REFERENCES

[1] Dengue Hemorrhagic Fever Section. Bureau of Vector Borne Diseases,and Ministry of Public Health. The situation of dengue hemorrhagic fever in Thailand at 34th week of the year (2012) [Online]. 2006. Available from : http://dhf.ddc.moph.go.th/Status/2555/week34.pdf [2012, August 27].

[2] Gubler, D.J. Dengue and dengue hemorrhagic fever. Clin Microbiol Rev 11 (July 1998) : 480-96.

[3] Guzman, M.G., Halstead, S.B., Artsob, H., Buchy, P., Farrar, J., Gubler, D.J., et al. Dengue: a continuing global threat. Nat Rev Microbiol 8 (December 2010) : S7-16.

[4] Halstead, S.B. Dengue. Lancet 370 (November 2007) : 1644-52.

[5] Di Lorenzo, C., Angus, A.G.,and Patel, A.H. Hepatitis C virus evasion mechanisms from neutralizing antibodies. Viruses 3 (November 2011) : 2280-300.

[6] Ding, X., Wu, X., Duan, T., Siirin, M., Guzman, H., Yang, Z., et al. Nucleotide and amino acid changes in West Nile virus strains exhibiting renal tropism in hamsters. Am J Trop Med Hyg 73 (October 2005) : 803-7.

[7] Murray, K., Walker, C., Herrington, E., Lewis, J.A., McCormick, J., Beasley, D.W., et al. Persistent infection with West Nile virus years after initial infection. J Infect Dis 201 (January 2010) : 2-4.

[8] Siirin, M.T., Duan, T., Lei, H., Guzman, H., da Rosa, A.P., Watts, D.M., et al. Chronic St. Louis encephalitis virus infection in the golden hamster (Mesocricetus auratus). Am J Trop Med Hyg 76 (February 2007) : 299-306.

[9] Tesh, R.B., Siirin, M., Guzman, H., Travassos da Rosa, A.P., Wu, X., Duan, T., et al. Persistent West Nile virus infection in the golden hamster: studies on its mechanism and possible implications for other flavivirus infections. J Infect Dis 192 (July 2005) : 287-95.

[10] Tonry, J.H., Xiao, S.Y., Siirin, M., Chen, H., da Rosa, A.P.,and Tesh, R.B. Persistent shedding of West Nile virus in urine of experimentally infected hamsters. Am J Trop Med Hyg 72 (March 2005) : 320-4.

[11] Wu, X., Lu, L., Guzman, H., Tesh, R.B.,and Xiao, S.Y. Persistent infection and associated nucleotide changes of West Nile virus serially passaged in hamsters. J Gen Virol 89 (December 2008) : 3073-9.

[12] Hirayama, T., Mizuno, Y., Takeshita, N., Kotaki, A., Tajima, S., Omatsu, T., et al. Detection of dengue virus genome in urine by real-time reverse transcriptase PCR: a laboratory diagnostic method useful after disappearance of the genome in serum. J Clin Microbiol 50 (June 2012) : 2047-52.

[13] Wang, W.K., Chao, D.Y., Kao, C.L., Wu, H.C., Liu, Y.C., Li, C.M., et al. High levels of plasma dengue viral load during defervescence in patients with dengue hemorrhagic fever: implications for pathogenesis. Virology 305 (January 2003) : 330-8.

[14] de Macedo, F.C., Nicol, A.F., Cooper, L.D., Yearsley, M., Pires, A.R.,and Nuovo, G.J. Histologic, viral, and molecular correlates of dengue fever infection of the liver using highly sensitive immunohistochemistry. Diagn Mol Pathol 15 (December 2006) : 223-8.

[15] Jessie, K., Fong, M.Y., Devi, S., Lam, S.K.,and Wong, K.T. Localization of dengue virus in naturally infected human tissues, by immunohistochemistry and in situ hybridization. J Infect Dis 189 (April 2004) : 1411-8.

[16] Jensen, M.M. Viruses and kidney disease. Am J Med 43 (December 1967) : 897-911.

[17] Urnovitz, H.B., Murphy, W.H., Gottfried, T.D.,and Friedman-Kien, A.E. Urine-based diagnostic technologies. Trends Biotechnol 14 (October 1996) : 361-4.

[18] Utz, J.P. Viruria in man, an update. Prog Med Virol 17 (1974) : 77-90.

[19] Poloni, T.R., Oliveira, A.S., Alfonso, H.L., Galvao, L.R., Amarilla, A.A., Poloni, D.F., et al. Detection of dengue virus in saliva and urine by

real time RT-PCR. Virol J 7 (2010) : 22.

[20] Domingo, E. Quasispecies and the implications for virus persistence and escape. Clin Diagn Virol 10 (July 1998) : 97-101.

[21] Domingo, E., Baranowski, E., Ruiz-Jarabo, C.M., Martin-Hernandez, A.M., Saiz, J.C.,and Escarmis, C. Quasispecies structure and persistence of RNA viruses. Emerg Infect Dis 4 (Oct-Dec 1998) : 521-7.

[22] Aaskov, J., Buzacott, K., Thu, H.M., Lowry, K.,and Holmes, E.C. Long-term transmission of defective RNA viruses in humans and Aedes mosquitoes. Science 311 (January 2006) : 236-8.

[23] Craig, S., Thu, H.M., Lowry, K., Wang, X.F., Holmes, E.C.,and Aaskov, J. Diverse dengue type 2 virus populations contain recombinant and both parental viruses in a single mosquito host. J Virol 77 (April 2003) : 4463-7.

[24] Lin, S.R., Hsieh, S.C., Yueh, Y.Y., Lin, T.H., Chao, D.Y., Chen, W.J., et al. Study of sequence variation of dengue type 3 virus in naturally infected mosquitoes and human hosts: implications for transmission and evolution. J Virol 78 (November 2004) : 12717-21.

[25] Wang, W.K., Lin, S.R., Lee, C.M., King, C.C.,and Chang, S.C. Dengue type 3 virus in plasma is a population of closely related genomes: quasispecies. J Virol 76 (May 2002) : 4662-5.

[26] Wang, W.K., Sung, T.L., Lee, C.N., Lin, T.Y.,and King, C.C. Sequence diversity of the capsid gene and the nonstructural gene NS2B of dengue-3 virus in vivo. Virology 303 (November 2002) : 181-91.

[27] Mukhopadhyay, S., Kuhn, R.J.,and Rossmann, M.G. A structural perspective of the flavivirus life cycle. Nat Rev Microbiol 3 (January 2005) : 13-22.

[28] Kulwichit, W., Mekmullica, J., Krajiw, S., Prommalikit, O., Yapom, R., Intaraprasong, P., et al., editors. Highly-sensitive virologic diagnosis of dengue infection by a newly-developed protocol of reverse transcription-nested polymerase chain reaction(RT-Nested PCR) of serum/plasma, peripheral blood leukocyte(PBL), and Urine specimens. The 41st Annual Meeting of IDSA. San Diego, CA,

USA. October 9-12, 2003.Page 93. (Abstract 345)

[29] Kusuman Chaiyo. Isolation of dengue virus from urine during different phases of acute infection by mosquito inoculation. Master's Thesis, Faculty of Medicine, Chulalongkorn University, 2007.

[30] Chalinee Laosakul. Survival of dengue virus in blood, urine, saliva and buccal mucosa in complete recovery dengue patients. Master's Thesis, Depertment of Medicine, Faculty of Medicine, Chulalongkorn University, 2008.

[31] Rico-Hesse, R. Molecular evolution and distribution of dengue viruses type 1 and 2 in nature. Virology 174 (Febuary 1990) : 479-93.

[32] Thai, K.T., Henn, M.R., Zody, M.C., Tricou, V., Nguyet, N.M., Charlebois, P., et al. High-resolution analysis of intrahost genetic diversity in dengue virus serotype 1 infection identifies mixed infections. J Virol 86 (January 2011) : 835-43.

[33] Chen, R.,and Vasilakis, N. Dengue--quo tu et quo vadis? Viruses 3 (September 2011) : 1562-608.

[34] Weaver, S.C.,and Vasilakis, N. Molecular evolution of dengue viruses: contributions of phylogenetics to understanding the history and epidemiology of the preeminent arboviral disease. Infect Genet Evol 9 (July 2009) : 523-40.

[35] Whitehead, S.S., Blaney, J.E., Durbin, A.P.,and Murphy, B.R. Prospects for a dengue virus vaccine. Nat Rev Microbiol 5 (July 2007) : 518-28.

[36] Henchal, E.A.,and Putnak, J.R. The dengue viruses. Clin Microbiol Rev 3 (October 1990) : 376-96.

[37] Clyde, K., Kyle, J.L..and Harris, E. Recent advances in deciphering viral and host determinants of dengue virus replication and pathogenesis. J Virol 80 (December 2006) : 11418-31.

[38] Maron, G.M., Clara, A.W., Diddle, J.W., Pleites, E.B., Miller, L., Macdonald, G., et al. Association between nutritional status and severity of dengue infection in children in El Salvador. Am J Trop Med Hyg 82 (February 2010) : 324-9.

