AJ: Eosinophilic ascites due to hyperinfection with Strongyloides stercoralis. *Am J Gastroenterol* 1991, **86**(1):89–91.
66. Lemos LB, Qu Z, Laucirica R, Fred HL: Hyperinfection syndrome in strongyloidiasis: report of two cases. *Ann Diagn Pathol* 2003, **7**(2):87–94.
67. Lin AL, Kessimian N, Benditt JO: Restrictive pulmonary disease due to interlobular septal fibrosis associated with disseminated infection by Strongyloides stercoralis. *Am J Respir Crit Care Med* 1995, **151**(1):205–209.
68. Link K, Orenstein R: Bacterial complications of strongyloidiasis: Streptococcus bovis meningitis. *South Med J* 1999, **92**(7):728–731.
69. Malhotra A, Kochar T, Rangasetty UC: A perfect host. *Intern Med J* 2008, **38**(11):869–870.
70. Schaeffer MW, Buell JF, Gupta M, Conway GD, Akhter SA, Wagoner LE: Strongyloides hyperinfection syndrome after heart transplantation: case report and review of the literature. *J Heart Lung Transpl: Int Soc Heart Transpl* 2004, **23**(7):905–911.
71. Tarr PE, Miele PS, Peregoy KS, Smith MA, Neva FA, Lucey DR: Case report: Rectal administration of ivermectin to a patient with Strongyloides hyperinfection syndrome. *Am J Trop Med Hyg* 2003, **68**(4):453–455.
72. Martyr FM, Lowry CM, Rodriguez M, Milner DA, Pieciak WS, Sinha A, Fleckenstein L, Baden LR: Treatment of human disseminated strongyloidiasis with a parenteral veterinary formulation of ivermectin. *Clin Inf Dis: Inf Dis Soc Am* 2005, **41**(1):e5–e8.
73. Miller MA, Church LW, Salgado CD: Strongyloides hyperinfection: a treatment dilemma. *Am J Med Sci* 2008, **336**(4):358–361.
74. Mizuno S, Iida T, Zendejas I, Martin TD, Schain DC, Turner B, Fujita S: Strongyloides hyperinfection syndrome following simultaneous heart and kidney transplantation. *Transplant Int: J European Soc Organ Transplant* 2009, **22**(2):251–253.
75. Morgello S, Soifer FM, Lin CS, Wolfe DE: Central nervous system Strongyloides stercoralis in acquired immunodeficiency syndrome: a report of two cases and review of the literature. *Acta Neuropathol* 1993, **86**(3):285–288.
76. Morrell MR, Dallas J, Kollef MH: A 50-year-old woman with abdominal pain and respiratory failure 3 months after kidney transplantation. *Chest* 2008, **134**(2):442–446.
77. Newton RC, Limpuangthip P, Greenberg S, Gam A, Neva FA: Strongyloides stercoralis hyperinfection in a carrier of HTLV-I virus with evidence of selective immunosuppression. *Am J Med* 1992, **92**(2):202–208.
78. Gupta S, Jain A, Fanning TV, Couriel DR, Jimenez CA, Eapen GA: An unusual cause of alveolar hemorrhage post hematopoietic stem cell transplantation: a case report. *BMC Cancer* 2006, **6**:87.
79. Perazella MA, Sadigh M: Acute nonspecific illness in an AIDS patient with dysphagia. *Hosp Pract (Off Ed)* 1994, **29**(11):39. 43, 47.
80. Phelps KR, Ginsberg SS, Cunningham AW, Tschachler E, Dosik H: Case report: adult T-cell leukemia/lymphoma associated with recurrent strongyloides hyperinfection. *Am J Med Sci* 1991, **302**(4):224–228.
81. Qazilbash MH, Ueno NT, Hosing C, De Lima M, Cortes J, Massaro A, Rivera Z, Deavers M, Adachi JA, Champlin RE: Strongyloidiasis after unrelated nonmyeloablative allogeneic stem cell transplantation. *Bone Marrow Transplant* 2006, **38**(5):393–394.
82. Purvis RS, Beightler EL, Diven DG, Sanchez RL, Tyring SK: Strongyloides stercoralis hyperinfection. *Int J Dermatol* 1992, **31**(3):160–164.
83. Krishnamurthy R, Dincer HE, Whittemore D: Strongyloides stercoralis hyperinfection in a patient with rheumatoid arthritis after anti-TNF-alpha therapy. *J Clin Rheumatology: Rheumatic & musculoskeletal dis* 2007, **13**(3):150–152.
84. Reddy TS, Myers JW: Syndrome of inappropriate secretion of antidiuretic hormone and nonpalpable purpura in a woman with Strongyloides stercoralis hyperinfection. *Am Journal Med Sci* 2003, **325**(5):288–291.
85. Gorman SR, Craven DE: Images in clinical medicine. Strongyloides stercoralis hyperinfection. *New England J Med* 2008, **359**(11):e12.