[39] Rodenhuis-Zybert, I.A., Wilschut, J.,and Smit, J.M. Dengue virus life cycle:

viral and host factors modulating infectivity. Cell Mol Life Sci 67 (August 2010) : 2773-86.

[40] World Health Organization. DENGUE:Guidelines for diagnosis, treatment, prevention and control. Geneva, Switzerland: WHO Press, 2009.

[41] World Health Organization. Dengue haemorrhagic fever: diagnosis, treatment, prevention and control. 2 ed. Geneva, Switzerland: WHO Press, 1997.

[42] Special program for research and training in tropical diseases (TDR),and World Health Organization (WHO). Dengue guidelines for diagnosis, treatment, prevention and control. Geneva, Switzerland: WHO press, 2009.

[43] National Institue of Health,and Department of Medical Sciences. Dengue hemorrhagic fever [Online]. 2012. Available from : http://nih.dmsc.moph.go.th/fsheet/showimgpic.php?id=23 [2012, August 26].

[44] Center of Vector Borne and Infectious Diseases, Arbovirus Reseaech Unit,and Ministry of Public Health. Prevalence of dengue virus serotypes in Thailand [Online]. 2012. Available from : http://webdb.dmsc.moph.go.th/ifc_nih/ez_004_001.asp [2012, September 12].

[45] Khawsak, P., Phantana, S.,and Chansiri, K. Determination of dengue virus serotypes in Thailand using PCR based method. Southeast Asian J Trop Med Public Health 34 (December 2003) : 781-5.

[46] Kulwichit, W., Krajiw, S., Chansinghakul, D., Suwanpimolkul, G., Prommalikit, O., Suandork, P., et al. Concurrent multi-serotypic dengue infections in various body fluids. The 19th European Congress of Clinical Microbiology and Infectious diseases (ECCMID). Helsinki, Finland. May 16-19, 2009. Page S19. (Abstract O82)

[47] Bureau of Epidemiology,and Department of Disease Control. 506 Surveillance weekly summarized reports of dengue virus infection during 1 January to 10 September 2012 [Online]. 2012.

Available from :
http://www.boe.moph.go.th/boedb/surdata/506wk/y55/d82_3655.
pdf [2012, September 12].

[48] Peeling, R.W., Artsob, H., Pelegrino, J.L., Buchy, P., Cardosa, M.J., Devi, S., et al. Evaluation of diagnostic tests: dengue. Nat Rev Microbiol 8 (December 2010) : S30-8.

[49] Kao, C.L., King, C.C., Chao, D.Y., Wu, H.L.,and Chang, G.J. Laboratory diagnosis of dengue virus infection: current and future perspectives in clinical diagnosis and public health. J Microbiol Immunol Infect 38 (February 2005) : 5-16.

[50] Rosen, L. The use of Toxorhynchites mosquitoes to detect and propagate dengue and other arboviruses. Am J Trop Med Hyg 30 (January 1981) : 177-83.

[51] Rosen, L.,and Gubler, D. The use of mosquitoes to detect and propagate dengue viruses. Am J Trop Med Hyg 23 (November 1974) : 1153-60.

[52] Vaughn, D.W., Nisalak, A., Solomon, T., Kalayanarooj, S., Nguyen, M.D., Kneen, R., et al. Rapid serologic diagnosis of dengue virus infection using a commercial capture ELISA that distinguishes primary and secondary infections. Am J Trop Med Hyg 60 (April 1999) : 693-8.

[53] Wang, H.L., Lin, K.H., Yueh, Y.Y., Chow, L., Wu, Y.C., Chen, H.Y., et al. Efficient diagnosis of dengue infections using patients' peripheral blood leukocytes and serum/plasma. Intervirology 43 (2000) : 107-11.

[54] Scott, R.M., Nisalak, A., Cheamudon, U., Seridhoranakul, S.,and Nimmannitya, S. Isolation of dengue viruses from peripheral blood leukocytes of patients with hemorrhagic fever. J Infect Dis 141 (January 1980) : 1-6.

[55] King, A.D., Nisalak, A., Kalayanrooj, S., Myint, K.S., Pattanapanyasat, K., Nimmannitya, S., et al. B cells are the principal circulating mononuclear cells infected by dengue virus. Southeast Asian J Trop Med Public Health 30 (December 1999) : 718-28.

[56] Yenchitsomanus, P.T., Sricharoen, P., Jaruthasana, I., Pattanakitsakul, S.N., Nitayaphan, S., Mongkolsapaya, J., et al. Rapid detection and identification of dengue viruses by polymerase chain reaction (PCR). Southeast Asian J Trop Med Public Health 27 (June 1996) : 228-36.

[57] Harris, E., Roberts, T.G., Smith, L., Selle, J., Kramer, L.D., Valle, S., et al. Typing of dengue viruses in clinical specimens and mosquitoes by single-tube multiplex reverse transcriptase PCR. J Clin Microbiol 36 (September 1998) : 2634-9.

[58] Lanciotti, R.S., Calisher, C.H., Gubler, D.J., Chang, G.J.,and Vorndam, A.V. Rapid detection and typing of dengue viruses from clinical samples by using reverse transcriptase-polymerase chain reaction. J Clin Microbiol 30 (March 1992) : 545-51.

[59] Callahan, J.D., Wu, S.J., Dion-Schultz, A., Mangold, B.E., Peruski, L.F., Watts, D.M., et al. Development and evaluation of serotype- and group-specific fluorogenic reverse transcriptase PCR (TaqMan) assays for dengue virus. J Clin Microbiol 39 (November 2001) : 4119-24.

[60] Conceicao, T.M., Da Poian, A.T.,and Sorgine, M.H. A real-time PCR procedure for detection of dengue virus serotypes 1, 2, and 3, and their quantitation in clinical and laboratory samples. J Virol Methods 163 (January 2010) : 1-9.

[61] dos Santos, H.W., Poloni, T.R., Souza, K.P., Muller, V.D., Tremeschin, F., Nali, L.C., et al. A simple one-step real-time RT-PCR for diagnosis of dengue virus infection. J Med Virol 80 (August 2008) : 1426-33.

[62] Shu, P.Y., Chang, S.F., Kuo, Y.C., Yueh, Y.Y., Chien, L.J., Sue, C.L., et al. Development of group- and serotype-specific one-step SYBR green I-based real-time reverse transcription-PCR assay for dengue virus. J Clin Microbiol 41 (June 2003) : 2408-16.

[63] Lolekha, R., Chokephaibulkit, K., Yoksan, S., Vanprapar, N., Phongsamart, W.,and Chearskul, S. Diagnosis of dengue infection using various diagnostic tests in the early stage of illness. Southeast Asian J Trop

Med Public Health 35 (June 2004) : 391-5.

[64] Hermida, M., Ferreiro, M.C., Barral, S., Laredo, R., Castro, A.,and Diz Dios, P. Detection of HCV RNA in saliva of patients with hepatitis C virus infection by using a highly sensitive test. J Virol Methods 101 (March 2002) : 29-35.

[65] Tonry, J.H., Brown, C.B., Cropp, C.B., Co, J.K., Bennett, S.N., Nerurkar, V.R., et al. West Nile virus detection in urine. Emerg Infect Dis 11 (August 2005) : 1294-6.

[66] Bodur, H., Akinci, E., Onguru, P., Carhan, A., Uyar, Y., Tanrici, A., et al. Detection of Crimean-Congo hemorrhagic fever virus genome in saliva and urine. Int J Infect Dis 14 (March 2010) : e247-9.

[67] Rossi, A., Delbue, S., Mazziotti, R., Valli, M., Borghi, E., Mancuso, R., et al. Presence, quantitation and characterization of JC virus in the urine of Italian immunocompetent subjects. J Med Virol 79 (April 2007) : 408-12.

[68] Chakravarti, A., Matlani, M.,and Jain, M. Immunodiagnosis of dengue virus infection using saliva. Curr Microbiol 55 (December 2007) : 461-4.

[69] Chuansumrit, A., Chaiyaratana, W., Tangnararatchakit, K., Yoksan, S., Flamand, M.,and Sakuntabhai, A. Dengue nonstructural protein 1 antigen in the urine as a rapid and convenient diagnostic test during the febrile stage in patients with dengue infection. Diagn Microbiol Infect Dis 71 (December 2011) : 467-9.

[70] Torres, J.R., Liprandi, F.,and Goncalvez, A.P. Acute parotitis due to dengue virus. Clin Infect Dis 31 (November 2000) : E28-9.

[71] Mizuno, Y., Kotaki, A., Harada, F., Tajima, S., Kurane, I.,and Takasaki, T. Confirmation of dengue virus infection by detection of dengue virus type 1 genome in urine and saliva but not in plasma. Trans R Soc Trop Med Hyg 101 (July 2007) : 738-9.

[72] Bhatnagar, J., Blau, D.M., Shieh, W.J., Paddock, C.D., Drew, C., Liu, L., et al. Molecular detection and typing of dengue viruses from archived tissues of fatal cases by rt-PCR and sequencing: diagnostic and epidemiologic implications. Am J Trop Med Hyg 86 (February

2012) : 335-40.

[73] de Araujo, J.M., Schatzmayr, H.G., de Filippis, A.M., Dos Santos, F.B., Cardoso, M.A., Britto, C., et al. A retrospective survey of dengue virus infection in fatal cases from an epidemic in Brazil. J Virol Methods 155 (January 2009) : 34-8.

[74] Sariol, C.A., Pelegrino, J.L., Martinez, A., Arteaga, E., Kouri, G.,and Guzman, M.G. Detection and genetic relationship of dengue virus sequences in seventeen-year-old paraffin-embedded samples from Cuba. Am J Trop Med Hyg 61 (December 1999) : 994-1000.

[75] Jakrapun Pupaibool. Diagnosis of dengue infection in adults by reverse-transcription polymerase chain reaction (RT-PCR) from saliva and/or bucccal mucsal cells. Master's Thesis, Department of Medicine, Faculty of Medicine, Chulalongkorn University, 2005.

[76] Gompol Suwanpimolkul. Early diagnosis of dengue virus infection using saliva, oral brush, and urine during febrile stage by RT-PCR: To avoid diagnostic venipuncture. Master's Thesis, Department of Medicine, Faculty of Medicine, Chulalongkorn University, 2007.

[77] Pugnale, P., Latorre, P., Rossi, C., Crovatto, K., Pazienza, V., Gottardi, A.D., et al. Real-time multiplex PCR assay to quantify hepatitis C virus RNA in peripheral blood mononuclear cells. J Virol Methods 133 (May 2006) : 195-204.

[78] Burgos, J.S., Ramirez, C., Sastre, I., Alfaro, J.M.,and Valdivieso, F. Herpes simplex virus type 1 infection via the bloodstream with apolipoprotein E dependence in the gonads is influenced by gender. J Virol 79 (February 2005) : 1605-12.

[79] Ngaosuwankul, N., Noisumdaeng, P., Komolsiri, P., Pooruk, P., Chokephaibulkit, K., Chotpitayasunondh, T., et al. Influenza A viral loads in respiratory samples collected from patients infected with pandemic H1N1, seasonal H1N1 and H3N2 viruses. Virol J 7 (2010) : 75.

[80] Murgue, B., Roche, C., Chungue, E.,and Deparis, X. Prospective study of the duration and magnitude of viraemia in children hospitalised during

the 1996-1997 dengue-2 outbreak in French Polynesia. J Med Virol 60 (April 2000) : 432-8.

[81] Cleaves, G.R., Ryan, T.E.,and Schlesinger, R.W. Identification and characterization of type 2 dengue virus replicative intermediate and replicative form RNAs. Virology 111 (May 1981) : 73-83.

[82] Peyrefitte, C.N., Pastorino, B., Bessaud, M., Tolou, H.J.,and Couissinier-Paris, P. Evidence for in vitro falsely-primed cDNAs that prevent specific detection of virus negative strand RNAs in dengue-infected cells: improvement by tagged RT-PCR. J Virol Methods 113 (October 2003) : 19-28.

[83] Craggs, J.K., Ball, J.K., Thomson, B.J., Irving, W.L.,and Grabowska, A.M. Development of a strand-specific RT-PCR based assay to detect the replicative form of hepatitis C virus RNA. J Virol Methods 94 (May 2001) : 111-20.

[84] Lanford, R.E., Sureau, C., Jacob, J.R., White, R.,and Fuerst, T.R. Demonstration of in vitro infection of chimpanzee hepatocytes with hepatitis C virus using strand-specific RT/PCR. Virology 202 (August 1994) : 606-14.

[85] Kao, J.H., Chen, P.J., Lai, M.Y., Wang, T.H.,and Chen, D.S. Positive and negative strand of hepatitis C virus RNA sequences in peripheral blood mononuclear cells in patients with chronic hepatitis C: no correlation with viral genotypes 1b, 2a, and 2b. J Med Virol 52 (July 1997) : 270-4.

[86] Radkowski, M., Kubicka, J., Kisiel, E., Cianciara, J., Nowicki, M., Rakela, J., et al. Detection of active hepatitis C virus and hepatitis G virus/GB virus C replication in bone marrow in human subjects. Blood 95 (June 2000) : 3986-9.

[87] Radkowski, M., Wilkinson, J., Nowicki, M., Adair, D., Vargas, H., Ingui, C., et al. Search for hepatitis C virus negative-strand RNA sequences and analysis of viral sequences in the central nervous system: evidence of replication. J Virol 76 (January 2002) : 600-8.

[88] Yuki, N., Matsumoto, S., Tadokoro, K., Mochizuki, K., Kato, M.,and

Yamaguchi, T. Significance of liver negative-strand HCV RNA quantitation in chronic hepatitis C. J Hepatol 44 (February 2006) : 302-9.

[89] Noisakran, S., Gibbons, R.V., Songprakhon, P., Jairungsri, A., Ajariyakhajorn, C., Nisalak, A., et al. Detection of dengue virus in platelets isolated from dengue patients. Southeast Asian J Trop Med Public Health 40 (March 2009) : 253-62.

[90] Paes, M.V., Lenzi, H.L., Nogueira, A.C., Nuovo, G.J., Pinhao, A.T., Mota, E.M., et al. Hepatic damage associated with dengue-2 virus replication in liver cells of BALB/c mice. Lab Invest 89 (October 2009) : 1140-51.

[91] Richardson, J., Molina-Cruz, A., Salazar, M.I.,and Black, W.t. Quantitative analysis of dengue-2 virus RNA during the extrinsic incubation period in individual Aedes aegypti. Am J Trop Med Hyg 74 (January 2006) : 132-41.

[92] Virgin, H.W., Wherry, E.J.,and Ahmed, R. Redefining chronic viral infection. Cell 138 (July 2009) : 30-50.

[93] Bangham, C.R.,and Kirkwood, T.B. Defective interfering particles and virus evolution. Trends Microbiol 1 (October 1993) : 260-4.

[94] Thomas, S., Thomson, G., Dowall, S., Bruce, C., Cook, N., Easterbrook, L., et al. Review of Crimean Congo hemorrhagic fever infection in Kosova in 2008 and 2009: prolonged viremias and virus detected in urine by PCR. Vector Borne Zoonotic Dis 12 (September 2012) : 800-4.

[95] Ubol, S., Phuklia, W., Kalayanarooj, S.,and Modhiran, N. Mechanisms of immune evasion induced by a complex of dengue virus and preexisting enhancing antibodies. J Infect Dis 201 (March 2010) : 923-35.

[96] Wang, W.K., Chen, H.L., Yang, C.F., Hsieh, S.C., Juan, C.C., Chang, S.M., et al. Slower rates of clearance of viral load and virus-containing immune complexes in patients with dengue hemorrhagic fever. Clin Infect Dis 43 (October 2006) : 1023-30.

[97] Laosakul, C., Sriprapun, M., Chaiyo, K., Krajiw, S., Chansinghakul, D., Suwanpimolkul, G., et al. Prolonged survival of dengue virus in blood and excretion in urine after clinical recovery. 19th European Congress of Clinical Microbiology and Infectious Diseases (ECCMID). Helsinki, Finland. May 16-19, 2009. Page S106. (Abstract O508)

[98] Nilaratanakul, V., Thaivanich, S., Songcharoen, K., Arunyingmongkol, K., Plongla, R., Sriprapun, M., et al. Detection of dengue virus in lymphoid tissues of persons with remote dengue infections. 20th European Congress of Clinical Microbiology and Infectious Diseases (ECCMID). Vienna, Austria. April 10-13, 2010. Page S630. (Abstract P2114)

[99] Plongla, R., Songchareon, K., Arunyingmongkol, K., Tantiwongse, K.,and Kulwichit, W. Presence of dengue virus genome in kidney tissue of adults without recent dengue infection: another piece of evidence of in vivo persistence of the virus. 22nd European Congress of Clinical Microbiology and Infectious Diseases (ECCMID). London, United Kingdom. March 21 – April 3, 2012. Page 188. (Abstract P875)

[100] Putcharoen, O., Krajiw, S., Nilratanakul, V., Rojnuckarin, P., Bhattarakosol, P., Nisalak, A., et al. Presence of dengue virus genome in the bone marrow of asymptomatic adults in a dengue-hyperendemic country: implication for complicated dengue pathogenesis. 17th European Congress of Clinical Microbiology and Infectious Diseases (ECCMID) & 25th International Conference of Chemotherapy (ICC). Munich, Germany. March 31 – April 3, 2007. Page S14. (Abstract O58)

[101] Grenfell, B.T., Pybus, O.G., Gog, J.R., Wood, J.L., Daly, J.M., Mumford, J.A., et al. Unifying the epidemiological and evolutionary dynamics of pathogens. Science 303 (January 2004) : 327-32.

[102] Kurosu, T. Quasispecies of dengue virus. Trop Med Health 39 (December 2011) : 29-36.

[103] Philpott, S., Burger, H., Tsoukas, C., Foley, B., Anastos, K., Kitchen, C., et

al. Human immunodeficiency virus type 1 genomic RNA sequences in the female genital tract and blood: compartmentalization and intrapatient recombination. J Virol 79 (January 2005) : 353-63.