86. Reiman S, Fisher R, Dodds C, Trinh C, Laucirica R, Whigham CJ: Mesenteric arteriographic findings in a patient with strongyloides stercoralis hyperinfection. *JVIR* 2002, **13**(6):635–638.
87. Roxby AC, Gottlieb GS, Limaye AP: Strongyloidiasis in transplant patients. *Clin Inf Dis: Inf Dis So Am* 2009, **49**(9):1411–1423.
88. Patel G, Arvelakis A, Sauter BV, Gondoless GE, Caplivski D, Huprikar S: Strongyloides hyperinfection syndrome after intestinal transplantation. *Transpl Int Dis: J Transplant Soc* 2008, **10**(2):137–141.
89. Schindzielorz A, Ederberg SC, Bia FJ: Strongyloides stercoralis hyperinfection and central nervous system involvement in a patient with relapsing polyorchiditis. *Southern Med J* 1991, **84**(8):1055–1057.

90. Lichtenberger P, Rosa-Cunha I, Morris M, Nishida S, Akpinar E, Gaitan J, Tzakis A, Doblecki-Lewis S: **Hyperinfection strongyloidiasis in a liver transplant recipient treated with parenteral ivermectin.** *Transplant Inf Disease: J Transplant SocS* 2009, **11**(2):137–142.
91. Agarwal VK, Khurana HS, Le HX, Mathisen G, Kamangar N: **30-year-old HIV-positive female with diffuse alveolar hemorrhage.** *J Int Care Med* 2009, **24**(3):200–204.
92. Balagopal A, Mills L, Shah A, Subramanian A: **Detection and treatment of Strongyloides hyperinfection syndrome following lung transplantation.** *Transplant Inf Dis: J Transplant Soc* 2009, **11**(2):149–154.
93. Simpson WG, Gerhardstein DC, Thompson JR: **Disseminated Strongyloides stercoralis infection.** *Southern Med J* 1993, **86**(7):821–825.
94. Huston JM, Eachempati SR, Rodney JR, Cayci C, Fusco D, Mathew M, Shou J, Goldstein MJ, Kapur S, Barie PS: **Treatment of Strongyloides stercoralis hyperinfection-associated septic shock and acute respiratory distress syndrome with drotrecogin alfa (activated) in a renal transplant recipient.** *Transplant Inf Dis: J Transplant Soc* 2009, **11**(3):277–280.
95. Khasawneh F, Sreedhar R, Chundi V: **Strongyloides hyperinfection: an unusual cause of respiratory failure.** *Ann Intern Med* 2009, **150**(8):570–571.
96. Thompson JR, Berger R: **Fatal adult respiratory distress syndrome following successful treatment of pulmonary strongyloidiasis.** *Chest* 1991, **99**(3):772–774.
97. Aregawi D, Lopez D, Wick M, Scheld WM, Schiff D: **Disseminated strongyloidiasis complicating glioblastoma therapy: a case report.** *J Neurooncol* 2009, **94**(3):439–443.
98. Apewokun S, Steciuk M, Griffin S, Jhala D: **Strongyloides hyperinfection diagnosed by bronchoalveolar lavage in an immunocompromised host.** *Cytopathology: Journal of the British Soc Clin Cytol* 2010, **21**(5):345–347.
99. Upadhyay D, Corbridge T, Jain M, Shah R: **Pulmonary hyperinfection syndrome with Strongyloides stercoralis.** *Am J Med* 2001, **111**(2):167–169.
100. Basile A, Simzar S, Bentow J, Antelo F, Shitabata P, Peng SK, Craft N: **Disseminated Strongyloides stercoralis: hyperinfection during medical immunosuppression.** *J Am Acad Dermatol* 2010, **63**(5):896–902.
101. Vadlamudi RS, Van Dort M, Barklow T, Byrd RP Jr, Moorman JP: **Strongyloides hyperinfection syndrome complicating (ectopic) Cushing syndrome.** *Southern Med J* 2008, **101**(7):750–752.
102. Wang BY, Krishnan S, Isenberg HD: **Mortality associated with concurrent strongyloidosis and cytomegalovirus infection in a patient on steroid therapy.** *Mount Sinai J Med New York* 1999, **66**(2):128–132.
103. Williams BT, Guerry-Force ML: **Disseminated strongyloidiasis in a World War II Veteran with metastatic undifferentiated carcinoma of neuroendocrine type.** *Southern Med J* 1992, **85**(10):1023–1026.
104. Wirk B, Wingard JR: **Strongyloides stercoralis hyperinfection in hematopoietic stem cell transplantation.** *Transplant Inf Dis: J Transplant Soc* 2009, **11**(2):143–148.
105. Grein JD, Mathisen GE, Donovan S, Fleckenstein L: **Serum ivermectin levels after enteral and subcutaneous administration for Strongyloides hyperinfection: a case report.** *Scandinavian J Inf Dis* 2010, **42**(3):234–236.