[104] Navas, S., Martin, J., Quiroga, J.A., Castillo, I.,and Carreno, V. Genetic diversity and tissue compartmentalization of the hepatitis C virus genome in blood mononuclear cells, liver, and serum from chronic hepatitis C patients. J Virol 72 (February 1998) : 1640-6.

[105] Fishman, S.L.,and Branch, A.D. The quasispecies nature and biological implications of the hepatitis C virus. Infect Genet Evol 9 (December 2009) : 1158-67.

[106] Martell, M., Esteban, J.I., Quer, J., Genesca, J., Weiner, A., Esteban, R., et al. Hepatitis C virus (HCV) circulates as a population of different but closely related genomes: quasispecies nature of HCV genome distribution. J Virol 66 (May 1992) : 3225-9.

[107] Wang, W., Lin, J., Tan, D., Xu, Y., Brunt, E.M., Fan, X., et al. Divergent quasispecies evolution in de novo hepatitis C virus infection associated with bone marrow transplantation. Biochem Biophys Res Commun 414 (October 2011) : 148-52.

[108] Cabot, B., Martell, M., Esteban, J.I., Piron, M., Otero, T., Esteban, R., et al. Longitudinal evaluation of the structure of replicating and circulating hepatitis C virus quasispecies in nonprogressive chronic hepatitis C patients. J Virol 75 (December 2001) : 12005-13.

[109] Cabot, B., Martell, M., Esteban, J.I., Sauleda, S., Otero, T., Esteban, R., et al. Nucleotide and amino acid complexity of hepatitis C virus quasispecies in serum and liver. J Virol 74 (January 2000) : 805-11.

[110] Fishman, S.L., Murray, J.M., Eng, F.J., Walewski, J.L., Morgello, S.,and Branch, A.D. Molecular and bioinformatic evidence of hepatitis C virus evolution in brain. J Infect Dis 197 (February 2008) : 597-607.

[111] Forton, D.M., Karayiannis, P., Mahmud, N., Taylor-Robinson, S.D.,and Thomas, H.C. Identification of unique hepatitis C virus quasispecies in the central nervous system and comparative analysis of internal translational efficiency of brain, liver, and serum variants. J Virol 78

(May 2004) : 5170-83.

[112] Laskus, T., Wilkinson, J., Gallegos-Orozco, J.F., Radkowski, M., Adair, D.M., Nowicki, M., et al. Analysis of hepatitis C virus quasispecies transmission and evolution in patients infected through blood transfusion. Gastroenterology 127 (September 2004) : 764-76.

[113] Maggi, F., Fornai, C., Vatteroni, M.L., Giorgi, M., Morrica, A., Pistello, M., et al. Differences in hepatitis C virus quasispecies composition between liver, peripheral blood mononuclear cells and plasma. J Gen Virol 78 (July 1997) : 1521-5.

[114] Minosse, C., Calcaterra, S., Abbate, I., Selleri, M., Zaniratti, M.S.,and Capobianchi, M.R. Possible compartmentalization of hepatitis C viral replication in the genital tract of HIV-1-coinfected women. J Infect Dis 194 (December 2006) : 1529-36.

[115] Okuda, M., Hino, K., Korenaga, M., Yamaguchi, Y., Katoh, Y.,and Okita, K. Differences in hypervariable region 1 quasispecies of hepatitis C virus in human serum, peripheral blood mononuclear cells, and liver. Hepatology 29 (January 1999) : 217-22.

[116] Roque-Afonso, A.M., Ducoulombier, D., Di Liberto, G., Kara, R., Gigou, M., Dussaix, E., et al. Compartmentalization of hepatitis C virus genotypes between plasma and peripheral blood mononuclear cells. J Virol 79 (May 2005) : 6349-57.

[117] Vera-Otarola, J., Barria, M.I., Leon, U., Marsac, D., Carvallo, P., Soza, A., et al. Hepatitis C virus quasispecies in plasma and peripheral blood mononuclear cells of treatment naive chronically infected patients. J Viral Hepat 16 (September 2009) : 633-43.

[118] Rodriguez, L.L., De Roo, A., Guimard, Y., Trappier, S.G., Sanchez, A., Bressler, D., et al. Persistence and genetic stability of Ebola virus during the outbreak in Kikwit, Democratic Republic of the Congo, 1995. J Infect Dis 179 Suppl 1 (February 1999) : S170-6.

[119] Bello, G., Casado, C., Garcia, S., Rodriguez, C., del Romero, J.,and Lopez-Galindez, C. Co-existence of recent and ancestral nucleotide sequences in viral quasispecies of human immunodeficiency virus

type 1 patients. J Gen Virol 85 (February 2004) : 399-407.

[120] Collins, K.R., Quinones-Mateu, M.E., Wu, M., Luzze, H., Johnson, J.L., Hirsch, C., et al. Human immunodeficiency virus type 1 (HIV-1) quasispecies at the sites of Mycobacterium tuberculosis infection contribute to systemic HIV-1 heterogeneity. J Virol 76 (February 2002) : 1697-706.

[121] Poss, M., Martin, H.L., Kreiss, J.K., Granville, L., Chohan, B., Nyange, P., et al. Diversity in virus populations from genital secretions and peripheral blood from women recently infected with human immunodeficiency virus type 1. J Virol 69 (December 1995) : 8118-22.

[122] Steuler, H., Storch-Hagenlocher, B.,and Wildemann, B. Distinct populations of human immunodeficiency virus type 1 in blood and cerebrospinal fluid. AIDS Res Hum Retroviruses 8 (January 1992) : 53-9.

[123] van't Wout, A.B., Ran, L.J., Kuiken, C.L., Kootstra, N.A., Pals, S.T.,and Schuitemaker, H. Analysis of the temporal relationship between human immunodeficiency virus type 1 quasispecies in sequential blood samples and various organs obtained at autopsy. J Virol 72 (January 1998) : 488-96.

[124] Zhang, L., Rowe, L., He, T., Chung, C., Yu, J., Yu, W., et al. Compartmentalization of surface envelope glycoprotein of human immunodeficiency virus type 1 during acute and chronic infection. J Virol 76 (September 2002) : 9465-73.

[125] Chao, D.Y., King, C.C., Wang, W.K., Chen, W.J., Wu, H.L.,and Chang, G.J. Strategically examining the full-genome of dengue virus type 3 in clinical isolates reveals its mutation spectra. Virol J 2 (2005) : 72.

[126] Descloux, E., Cao-Lormeau, V.M., Roche, C.,and De Lamballerie, X. Dengue 1 diversity and microevolution, French Polynesia 2001-2006: connection with epidemiology and clinics. PLoS Negl Trop Dis 3 (2009) : e493.

[127] Chen, W.J., Wu, H.R.,and Chiou, S.S. E/NS1 modifications of dengue 2 virus after serial passages in mammalian and/or mosquito cells.

Intervirology 46 (2003) : 289-95.

[128] Sanchez, I.J.,and Ruiz, B.H. A single nucleotide change in the E protein gene of dengue virus 2 Mexican strain affects neurovirulence in mice. J Gen Virol 77 (October 1996) : 2541-5.

[129] Sistayanarain, A., Maneekarn, N., Polprasert, B., Sirisanthana, V., Makino, Y., Fukunaga, T., et al. Primary sequence of the envelope glycoprotein of a dengue type 2 virus isolated from patient with dengue hemorrhagic fever and encephalopathy. Southeast Asian J Trop Med Public Health 27 (June 1996) : 221-7.

[130] Hertzog, M.A. Considerations in determining sample size for pilot studies. Res Nurs Health 31 (April 2008) : 180-91.

[131] Falsey, A.R., Formica, M.A., Treanor, J.J.,and Walsh, E.E. Comparison of quantitative reverse transcription-PCR to viral culture for assessment of respiratory syncytial virus shedding. J Clin Microbiol 41 (September 2003) : 4160-5.

[132] Vanlandingham, D.L., Schneider, B.S., Klingler, K., Fair, J., Beasley, D., Huang, J., et al. Real-time reverse transcriptase-polymerase chain reaction quantification of West Nile virus transmitted by Culex pipiens quinquefasciatus. Am J Trop Med Hyg 71 (July 2004) : 120-3.

[133] Dhanasekaran, S., Doherty, T.M.,and Kenneth, J. Comparison of different standards for real-time PCR-based absolute quantification. J Immunol Methods 354 (March 2010) : 34-9.

[134] Viral Bioinformatics Resource Center. Dengue virus database [Online] 2004. Available from : http://www.denguedb.org/index.asp [2012, September 15].

[135] Figueiredo, R.M., Naveca, F.G., Oliveira, C.M., Bastos Mde, S., Mourao, M.P., Viana Sde, S., et al. Co-infection of Dengue virus by serotypes 3 and 4 in patients from Amazonas, Brazil. Rev Inst Med Trop Sao Paulo 53 (December 2011) : 321-3.

[136] Hall, T.A. BioEdit: a user-friendly biological sequence alignment editor and analysis program for Windows 95/98/NT. Nucl Acids Symp Ser 41

(1999) : 95-8.