106. Martin SJ, Cohen PR, MacFarlane DF, Grossman ME: **Cutaneous manifestations of Strongyloides stercoralis hyperinfection in an HIV-seropositive patient.** *Skinmed* 2011, **9**(3):199–202.
107. Weiser JA, Scully BE, Bulman WA, Husain S, Grossman ME: **Periumbilical parasitic thumbprint purpura: strongyloides hyperinfection syndrome acquired from a cadaveric renal transplant.** *Transplant Inf Dis: J Transplant Soc* 2011, **13**(1):58–62.
108. Lessnau KD, Can S, Talavera W: **Disseminated Strongyloides stercoralis in human immunodeficiency virus-infected patients. Treatment failure and a review of the literature.** *Chest* 1993, **104**(1):119–122.
109. Ali HA, Walkenstein M: **Bilateral nodular pulmonary infiltrates in an immunocompromised host.** *Thorax* 2008, **63**(8):746–753.
110. Hughes R, McGuire G: **Delayed diagnosis of disseminated strongyloidiasis.** *Intensive Care Med* 2001, **27**(1):310–312.
111. Lagace-Wiens PR, Harding GK: **A Canadian immigrant with coinfection of Strongyloides stercoralis and human T-lymphotropic virus 1.** *CMAJ* 2007, **177**(5):451–453.
112. Leung V, Al-Rawahi GN, Grant J, Fleckenstein L, Bowie W: **Case report: failure of subcutaneous ivermectin in treating Strongyloides hyperinfection.** *Am J Trop Med Hyg* 2008, **79**(6):853–855.
113. Lim S, Katz K, Krajden S, Fuksa M, Keystone JS, Kain KC: **Complicated and fatal Strongyloides infection in Canadians: risk factors, diagnosis and management.** *CMAJ* 2004, **171**(5):479–484.
114. Peters L, McCarthy AE, Faught C: **Secondary Strongyloides stercoralis prophylaxis in patients with human T-cell lymphotropic virus type 1 infection: report of two cases.** *IID: Int Soc Inf Dis* 2009, **13**(6):e501–e503.
115. Rawat B, Simons ME: **Strongyloides stercoralis hyperinfection. Another cause of focal hepatic lesions.** *Clin Imaging* 1993, **17**(4):274–275.
116. Turner SA, Maclean JD, Fleckenstein L, Greenaway C: **Parenteral administration of ivermectin in a patient with disseminated strongyloidiasis.** *Am J Trop Med Hyg* 2005, **73**(5):911–914.
117. Vandebosch S, Mana F, Goossens A, Urbain D: **Strongyloides Stercoralis infection associated with repetitive bacterial meningitis and SIADH: a case report.** *Acta gastro-enterologica Belgica* 2008, **71**(4):413–417.
118. Collet F, Favory R, Augusto D, Moukassa D, Dutoit E, Mathieu D: **[Massive haemoptysis associated with pulmonary Strongyloides stercoralis hyperinfection].** *Rev Mal Respir* 2005, **22**(5 Pt 1):815–818.
119. Couprie R, Maslo C, Bouchaud O, Matheron S, Saimot AG, Coulaud JP: **[Disseminated anguilluliasis in HIV infection. A new case].** *Presse Med* 1993, **22**(20):968.
120. Daoudal P, Ribier G, Numeric P, Desbois N, Ramialison C: **[Disseminated strongyloidiasis, a rare cause of multiple organ failure].** *Presse Med* 2002, **31**(26):1216–1217.
121. Gloro R, Ollivier-Hourmand I, Morin-Fatome A, Rousselot P, Le Moel G, Dao T: **[Disseminated strongyloidiasis associated with pulmonary fibrosis and gastrointestinal bleeding].** *Gastroenterol Clin Biol* 2004, **28**(12):1287–1290.
122. Hovette P, Tuan JF, Camara P, Lejean Y, Lo N, Colbacchini P: **[Pulmonary strongyloidiasis complicated by E. coli meningitis in a HIV-1 and HTLV-1 positive patient].** *Presse Med* 2002, **31**(22):1021–1023.
123. Marsan C, Marais MH, Sollet JP, Le Turdu F, Guerin PH, Garcia R, Bleichner G: **Disseminated strongyloidiasis: a case report.** *Cytopathology: J British Soc Clin Cytol* 1993, **4**(2):123–126.
124. Mattioni S, Valin N, Cracco C, Thellier M, Danis M, Caumes E: **Fatal relapse of disseminated strongyloidiasis in an HIV-positive patient, despite ivermectin treatment.** *Ann Trop Med Parasitol* 2008, **102**(8):693–698.
125. Mejia JH, Denis M, Leleu G, Roux P, Mayaud C, Akoun G: **[Acute respiratory insufficiency caused by hyperinfection with strongyloides. BALF diagnosis and favourable outcome].** *Rev Pneumol Clin* 1992, **48**(2):75–78.
126. Pacanowski J, Santos MD, Roux A, LEM C, Guillot J, Lavarde V, Cornet M: **Subcutaneous ivermectin as a safe salvage therapy in Strongyloides stercoralis hyperinfection syndrome: a case report.** *Am J Trop Med Hyg* 2005, **73**(1):122–124.
127. Pinatelle P, De Monbrison F, Bedock B: **[Disseminated strongyloidiasis with parasitemia in a patient under corticosteroid-treatment].** *Med Mal Infect* 2009, **39**(4):267–269.
128. Quinio D, Moalic E, Masure O, Renault A, Le Flohic AM: **[Pulmonary manifestations of malignant strongyloidiasis].** *Rev Mal Respir* 2002, **19**(2 Pt 1):265–266.
129. Said S, Nevez G, Moriniere P, Fournier A, Raccurt CP: **[Hemodialysis and strongyloidiasis: a presumed cause of eosinophilia able to mask the other].** *Nephrologie* 1999, **20**(6):343–346.
130. Hauber HP, Galle J, Chiodini PL, Rupp J, Birke R, Vollmer E, Zabel P, Lange C: **Fatal outcome of a hyperinfection syndrome despite successful eradication of Strongyloides with subcutaneous ivermectin.** *Infection* 2005, **33**(5–6):383–386.
131. Steiner B, Riebold D, Wolff D, Freund M, Reisinger EC: **Strongyloides stercoralis eggs in a urethral smear after bone marrow transplantation.** *Clin Inf Dis: Inf Dis Soc Am* 2002, **34**(9):1280–1281.
132. Almasidou D, Maniatis M, Vassiou K, Damani E, Vakalis N, Fesoulidis I, Gourgoulis K: **Strongyloides hyperinfection in a patient with sarcoidosis.** *Respirology* 2003, **8**(1):105–106.
133. Bamias G, Toskas A, Psychogiou M, Delladetsima I, Siakavellas SI, Dimarogona K, Daikos GL: **Strongyloides hyperinfection syndrome presenting as enterococcal meningitis in a low-endemicity area.** *Virulence* 2010, **1**(5):468–470.
134. Kosmadakis G, Georgoulis C, Filiopoulos V, Stefanou I, Smirloglou D, Michail S: **Lethal Strongyloides stercoralis superinfection in an immunocompromised patient.** *Ren Fail* 2010, **32**(6):750–752.
135. Casati A, Cornero G, Muttini S, Tresoldi M, Gallioli G, Torri G: **Hyperacute pneumonitis in a patient with overwhelming Strongyloides stercoralis infection.** *Eur J Anaesthesiol* 1996, **13**(5):498–501.
136. Gulletta M, Chatel G, Pavia M, Signorini L, Tebaldi A, Bombana E, Carosi G: **AIDS and strongyloidiasis.** *Int J STD AIDS* 1998, **9**(7):427–429.

137. Mariotta S, Pallone G, Li Bianchi E, Gilardi G, Bisetti A: **Strongyloides stercoralis hyperinfection in a case of idiopathic pulmonary fibrosis.** *Panminerva Med* 1996, **38**(1):45–47.
138. Pampiglione S, Pampiglione E, Di Stefano MA: [Strongyloides stercoralis hyperinfection with encephalitis manifestations]. *Pathologica* 1993, **85**(1096):195–204.
139. Rotolo U, Scarlata F, Giordano S, Tortorici C, Bono L, Cogliatore M, Faraci C, Infurnari L, Rubino R, Romano A: [Nephrotic syndrome and Gram-negative sepsis in a patient with strongyloidiasis: a case report]. *Le infezioni in medicina: rivista periodica di eziologia, epidemiologia, diagnostica, clinica e terapia delle patologie infettive* 2007, **15**(1):59–62.
140. Sidoni A, Polidori GA, Alberti PF, Scionti L: **Fatal Strongyloides stercoralis hyperinfection diagnosed by Papanicolaou-stained sputum smears.** *Pathologica* 1994, **86**(1):87–90.
141. Lanzafame M, Faggian F, Lattuada E, Antolini D, Vento S: **Strongyloidiasis in an HIV-1-infected patient after highly active antiretroviral therapy-induced immune restoration.** *J Infect Dis* 2005, **191**(6):1027.
142. Brügemann J, Kampinga GA, Riezebos-Brilman A, Stek CJ, Edel JP, van der Bij W, Sprenger HG, Zijlstra F: **Two donor-related infections in a heart transplant recipient: one common, the other a tropical surprise.** *J Heart Lung Transplant: Int Soc Heart Transplant* 2010, **29**(12):1433–1437.
143. Grijnsen M, van den Berk G, Hoekstra E, Terpstra W, Veldman S, Jansen J: **Intestinal strongyloidiasis as a presenting symptom of HTLV-1-associated adult T-cell leukemia/lymphoma.** *Endoscopy* 2009, **41**(Suppl 2):E271–E272.