[137] Pawlotsky, J.M., Germanidis, G., Neumann, A.U., Pellerin, M., Frainais, P.O.,and Dhumeaux, D. Interferon resistance of hepatitis C virus genotype 1b: relationship to nonstructural 5A gene quasispecies mutations. J Virol 72 (April 1998) : 2795-805.

[138] Kosakovsky Pond, S.L.,and Frost, S.D. Not so different after all: a comparison of methods for detecting amino acid sites under selection. Mol Biol Evol 22 (May 2005) : 1208-22.

[139] Pond, S.L.,and Frost, S.D. Datamonkey: rapid detection of selective pressure on individual sites of codon alignments. Bioinformatics 21 (May 15 2005) : 2531-3.

[140] Vasilakis, N., Holmes, E.C., Fokam, E.B., Faye, O., Diallo, M., Sall, A.A., et al. Evolutionary processes among sylvatic dengue type 2 viruses. J Virol 81 (September 2007) : 9591-5.

[141] Huhtamo, E., Uzcategui, N.Y., Siikamaki, H., Saarinen, A., Piiparinen, H., Vaheri, A., et al. Molecular epidemiology of dengue virus strains from Finnish travelers. Emerg Infect Dis 14 (Jan 2008) : 80-3.

[142] Tamura, K., Peterson, D., Peterson, N., Stecher, G., Nei, M.,and Kumar, S. MEGA5: molecular evolutionary genetics analysis using maximum likelihood, evolutionary distance, and maximum parsimony methods. Mol Biol Evol 28 (October 2011) : 2731-9.

[143] Puiprom, O., Yamashita, A., Sasayama, M., Limkittikul, K., Boonha, K., Jittmitraphap, A., et al. Co-existence of major and minor viral populations from two different origins in patients secondarily infected with dengue virus serotype 2 in Bangkok. Biochem Biophys Res Commun 413 (September 2011) : 136-42.

[144] Gromowski, G.D., Barrett, N.D.,and Barrett, A.D. Characterization of dengue virus complex-specific neutralizing epitopes on envelope protein domain III of dengue 2 virus. J Virol 82 (September 2008) : 8828-37.

[145] Sriprom, M., Pongsumpun, P., Yoksan, S., Barbazan, P., Gonzalez, J.P.,and Tang, M.I. Dengue haemorrhagic fever in Thailand, 1998-2003:

Primary or secondary infection. Den Bull 27 (2003) : 39-45.

[146] Kittigul, L., Suankeow, K., Sujirarat, D.,and Yoksan, S. Dengue hemorrhagic fever: knowledge, attitude and practice in Ang Thong Province, Thailand. Southeast Asian J Trop Med Public Health 34 (June 2003) : 385-92.

[147] Imrie, A., Meeks, J., Gurary, A., Sukhbaatar, M., Truong, T.T., Cropp, C.B., et al. Antibody to dengue 1 detected more than 60 years after infection. Viral Immunol 20 (December 2007) : 672-5.

[148] Halstead, S.B. Etiologies of the experimental dengues of Siler and Simmons. Am J Trop Med Hyg 23 (September 1974) : 974-82.

[149] Okuno, Y., Fukunaga, T., Tadano, M., Fukai, K., Ikeda, T., Sekii, K., et al. Serological studies on volunteers inoculated experimentally with a dengue virus strain in 1943. Biken J 26 (December 1983) : 161-3.

[150] Bona, A.C., Twerdochlib, A.L.,and Navarro-Silva, M.A. Genetic diversity of dengue virus serotypes 1 and 2 in the State of Parana, Brazil, based on a fragment of the capsid/premembrane junction region. Rev Soc Bras Med Trop 45 (June 2012) : 297-300.

[151] Chinnawirotpisan, P., Mammen, M.P., Jr., Nisalak, A., Thaisomboonsuk, B., Narupiti, S., Thirawuth, V., et al. Detection of concurrent infection with multiple dengue virus serotypes in Thai children by ELISA and nested RT-PCR assay. Arch Virol 153 2008) : 2225-32.

[152] Dissanayake, V.H., Gunawardena, N.D., Gunasekara, N.C., Siriwardhana, D.R.,and Senarath, N. Shift in the transmission pattern of dengue serotypes and concurrent infection with more than one dengue virus serotype. Ceylon Med J 56 (December 2011) : 176-8.

[153] dos Santos, C.L., Bastos, M.A., Sallum, M.A.,and Rocco, I.M. Molecular characterization of dengue viruses type 1 and 2 isolated from a concurrent human infection. Rev Inst Med Trop Sao Paulo 45 (January-February 2003) : 11-6.

[154] Gupta, E., Dar, L.,and Broor, S. Concurrent infection by two dengue virus serotypes among dengue patients. Indian J Med Microbiol 26 (October-December 2008) : 402-3.

[155] Lorono-Pino, M.A., Cropp, C.B., Farfan, J.A., Vorndam, A.V., Rodriguez-Angulo, E.M., Rosado-Paredes, E.P., et al. Common occurrence of concurrent infections by multiple dengue virus serotypes. Am J Trop Med Hyg 61 (November 1999) : 725-30.

[156] Pessanha, J.E., Caiaffa, W.T., Cecilio, A.B., Iani, F.C., Araujo, S.C., Nascimento, J.C., et al. Cocirculation of two dengue virus serotypes in individual and pooled samples of Aedes aegypti and Aedes albopictus larvae. Rev Soc Bras Med Trop 44 (January-February 2011) : 103-5.

[157] Pongsiri, P., Themboonlers, A.,and Poovorawan, Y. Changing pattern of dengue virus serotypes in Thailand between 2004 and 2010. J Health Popul Nutr 30 (September 2012) : 366-70.

[158] Pepin, K.M., Lambeth, K.,and Hanley, K.A. Asymmetric competitive suppression between strains of dengue virus. BMC Microbiol 8 (2008) : 28.

[159] Lole, K.S., Bollinger, R.C., Paranjape, R.S., Gadkari, D., Kulkarni, S.S., Novak, N.G., et al. Full-length human immunodeficiency virus type 1 genomes from subtype C-infected seroconverters in India, with evidence of intersubtype recombination. J Virol 73 (January 1999) : 152-60.

[160] Chang, S.F., Su, C.L., Shu, P.Y., Yang, C.F., Liao, T.L., Cheng, C.H., et al. Concurrent isolation of chikungunya virus and dengue virus from a patient with coinfection resulting from a trip to Singapore. J Clin Microbiol 48 (December 2010) : 4586-9.

[161] Huang, J.H., Liao, T.L., Chang, S.F., Su, C.L., Chien, L.J., Kuo, Y.C., et al. Laboratory-based dengue surveillance in Taiwan, 2005: a molecular epidemiologic study. Am J Trop Med Hyg 77 (November 2007) : 903-9.

[162] Klungthong, C., Putnak, R., Mammen, M.P., Li, T.,and Zhang, C. Molecular genotyping of dengue viruses by phylogenetic analysis of the sequences of individual genes. J Virol Methods 154 (December 2008) : 175-81.

[163] Ong, S.H., Yip, J.T., Chen, Y.L., Liu, W., Harun, S., Lystiyaningsih, E., et al. Periodic re-emergence of endemic strains with strong epidemic potential-a proposed explanation for the 2004 Indonesian dengue epidemic. Infect Genet Evol 8 (March 2008) : 191-204.

[164] Shu, P.Y., Su, C.L., Liao, T.L., Yang, C.F., Chang, S.F., Lin, C.C., et al. Molecular characterization of dengue viruses imported into Taiwan during 2003-2007: geographic distribution and genotype shift. Am J Trop Med Hyg 80 (June 2009) : 1039-46.

[165] Zhang, C., Mammen, M.P., Jr., Chinnawirotpisan, P., Klungthong, C., Rodpradit, P., Nisalak, A., et al. Structure and age of genetic diversity of dengue virus type 2 in Thailand. J Gen Virol 87 (April 2006) : 873-83.

[166] Fatima, Z., Idrees, M., Bajwa, M.A., Tahir, Z., Ullah, O., Zia, M.Q., et al. Serotype and genotype analysis of dengue virus by sequencing followed by phylogenetic analysis using samples from three mini outbreaks-2007-2009 in Pakistan. BMC Microbiol 11 (2011) : 200.

[167] Tissera, H.A., Ooi, E.E., Gubler, D.J., Tan, Y., Logendra, B., Wahala, W.M., et al. New dengue virus type 1 genotype in Colombo, Sri Lanka. Emerg Infect Dis 17 (November 2011) : 2053-5.

[168] de Oliveira Poersch, C., Pavoni, D.P., Queiroz, M.H., de Borba, L., Goldenberg, S., dos Santos, C.N., et al. Dengue virus infections: comparison of methods for diagnosing the acute disease. J Clin Virol 32 (April 2005) : 272-7.

[169] Paudel, D., Jarman, R., Limkittikul, K., Klungthong, C., Chamnanchanunt, S., Nisalak, A., et al. Comparison of real-time SYBR green dengue assay with real-time taqman RT-PCR dengue assay and the conventional nested PCR for diagnosis of primary and secondary dengue infection. N Am J Med Sci 3 (October 2011) : 478-85.

[170] Kwok, S.,and Higuchi, R. Avoiding false positives with PCR. Nature 339 (May 1989) : 237-8.