144. Janssen R, Vlamincx BJ, Seldenrijk CA, Voorn GP, Grutters JC: **Strongyloides stercoralis hyperinfection mimicking accelerated form of idiopathic pulmonary fibrosis.** *Lancet Inf Dis* 2008, **8**(7):456.
145. Van Hattem S, Schuttelaar ML: **Disseminated strongyloidiasis caused by heart donor-to-host transmission presenting with purpura.** *Clin Exp Dermatol* 2010, **35**(4):e149–e150.
146. Gomez J, Plaza V, Munoz C, Franquet T: [Hyperinfection by Strongyloides stercoralis and other pathogens in a patient with chronic obstructive airways disease]. *Medicina clinica* 1997, **109**(15):609.
147. Llagunes J, Mateo E, Pena JJ, Carmona P, De Andres J: [Hyperinfection caused by Strongyloides stercoralis]. *Medicina intensiva/Sociedad Espanola de Medicina Intensiva y Unidades Coronarias* 2010, **34**(5):353–356.
148. Lopez Gallardo A, Diez Garcia F, Yelamos F, Orozco F: [Hyperinfection by Strongyloides stercoralis in a patient with ulcerative colitis]. *Enferm Infecc Microbiol Clin* 1997, **15**(5):273.
149. Mayayo E, Gomez-Aracil V, Azua-Blanco J, Azua-Romeo J, Capilla J, Mayayo R: **Strongyloides stercoralis infection mimicking a malignant tumour in a non-immunocompromised patient. Diagnosis by bronchoalveolar cytology.** *J Clin Pathol* 2005, **58**(4):420–422.
150. Rodriguez-Hernandez MJ, Ruiz-Perez-Pipaon M, Canas E, Bernal C, Gavilan F: **Strongyloides stercoralis hyperinfection transmitted by liver allograft in a transplant recipient.** *Am J Transplant: J Am Soc Transplant Am Soc Transplant Sur* 2009, **9**(11):2637–2640.
151. Rojo-Marcos G, Cuadros-Gonzalez J, Gonzalez-Juarez MJ, Gomez-Ayerbe C: [Strongyloides stercoralis hyperinfection syndrome in a Colombian patient receiving immunosuppressive treatment]. *Enferm Infecc Microbiol Clin* 2009, **27**(7):432–434.
152. Sauca Subias G, Barrufet Barque P, Besa Beringues A, Rodriguez Ramos E: [Strongyloides stercoralis hyperinfection in a patient with acquired immunodeficiency syndrome]. *An Med Interna* 2005, **22**(3):139–141.
153. Tirado MD, Gil M, Galiano J, Pardo F, Moreno R, Del Busto AG, Sabater S, Gomila B: [Respiratory and renal insufficiency in a COPD patient receiving corticoid treatment]. *Enferm Infecc Microbiol Clin* 2002, **20**(8):401–402.
154. Tornero C, Galan A, Garrigos E, Ramos JA, Pastor A: [Hyperinfection by S. stercoralis: membranous glomerulonephritis, double bacteremia and petechiae exanthema]. *Enferm Infecc Microbiol Clin* 1998, **16**(10):495–496.
155. Troncoso Garcia E, Munoz Medina L, Callejas Rubio JL, Lopez Ruz MA: [Klebsiella pneumoniae meningitis, Strongyloides stercoralis infection and HTLV-1]. *Medicina clinica* 2000, **115**(4):158.
156. Pusztaszeri M, Bouzourene H: [Intestinal and disseminated strongyloidosis: two case studies]. *Ann Pathol* 2005, **25**(4):322–326.
157. Brown M, Cartledge JD, Miller RF: **Dissemination of Strongyloides stercoralis as an immune restoration phenomenon in an HIV-1-infected man on antiretroviral therapy.** *Int J STD AIDS* 2006, **17**(8):560–561.
158. Chiodini PL, Reid AJ, Wiselka MJ, Firmin R, Foweraker J: **Parenteral ivermectin in Strongyloides hyperinfection.** *Lancet* 2000, **355**(9197):43–44.
159. Feely NM, Waghorn DJ, Dexter T, Gallen I, Chiodini P: **Strongyloides stercoralis hyperinfection: difficulties in diagnosis and treatment.** *Anaesthesia* 2010, **65**(3):298–301.
160. Gill GV, Beeching NJ, Khoo S, Bailey JW, Partridge S, Blundell JW, Luksza AR: **A British Second World War veteran with disseminated strongyloidiasis.** *T Roy Soc Trop Med H* 2004, **98**(6):382–386.
161. Harcourt-Webster JN, Scaravilli F, Darwish AH: **Strongyloides stercoralis hyperinfection in an HIV positive patient.** *J Clin Pathol* 1991, **44**(4):346–348.
162. Orlent H, Crawley C, Cwynarski K, Dina R, Apperley J: **Strongyloidiasis pre and post autologous peripheral blood stem cell transplantation.** *Bone Marrow Transplant* 2003, **32**(1):115–117.
163. Pagliuca A: **Strongyloides hyperinfection in adult T-cell leukaemia/lymphoma.** *British J Haematol* 1999, **105**(1):1.
164. Rahim S, Drabu Y, Jarvis K, Melville D: **Strongyloidiasis: a mistaken diagnosis and a fatal outcome in a patient with diarrhoea.** *Trans R Soc Trop Med H* 2005, **99**(3):215–217.
165. Heath T, Riminton S, Garsia R, MacLeod C: **Systemic strongyloidiasis complicating HIV: a promising response to ivermectin.** *Int J STD AIDS* 1996, **7**(4):294–296.
166. Lim L, Biggs BA: **Fatal disseminated strongyloidiasis in a previously treated patient.** *Med J Australia* 2001, **174**(7):355–356.
167. Mak DB: **Recurrent bacterial meningitis associated with strongyloides hyperinfection.** *Med J Australia* 1993, **159**(5):354.
168. Mak DB: **Recurrent bacterial meningitis associated with strongyloides hyperinfection.** *Med J Aust* 1993, **159**(5):354.
169. Thomas MC, Costello SA: **Disseminated strongyloidiasis arising from a single dose of dexamethasone before stereotactic radiosurgery.** *Int J Clin Prac* 1998, **52**(7):520–521.
170. Kanazawa S, Yamaguchi K, Kinoshita Y, Nomura S: **Adult T-cell leukaemia and strongyloidiasis.** *Eur J Cancer Care (Engl)* 2008, **17**(2):209–210.
171. Kinjo T, Tshako K, Nakazato I, Ito E, Sato Y, Koyanagi Y, Iwamasa T: **Extensive intra-alveolar haemorrhage caused by disseminated strongyloidiasis.** *Int J Parasitol* 1998, **28**(2):323–330.
172. Miyazaki M, Tamura M, Kabashima N, Serino R, Shibata T, Miyamoto T, Furuno Y, Nishio T, Ohara J, Sakurai T, et al: **Minimal change nephrotic syndrome in a patient with strongyloidiasis.** *Clin Exp Nephrol* 2010, **14**(4):367–371.
173. Mori S, Konishi T, Matsuoka K, Deguchi M, Ohta M, Mizuno O, Ueno T, Okinaka T, Nishimura Y, Ito N, et al: **Strongyloidiasis associated with nephrotic syndrome.** *Intern Med* 1998, **37**(7):606–610.
174. Morimoto J, Kaneoka H, Sasatomi Y, Sato YN, Murata T, Ogahara S, Sakata N, Takebayashi S, Naito S, Saito T: **Disseminated strongyloidiasis in nephrotic syndrome.** *Clin Nephrol* 2002, **57**(5):398–401.
175. Satoh M, Futami A, Takahira K, Kodaira M, Tanaka T, Kuriki K, Hori E: **Severe strongyloidiasis complicated by meningitis and hydrocephalus in an HTLV-1 carrier with increased proviral load.** *J Infect Chemother* 2003, **9**(4):355–357.
176. Setoyama M, Fukumaru S, Takasaki T, Yoshida H, Kanzaki T: **SLE with death from acute massive pulmonary hemorrhage caused by disseminated strongyloidiasis.** *Scand J Rheumatol* 1997, **26**(5):389–391.
177. Wong VW, Leung WK, To KF, Sung JJ: **Diarrhoea and rash in a retired farmer.** *HKMJ, Xianggang yi xue za zhi/Hong Kong Academy of Medicine* 2005, **11**(5):397–398.
178. Chiu HH, Lai SL: **Fatal meningoencephalitis caused by disseminated strongyloidiasis.** *Acta Neurol Taiwan* 2005, **14**(1):24–27.
179. Hsieh YP, Wen YK, Chen ML: **Minimal change nephrotic syndrome in association with strongyloidiasis.** *Clin Nephrol* 2006, **66**(6):459–463.
180. Huang MS, Hwang KP, Chiang PC, Hwang JJ: **Pulmonary hyperinfection with Strongyloides stercoralis.** *J Formos Med Asso, Taiwan yi zhi* 1996, **95**(7):551–554.
181. Ting YM: **Pulmonary strongyloidiasis—case report of 2 cases.** *Kaohsiung J Med Sci* 2000, **16**(5):269–274.
182. Liu HC, Hsu JY, Chang KM: **Strongyloides stercoralis hyperinfection presenting with symptoms mimicking acute exacerbation of chronic obstructive pulmonary disease.** *JCMA* 2009, **72**(8):442–445.