[171] Boonpucknavig, V., Bhamarapravati, N., Boonpucknavig, S., Futrakul, P.,and Tanpaichitr, P. Glomerular changes in dengue hemorrhagic

fever. Arch Pathol Lab Med 100 (April 1976) : 206-12.

[172] Srikiatkhachorn, A., Wichit, S., Gibbons, R.V., Green, S., Libraty, D.H., Endy, T.P., et al. Dengue viral RNA levels in peripheral blood mononuclear cells are associated with disease severity and preexisting dengue immune status. PLoS One 7 (2012) : e51335.

[173] White, P.A., Pan, Y., Freeman, A.J., Marinos, G., Ffrench, R.A., Lloyd, A.R., et al. Quantification of hepatitis C virus in human liver and serum samples by using LightCycler reverse transcriptase PCR. J Clin Microbiol 40 (November 2002) : 4346-8.

[174] Sudiro, T.M., Zivny, J., Ishiko, H., Green, S., Vaughn, D.W., Kalayanarooj, S., et al. Analysis of plasma viral RNA levels during acute dengue virus infection using quantitative competitor reverse transcription-polymerase chain reaction. J Med Virol 63 (January 2001) : 29-34.

[175] Gubler, D.J., Suharyono, W., Tan, R., Abidin, M.,and Sie, A. Viraemia in patients with naturally acquired dengue infection. Bull World Health Organ 59 (1981) : 623-30.

[176] Komurian-Pradel, F., Perret, M., Deiman, B., Sodoyer, M., Lotteau, V., Paranhos-Baccala, G., et al. Strand specific quantitative real-time PCR to study replication of hepatitis C virus genome. J Virol Methods 116 (March 2004) : 103-6.

[177] Lin, L., Fevery, J.,and Hiem Yap, S. A novel strand-specific RT-PCR for detection of hepatitis C virus negative-strand RNA (replicative intermediate) : evidence of absence or very low level of HCV replication in peripheral blood mononuclear cells. J Virol Methods 100 (February 2002) : 97-105.

[178] Vaughan, G., Olivera, H., Santos-Argumedo, L., Landa, A., Briseno, B.,and Escobar-Gutierrez, A. Dengue virus replicative intermediate RNA detection by reverse transcription-PCR. Clin Diagn Lab Immunol 9 (January 2002) : 198-200.

[179] Chang, M., Marquardt, A.P., Wood, B.L., Williams, O., Cotler, S.J., Taylor, S.L., et al. In situ distribution of hepatitis C virus replicative-intermediate RNA in hepatic tissue and its correlation with liver

disease. J Virol 74 (January 2000) : 944-55.

[180] Fan, X., Solomon, H., Poulos, J.E., Neuschwander-Tetri, B.A.,and Di Bisceglie, A.M. Comparison of genetic heterogeneity of hepatitis C viral RNA in liver tissue and serum. Am J Gastroenterol 94 (May 1999) : 1347-54.

[181] Chavez, J.H., Silva, J.R., Amarilla, A.A.,and Moraes Figueiredo, L.T. Domain III peptides from flavivirus envelope protein are useful antigens for serologic diagnosis and targets for immunization. Biologicals 38 (November 2010) : 613-8.

[182] Dickover, R.E., Garratty, E.M., Plaeger, S.,and Bryson, Y.J. Perinatal transmission of major, minor, and multiple maternal human immunodeficiency virus type 1 variants in utero and intrapartum. J Virol 75 (March 2001) : 2194-203.

[183] Woelk, C.H.,and Holmes, E.C. Reduced positive selection in vector-borne RNA viruses. Mol Biol Evol 19 (December 2002) : 2333-6.

[184] Holmes, E.C. Patterns of intra- and interhost nonsynonymous variation reveal strong purifying selection in dengue virus. J Virol 77 (October 2003) : 11296-8.

[185] Goncalves, D., de Queiroz Prado, R., Almeida Xavier, E., Cristina de Oliveira, N., da Matta Guedes, P.M., da Silva, J.S., et al. Imunocompetent mice model for dengue virus infection. ScientificWorldJournal (2012) : 525947.

[186] Quan, Y., Brenner, B.G., Dascal, A.,and Wainberg, M.A. Highly diversified multiply drug-resistant HIV-1 quasispecies in PBMCs: a case report. Retrovirology 5 (2008) : 43.

[187] Lohmann, V., Korner, F., Dobierzewska, A.,and Bartenschlager, R. Mutations in hepatitis C virus RNAs conferring cell culture adaptation. J Virol 75 (February 2001) : 1437-49.

[188] Inoue, J., Ueno, Y., Wakui, Y., Fukushima, K., Kondo, Y., Kakazu, E., et al. Enhanced replication of hepatitis B virus with frameshift in the precore region found in fulminant hepatitis patients. J Infect Dis 204 (October 2011) : 1017-25.

[189] Luby, J.P., Murphy, F.K., Gilliam, J.N., Kang, C.Y., and Frank, R. Antigenuria in St. Louis encephalitis. Am J Trop Med Hyg 29 (March 1980) : 265-8.

[190] Chuansumrit, A., Chaiyaratana, W., Tangnararatchakit, K., Yoksan, S., Flamand, M.,and Sakuntabhai, A. Dengue nonstructural protein 1 antigen in the urine as a rapid and convenient diagnostic test during the febrile stage in patients with dengue infection. Diagn Microbiol Infect Dis 71 (December 2011) : 467-9.

APPENDICES

APPENDIX A

Chemical and reagent preparations

0.5 M EDTA (pH 8.0)

Dissolve EDTA.$2H_2O$ 186.1 g in distilled water 800 ml. Then mix gently and adjust pH to 8.0 with NaOH. Autoclave the solution at 121 °C, 15 lb/inch^2 for 15 minutes.

5X Tris borate (TBE)

Tris base	54	g
Boric acid	27.5	g
0.5 M EDTA (pH 8.0)	20	ml

Adjust the volume to 1000 ml by distilled water. Keep the solution at room temperature.

Phosphate buffer saline (PBS) pH 7.4

NaCl	8	g
KCl	0.2	g
Na_2HPO_4	1.44	g
KH_2PO_4	0.24	g

Dissolve in distilled water, adjust volume to 1000 ml and pH to 7.4. Incubate 37°C overnight and Autoclave the solution at 121 °C, 15 lb/inch^2 for 15 minutes.

5M NaOH

NaOH	200	g

Dissolve in distilled water and adjust volume to 1000 ml. Keep the solution at room temperature.

5M NaCl

NaCl	292.2	g

Dissolve in distilled water and adjust volume to 1000 ml. Keep the solution at room temperature.

1M Tris-HCl (pH 8.0)

Tris base	121.1	g

Dissolve in distilled water and adjust pH to 8.0 with HCl. Then adjust volume to 1000 ml. Autoclave the solution at 121 °C, 15 lb/inch^2 for 15 minutes.

0.5 µg/ml ethidium bromide

Stock ethidium bromide 10 mg/ml	12.5	µl
Distilled water	237.5	ml

Mix gently and keep the solution in the dark chamber (light protection).

1.5% and 2% agarose gel electrophoresis

Agarose	1.5	g (for 1.5%) and 2 g (for 2%)
1X TBE	100	ml

Mix gently and heat with a microwave machine. Wait the gel solution until it cools down. Then pour the gel into gel chamber.

100 mg/ml specitinomycin

Spectinomycin	1	g
DNase and Rnase free water	10	ml

Mix gently and filter the solution through 0.2 µm pore size paper. Divide the solution in small volume and keep it at -20°C.

SOB medium*

Tryptone	20	g

Yeast extract	5	g
NaCl	5	g

Add distilled to a final of 1000 ml and autoclave the solution at 121 °C, 15 lb/inch^2 for 15 minutes. Add 10 ml of filter-sterilized 1M $MgCl_2$ and 10 ml of filtered sterilized 1M $MgSO_4$ before use.

SOC medium*

Prepare immediately before use by adding 1 ml of filter-sterized 2M glucose and adjust to final volume of 100 ml with SOC medium.

LB (Luria-Bertani) broth with 100 µg/ml spectinomycin

Tryptone	2.5	g
Yeast extract	1.25	g
NaCl	2.5	g

Dissolve in distilled water, adjust pH 7.0 and final volume of 250 ml. Autoclave the solution at 121 °C, 15 lb/inch^2 for 15 minutes. Wait the medium becomes warm. Then add 250µl of 10 mg/ml spectinomycin to prepare LB broth with 100 µg/ml.

LB (Luria-Bertani) agar with 100 µg/ml spectinomycin

Tryptone	2	g
Yeast extract	1	g
NaCl	2	g
Agar	4	g

Dissolve in distilled water, adjust pH 7.0 and final volume of 200 ml. Autoclave the solution at 121 °C, 15 lb/inch^2 for 15 minutes. Wait the medium becomes warm. Then add 200µl of 10 mg/ml spectinomycin to prepare LB agar with 100 µg/ml. Pour the medium into petri dishes (~25 ml/100 mm plate).

* The protocols are taken from StrataCloneTMSoloPack®Competent Cells data sheets (USA).

APPENDIX B

Summary data of specimen collections in dengue and non-dengue infected patients

Table 34: Summary data of specimen collections from both dengue and non dengue-infected patients

Code	DOF	Acute period (Febrile period)				Early convalescent period (After fever – day 25 of illness)				Late convalescent period (day 26 – day 90 of illness)			
		Pl	PB	S	U	Pl	PB	S	U	Pl	PB	S	U
N2	4	+ (3)	+ (3)	+ (3)	+ (3)	+ (21)	+ (21)	+ (21)	+ (21)	+ (90)	+ (90)	+ (90)	+ (90)
N3	7	+ (7)	+ (7)	+ (7)	+ (7)	+ (22)	+ (22)	+ (22)	+ (22)	+ (75)	+ (75)	+ (75)	+ (75)
N4	5	+ (5)	+ (5)	+ (5)	+ (5)	+ (21)	+ (21)	+ (21)	+ (21)	ND	ND	ND	ND
N5	7	+ (6)	+ (6)	+ (6)	+ (6)	+ (23)	+ (23)	+ (23)	+ (23)	ND	ND	ND	ND
N6	6	+ (4)	+ (4)	+ (4)	+ (4)	+ (23)	+ (23)	+ (23)	+ (23)	+ (80)	+ (80)	+ (80)	+ (80)
N8[¥]	5	ND	ND	ND	ND	+ (7) (25)	+ (7) (25)	+ (7) (25)	+ (7) (25)	ND	ND	ND	ND
N9[○]	9	+ (9)	+ (9)	+ (9)	+ (9)	+ (15)	+ (15)	+ (15)	+ (15)	+ (30) + (90)	+ (30) + (90)	+ (30) + (90)	+ (30) + (90)
N10[○]	5	+ (4)	+ (4)	+ (4)	+ (4)	ND	ND	ND	ND	+ (27) (90)	+ (27) (90)	+ (27) (90)	+ (27) (90)
N12[○]	6	+ (4)	+ (4)	+ (4)	+ (4)	+ (12)	+ (12)	+ (12)	+ (12)	+ (26) (75)	+ (26) (75)	+ (26) (75)	+ (26) (75)
N13[¥○]	5	ND	ND	ND	ND	+ (8) (15)	+ (8) (15)	+ (8) (15)	+ (8) (15)	+ (29) (64)	+ (29) (64)	+ (29) (64)	+ (29) (64)
N17	7	+ (7)	+ (7)	+ (7)	+ (7)	+ (13)	+ (13)	+ (13)	+ (13)	+ (33)	+ (33)	+ (33)	+ (33)
N20	8	ND	ND	+ (6)	+ (6)	ND	ND	ND	ND	+ (30)	+ (30)	+ (30)	+ (30)
N21[¥]	7	+ (7)	+ (7)	+ (7)	+ (7)	+ (14)	+ (14)	+ (14)	+ (14)	ND	ND	ND	ND

Code	DOF	Acute period (Febrile period)				Early convalescent period (After fever – day 25 of illness)				Late convalescent period (day 26 – day 90 of illness)			
		Pl	PB	S	U	Pl	PB	S	U	Pl	PB	S	U
N21¥	7					(24)	(24)	(24)	(24)				
N22	7	+ (4)	+ (4)	+ (4)	+ (4)	+ (24)	+ (24)	+ (24)	+ (24)	ND	ND	ND	ND
N23	8	+ (7)	+ (7)	+ (7)	+ (7)	+ (17)	+ (17)	+ (17)	+ (17)	+ (45)	+ (45)	+ (45)	+ (45)
N24°	6	+ (3)	+ (3)	+ (3)	+ (3)	+ (13)	+ (13)	+ (13)	+ (13)	+ (32) (49)	+ (32) (49)	+ (32) (49)	+ (32) (49)
N28°	8	+ (6)	+ (6)	+ (6)	+ (6)	+ (14)	+ (14)	+ (14)	+ (14)	+ (46) (90)	+ (46) (90)	+ (46) (90)	+ (46) (90)
N29	8	+ (5)	+ (5)	+ (5)	+ (5)	+ (19)	+ (19)	+ (19)	+ (19)	+ (33)	+ (33)	+ (33)	+ (33)
N30	9	+ (7)	+ (7)	+ (7)	+ (7)	+ (20)	+ (20)	+ (20)	+ (20)	+ (38)	+ (38)	+ (38)	+ (38)
N33¥	6	ND	ND	ND	ND	+ (7) (18)	+ (7) (18)	+ (7) (18)	+ (7) (18)	+ (31)	+ (31)	+ (31)	+ (31)
N34¥	6	ND	ND	ND	ND	+ (8) (14)	+ (8) (14)	+ (8) (14)	+ (8) (14)	+ (28)	+ (28)	+ (28)	+ (28)
N35¥	5	ND	ND	ND	ND	+ (7) (13)	+ (7) (13)	+ (7) (13)	+ (7) (13)	+ (27)	+ (27)	+ (27)	+ (27)
N40	4	+ (4)	+ (4)	+ (4)	+ (4)	+ (21)	+ (21)	+ (21)	+ (21)	+ (71)	+ (71)	+ (71)	+ (71)
N16*°	7	+ (6)	+ (6)	+ (6)	+ (6)	+ (13)	+ (13)	+ (13)	+ (13)	+ (34) (64)	+ (34) (64)	+ (34) (64)	+ (34) (64)
N27*	6	+ (5)	+ (5)	+ (5)	+ (5)	+ (14)	+ (14)	+ (14)	+ (14)	+ (54)	+ (54)	+ (54)	+ (54)
N37*	5	+ (4)	+ (4)	+ (4)	+ (4)	ND	ND	ND	ND	+ (28)	+ (28)	+ (28)	+ (28)
N39*	9	+ (1)	+ (1)	+ (1)	+ (1)	+ (15)	+ (15)	+ (15)	+ (15)	+ (33)	+ (33	+ (33)	+ (33)
N43*	15	+ (5)	+ (5)	+ (5)	+ (5)	+ (23)	+ (23)	+ (23)	+ (23)	+ (33)	+ (33)	+ (33)	+ (33)

+ = have specimen collection. ND = not have specimen collection. DOF = duration of fever.

¥ = have double specimen collections during early convalescent period. ° = have double specimen collections during late convalescent period. * = non dengue-infected patients. Pl = plasma, PB = PBMCs, S = saliva, U = urine. The number in "( )" presents the day of specimen collection.

APPENDIX C

The ELISA results of all DENV and non-DENV infected patients

Table 35: The ELISA results of 23 DENV-infected and 5 non-DENV infected patients

Code	DOF (day)	Clinical diagnosis	Day of specimen collection	IgM (Units)	IgG (Units)	IgM:IgG ratio	Interpretation
N2	4	DHF II	3	53	107	< 1.8	Secondary
			21	37	128		
			90	1	61		
N3	7	DHF II	7	55	25	< 1.8	Secondary
			22	58	66		
			75	38	38		
N4	5	DHF II	5	6	134	< 1.8	Secondary
			21	0	134		
N5	7	DHF II	6	25	126	< 1.8	Secondary
			23	62	129		
N6	6	DHF I	4	112	126	< 1.8	Secondary
			23	96	112		
			80	32	61		
N8	5	DHF I	7	64	86	< 1.8	Secondary
			25	41	93		
N9	9	DHF II	9	66	122	< 1.8	Secondary
			15	51	116		
			30	30	103		
			90	0	44		
N10	5	DHF II	4	4	10	< 1.8	Secondary
			27	66	129		
			90	48	103		
N12	6	DHF II	4	56	74	< 1.8	Secondary
			12	73	113		
			26	65	119		
			75	32	76		
N13	5	DHF I	8	101	101	<1.8	Secondary
			15	97	95		

Code	DOF (day)	Clinical diagnosis	Day of specimen collection	IgM (Units)	IgG (Units)	IgM:IgG ratio	Interpretation
N13	5	DHF I	29	85	85		
			64	33	33		
N17	7	DHF I	7	84	123	< 1.8	Secondary
			13	85	136		
			33	72	137		
N20	8	DHF I	6	ND	ND	< 1.8	Secondary
			30	75	112		
N21	7	DF	7	24	97	< 1.8	Secondary
			14	37	129		
			24	32	115		
N22	7	DHF II	4	66	93	< 1.8	Secondary
			24	59	94		
N23	8	DHF I	7	44	101	< 1.8	Secondary
			17	64	130		
			45	19	102		
N24	6	DSS	3	0	8	< 1.8	Secondary
			13	28	136		
			32	10	108		
			49	0	44		
N28	8	DHF II	6	49	0	< 1.8	Secondary
			14	87	66		
			46	78	53		
			90	62	38		
N29	8	DHF II	5	1	54	< 1.8	Secondary
			19	126	128		
			33	117	122		
N30	9	DHF III	7	9	36	< 1.8	Secondary
			20	32	122		
			38	23	110		
N33	6	DHF III	7	26	93	< 1.8	Secondary
			18	49	113		
			31	55	106		
N34	6	DHF II	8	98	9	>1.8	Primary
			14	101	27		

Code	DOF (day)	Clinical diagnosis	Day of specimen collection	IgM (Units)	IgG (Units)	IgM:IgG ratio	Interpretation
N34	6	DHF II	28	75	17		
N35	5	DHF II	7	24	120	< 1.8	Secondary
			13	27	123		
			27	17	105		
N40	4	DHF II	4	3	13	<1.8	Secondary
			21	59	117		
			71	6	82		
Negative control patient results (non-DENV-infected patients)							
N16	7	Graves'	6	9	13	ND	ND
		disease	13	9	10		
			34	7	4		
			64	8	8		
N27	6	Unspecified	5	1	19	ND	ND
		viral	14	3	13		
		infection	54	0	18		
N37	5	Influenza	4	4	13	ND	ND
		virus	28	0	10		
		infection					
N39	9	Unspecified	7	1	8	ND	ND
		viral	15	0	3		
		infection	33	0	2		
N43	15	Influenza	4	2	15	ND	ND
		virus	23	2	13		
		infection	33	1	10		

DOF= duration of fever. ND = not determined.