183. Hira PR, Al-Ali F, Shweiki HM, Abdella NA, Johnny M, Francis I, Iqbal J, Thompson R, Nevar F: **Strongyloidiasis: challenges in diagnosis and management in non-endemic Kuwait.** *Ann Trop Med Parasitol* 2004, **98**(3):261–270.

184. Mokaddas EM, Shati S, Abdulla A, Nampoori NR, Iqbal J, Nair PM, Said T, Abdulhalim M, Hira PR: **Fatal strongyloidiasis in three kidney recipients in Kuwait.** *Med Princ Pract: Int J K U, Health Sci Centre* 2009, **18**(5):414–417.
185. Al Maslamani MA, Al Soub HA, Al Khal AL, Al Bozom IA, Abu Khattab MJ, Chacko KC: **Strongyloides stercoralis hyperinfection after corticosteroid therapy: a report of two cases.** *Ann Saudi Med* 2009, **29**(5):397–401.
186. Uwaydah AK, Al Qadah F: **Strongyloides stercoralis hyperinfection in a patient with angioimmunoblastic lymphadenopathy.** *Postgrad Med J* 1992, **68**(806):974–975.
187. Malnick S, Somin M, Beilinson N, Basevitch A, Bregman G, Zimhony O: **Strongyloides hyperinfection in Ethiopian immigrants in Israel.** *IMAJ* 2009, **11**(11):660–663.
188. Somin M, Neogolani V, Zimhony O, Wolpart A, Sokolowski N, Malnick S: **Fatal recurrent bacterial meningitis: a complication of chronic Strongyloides infection.** *Eur J Int Med* 2008, **19**(6):e42–e43.
189. Kia EB, Rahimi HR, Mirhendi H, Nilforoushan MR, Talebi A, Zahabiun F, Kazemzadeh H, Meamar AR: **A case of fatal strongyloidiasis in a patient with chronic lymphocytic leukemia and molecular characterization of the isolate.** *Korean J Parasitol* 2008, **46**(4):261–263.
190. Gulbas Z, Kebapci M, Pasaoglu O, Vardareli E: **Successful ivermectin treatment of hepatic strongyloidiasis presenting with severe eosinophilia.** *South Med J* 2004, **97**(9):907–910.
191. Incani RN, Hernandez M, Cortez J, Gonzalez ME, Salazar YD: **Staphylococcus warneri meningitis in a patient with Strongyloides stercoralis hyperinfection and lymphoma: first report of a case.** *Rev Inst Med Trop Sao Paulo* 2010, **52**(3):169–170.
192. Chaudhary K, Smith RJ, Himelright IM, Baddour LM: **Case report: purpura in disseminated strongyloidiasis.** *Am J Med Sci* 1994, **308**(3):186–191.
193. Davidson RA: **Infection due to Strongyloides stercoralis in patients with pulmonary disease.** *South Med J* 1992, **85**(1):28–31.
194. Kim J, Joo HS, Ko HM, Na MS, Hwang SH, Im JC: **A case of fatal hyperinfective strongyloidiasis with discovery of autoinfective filariform larvae in sputum.** *Korean J Parasitol* 2005, **43**(2):51–55.
195. Ochoa MD, Ramirez-Mendoza P, Ochoa G, Vargas MH, Alba-Cruz R, Rico-Mendez FG: **[Bronchial nodules produced by Strongyloides stercoralis as the cause of bronchial obstruction].** *Arch Bronconeumol* 2003, **39**(11):524–526.
196. Roman-Velez JM, Martinez-Camacho RN, Alayan-Laguer D, Fernandez-Gonzalez R, Reyes-Sosa R, Santos-Llanos G, Colon-Perez M, Ferrer D: **An unusual presentation of alveolar hemorrhage.** *PCRJ: J Gen Prac Airways Group* 2009, **18**(4):337–339.
197. Arsic-Arsenijevic V, Dzamic A, Dzamic Z, Milobratovic D, Tomic D: **Fatal Strongyloides stercoralis infection in a young woman with lupus glomerulonephritis.** *J Nephrol* 2005, **18**(6):787–790.
198. Finkielman JD, Grinberg AR, Paz LA, Plana JL, Benchetrit GA, Nicastro MA, Roncoroni AJ: **Case report: reactive hemophagocytic syndrome associated with disseminated strongyloidiasis.** *Am J Med Sci* 1996, **312**(1):37–39.
199. Yun HR, Yoo DH, Lee HS, Kim TH, Ahn MH, Min DY, Park MH, Kim SY: **Fatal strongyloides hyperinfection in a patient with rheumatoid arthritis.** *Clin Exp Rheumatol* 2001, **19**(2):224.
200. Koh MS, Leng PH, Eng P, Hwang J: **An unusual cause of pulmonary haemorrhage in a patient with rheumatoid arthritis.** *Ann Acad Med Singap* 2004, **33**(3):365–367.