The IgM $\geq$ 40 units and IgG $\geq$ 100 units are considered as positive. IgM: IgG $\geq$ 1.8 is interpreted as primary DENV infection whereas < 1.8 is secondary infection.

Non-dengue diagnosis means the patients diagnosed other febrile illness.

The controls of this assay give the acceptable results (OD of NC = 0.076, < 0.1 is acceptable and OD of weak positive control (WPC) of mixed 4 serotypes = 0.288 (IgM) and 0.290 (IgG), acceptable OD is 0.25-0.60 for mixed 4 serotypes IgM and IgG).

Definitions: acute period (duration of fever), early convalescent period (first day of fever recovery until day 25 of illness) and late convalescent period (day 26 – day 90 of illness).

APPENDIX D

Comparison of the longest time of DENV detection

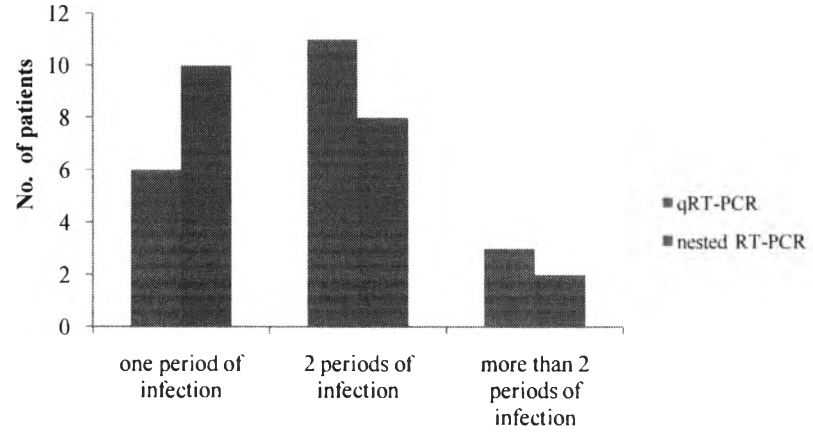

Figure 46: The comparison of the latest time of DENV detection in dengue-infected patients when using real time RT-PCR (qRT-PCR) and nested RT-PCR.

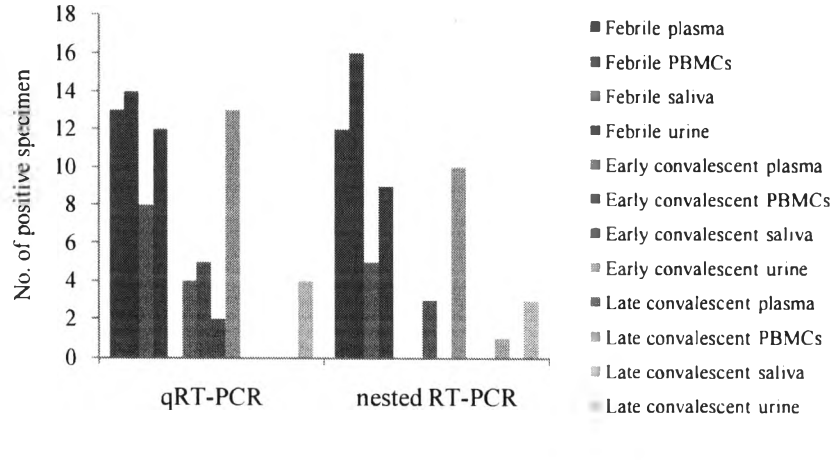

Figure 47: The comparison of DENV detection in different specimens and time points of dengue-infected patients when using real time RT-PCR (qRT-PCR) and nested RT-PCR.

APPENDIX E

Molecular techniques for negative strand detection (Tagged RT-PCR)

During viral replication of positive sense single strand RNA viruses, negative strand is synthesized as a template for new positive strand synthesis. The presence of negative strand may point out the evidence of viral replication. RT-PCR is applied to detect viral negative strand by using forward primer to generated cDNA and following by PCR assay. Strand specific RT-PCR known as tagged RT-PCR has been developed to detect negative strand detection.

Tagged RT-PCR is based on the use of modified forward primer with short oligonucleotide sequence at 5'end (Tag-F primer). Added oligonucleotide sequences are known as 'tag' primers not randomly bind with the target gene of interest. After cDNA synthesis, the reaction mixture is purified to reduce trace primer and non binding RNA with tag-F primer. PCR is done by using tag primers (without forward primer) as forward primer and reverse gene specific primer. Tagged RT-PCR can also be applied in real time RT-PCR. However, gel electrophoresis to confirm the result after doing real time RT-PCR is necessary because the result of real time PCR may be inconclusive especially when using SYBR Green I detection system. The diagram of tagged RT-PCR is presented in Figure 48.

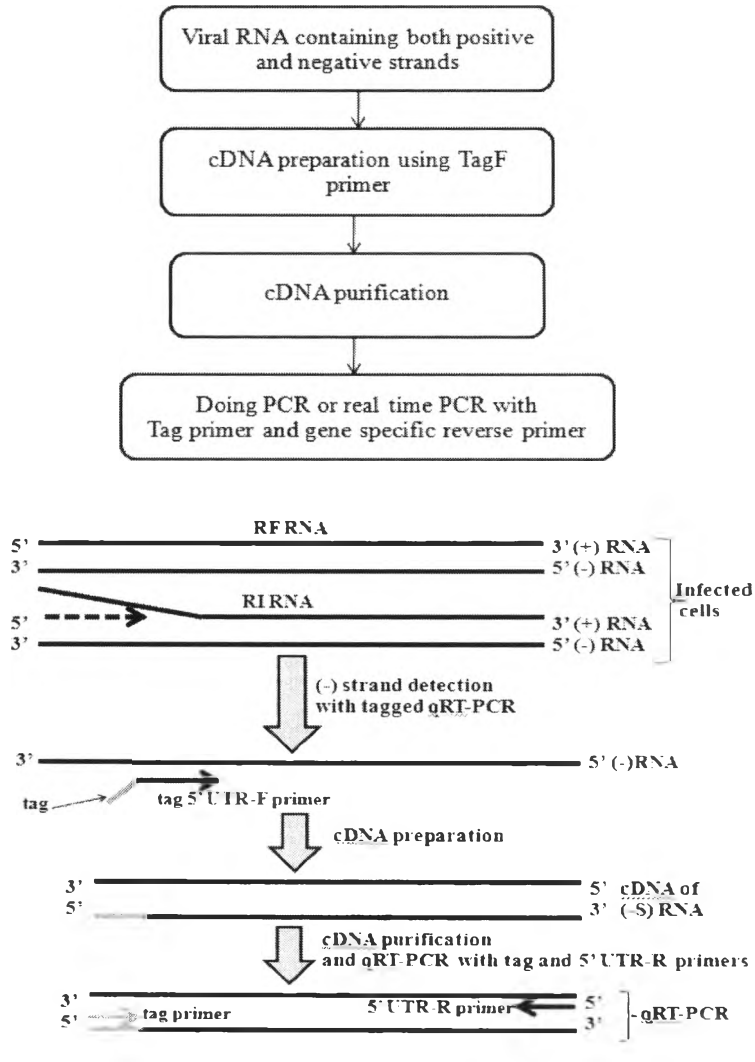

Figure 48: The strategy of tagged RT-PCR assay (Adapted from Peyrefitte *et al.* [82])

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2. **Oral Presentation:** "Prolonged and differential shedding of dengue virus serotype 2 (DEN2) in plasma, PBMCs, saliva and urine of adult patients during acute infection" 22nd European Congress of Clinical Microbiology and Infectious Diseases (ECCMID) London, United Kingdom, 31 March – 4 April 2012.
3. **Poster Presentation:** "Presence of multiple dengue serotypes in various body compartments in different time points of single clinical episodes" 22nd European Congress of Clinical Microbiology and Infectious Diseases (ECCMID) London, United Kingdom, 31 March – 4 April 2012.
4. **Poster Presentation:** "Presence of heterogeneous population of dengue virus serotype 2 (DENV2) in different body compartments and time points in adults" IDWEEK™2012, San Diego (CA), USA, 17-21 October 2012.

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