201. Leung VK, Liew CT, Sung JJ: **Fatal strongyloidiasis in a patient with ulcerative colitis after corticosteroid therapy.** *Am J Gastroenterol* 1997, **92**(8):1383–1384.
202. Shorman M, Al-Tawfiq JA: **Strongyloides stercoralis hyperinfection presenting as acute respiratory failure and Gram-negative sepsis in a patient with astrocytoma.** *IJID: Int Soc Inf Dis* 2009, **13**(5):e288–e291.
203. Fasih N, Irfan S, Sheikh U, Beg MS: **A fatal case of gram negative bacterial sepsis associated with disseminated strongyloidiasis in an immunocompromised patient.** *JPMA* 2008, **58**(2):91–92.
204. Seet RC, Lau LG, Tambyah PA: **Strongyloides hyperinfection and hypogammaglobulinemia.** *Clin Diagn Lab Immunol* 2005, **12**(5):680–682.
205. Czachor JS, Jonas AP: **Transmission of Strongyloides stercoralis person to person.** *J Travel Med* 2000, **7**(4):211–212.
206. Csermely L, Jaafar H, Kristensen J, Castella A, Gorka W, Chebli AA, Trab F, Alizadeh H, Hunyady B: **Strongyloides hyperinfection causing life-threatening gastrointestinal bleeding.** *WJG* 2006, **12**(39):6401–6404.
207. Azira NM, Zeehaida M: **Strongyloides stercoralis hyperinfection in a diabetic patient: case report.** *Trop Biomed* 2010, **27**(1):115–119.
208. Vithayasai N, Jennuvat S: **Gastrointestinal manifestations in severe strongyloidiasis: report of 3 cases and literature review.** *Southeast Asian J Trop Med Public Health* 2010, **41**(1):22–27.
209. Pornsuriyasak P, Niticharoenpong K, Sakapibunnana A: **Disseminated strongyloidiasis successfully treated with extended duration ivermectin combined with albendazole: a case report of intractable strongyloidiasis.** *Southeast Asian J Trop Med Public Health* 2004, **35**(3):531–534.
210. Suvajdzic N, Kranjic-Zec I, Jovanovic V, Popovic D, Colovic M: **Fatal strongyloidiasis following corticosteroid therapy in a patient with chronic idiopathic thrombocytopenia.** *Haematologia* 1999, **29**(4):323–326.
211. Hagelskjaer LH: **A fatal case of systemic strongyloidiasis and review of the literature.** *Eur J Clin Microbiol Infect Dis: Eur Soc Clin Microbiol* 1994, **13**(12):1069–1074.
212. Leang B, Lynen L, Tootill R, Griffiths S, Monchy D: **Death caused by strongyloides hyperinfection in a leprosy patient on treatment for a type II leprosy reaction.** *Lepr Rev* 2004, **75**(4):398–403.
213. Wong TY, Szeto CC, Lai FF, Mak CK, Li PK: **Nephrotic syndrome in strongyloidiasis: remission after eradication with anthelmintic agents.** *Nephron* 1998, **79**(3):333–336.
214. Adedayo AO, Grell GA, Bellot P: **Case study: Fatal strongyloidiasis associated with human T-cell lymphotropic virus type 1 infection.** *Am J Trop Med Hyg* 2001, **65**(5):650–651.
215. Foucan L, Genevier I, Lamaury I, Strobel M: **[Aseptic purulent meningitis in two patients co-infected by HTLV-1 and Strongyloides stercoralis].** *Med Trop (Mars)* 1997, **57**(3):262–264.
216. N'Dri K, Kouame KE, Sahari R, Hommel D, Hulin A: **[Strongyloides stercoralis hyperinfection syndrome with acute meningoencephalitis associated to HTLV-1 and HTLV-2 virus co-infection].** *Med Mal Infect* 2008, **38**(3):162–164.
217. Drug V, Haliga R, Akbar Q, Mihai C, Cijevschi Prelicean C, Stanciu C: **Ascites with Strongyloides stercoralis in a patient with acute alcoholic pancreatitis and liver cirrhosis.** *JGLD* 2009, **18**(3):367–369.
218. Ho PL, Luk WK, Chan AC, Yuen KY: **Two cases of fatal strongyloidiasis in Hong Kong.** *Pathology* 1997, **29**(3):324–326.
219. WHO: **Model Lists of Essential Medicines.** <http://www.who.int/medicines/publications/essentialmedicines/en/>.

doi:10.1186/1471-2334-13-78

Cite this article as: Buonfrate et al.: Severe strongyloidiasis: a systematic review of case reports. *BMC Infectious Diseases* 2013 **13**:78.

Submit your next manuscript to BioMed Central and take full advantage of:

- Convenient online submission
- Thorough peer review
- No space constraints or color figure charges
- Immediate publication on acceptance
- Inclusion in PubMed, CAS, Scopus and Google Scholar
- Research which is freely available for redistribution

Submit your manuscript at
www.biomedcentral.com/submit

