

6. References

- Abbatte, E.A., Fox, E., Said, S., Constantine, N.T. & Wassef, H.H. (1989) Ethnic differences in the prevalence of hepatitis delta agent in Djibouti. *Trans. R. Soc. trop. Med. Hyg.*, **83**, 107-108
- Aceti, A., Paparo, B.S., Celestino, D., Pennica, A., Caferro, M., Grilli, A., Sebastiani, A., Mohamud, O.M., Abdirahman, M. & Bile, K. (1989) Sero-epidemiology of hepatitis delta virus infection in Somalia. *Trans. R. Soc. trop. Med. Hyg.*, **83**, 399-400
- Arankalle, V.A., Ramamoorthy, C.L. & Banerjee, K. (1992) Seroepidemiology of hepatitis delta virus infection in Pune, India. *Trans. R. Soc. trop. Med. Hyg.*, **86**, 89
- Arico, S., Aragona, M., Rizzetto, M., Caredda, F., Zanetti, A., Marinucci, G., Diana, S., Farci, P., Arnone, M., Caporaso, N., Ascione, A., Dentico, P., Pastore, G., Raimondo, G. & Craxi, A. (1985) Clinical significance of antibody to the hepatitis delta virus in symptomless HBsAg carriers. *Lancet*, **ii**, 356-358

- Arrigoni, A., Ponzetto, A., Actis, G. & Bonino, F. (1983) Levamisole and chronic delta hepatitis (Letter to the Editor). *Ann. intern. Med.*, **98**, 1024
- Ashraf, S.J., Arya, S.C., Parande, C.M., Sahay, R. & Ageel, A.R. (1986) Anti-delta antibody in primary hepatocellular carcinoma patients in the Gizan area of Saudi Arabia. *Infection*, **14**, 250-251
- Bensabath, G., Hadler, S.C., Soares, P., Fields, H., Dias, L.B., Popper, H. & Maynard, J.E. (1987) Hepatitis delta virus infection and Labrea hepatitis. Prevalence and role in fulminant hepatitis in the Amazon basin. *J. Am. med. Assoc.*, **258**, 479-483
- Bergmann, K.F. & Gerin, J.L. (1986) Antigens of hepatitis delta virus in the liver and serum of humans and animals. *J. infect. Dis.*, **154**, 702-706
- Blum, H.E., Stowring, L., Figus, A., Montgomery, C.K., Haase, A.T. & Vyas, G.N. (1983) Detection of hepatitis B virus DNA in hepatocytes, bile duct epithelium, and vascular elements by in situ hybridization. *Proc. natl Acad. Sci. USA*, **80**, 6685-6688
- Bonino, F., Negro, F., Baldi, M., Brunetto, M.R., Chiaberge, E., Capalbo, M., Maran, E., Lavarini, C., Rocca, N. & Rocca, G. (1987) The natural history of chronic delta hepatitis. *Prog. clin. biol. Res.*, **234**, 145-152
- Boroń, P., Boroń-Kaczmarek, A., Bobrowska, E., Kamińska, H. & Łapiński, W. (1987) Prevalence of anti-delta antibodies in selected populations of HBsAg carriers in the Bialystok region, Poland. *Prog. clin. biol. Res.*, **234**, 427
- Branch, A.D., Benenfeld, B.J., Baroudy, B.M., Wells, F.V., Gerin, J.L. & Robertson, H.D. (1989) An ultraviolet-sensitive RNA structural element in a viroid-like domain of the hepatitis delta virus. *Science*, **243**, 649-652
- Branch, A.D., Levine, B.J. & Robertson, H.D. (1990) The brotherhood of circular RNA pathogens: viroids, circular satellites, and the delta agent. *Semin. Virol.*, **1**, 143-152
- Brindle, R.J., Eglin, R.P., Parsons, A.J., Hill, A.V.S. & Selkon, J.B. (1988) HTLV-1, HIV-1, hepatitis B and hepatitis delta in the Pacific and South-east Asia: a serological survey. *Epidemiol. Inf.*, **100**, 153-156
- Bruss, V. & Ganem, D. (1991) The role of envelope proteins in hepatitis B virus assembly. *Proc. natl Acad. Sci. USA*, **88**, 1059-1063
- Buti, M., Esteban, R., Jardí, R., Allende, H., Baselgam J.M. & Guardia, J. (1988) Epidemiology of delta infection in Spain. *J. med. Virol.*, **26**, 327-332
- Caredda, F., Antinori, S., Re, T., Pastecchia, C. & Moroni, M. (1987) Course and prognosis of acute HDV hepatitis. *Prog. clin. biol. Res.*, **234**, 267-276
- Casey, J.L., Bergmann, K.F., Brown, T.L. & Gerin, J.L. (1992) Structural requirements for RNA editing in hepatitis delta virus: evidence for a uridine-to-cytidine editing mechanism. *Proc. natl Acad. Sci. USA*, **89**, 7149-7153
- Cech, T.R. & Bass, B.L. (1986) Biological catalysis by RNA. *Ann. Rev. Biochem.*, **55**, 599-629
- Cenac, A., Develoux, M., Lamothe, F., Soubiran, G., Vetter, J.M., Soumana, I. & Trépo, C. (1987) Delta superinfection in patients with chronic hepatitis liver cirrhosis and hepatocellular carcinoma in a Sahelian area. Study of 112 cases versus 46 controls. *Trans. R. Soc. trop. Med. Hyg.*, **81**, 994-997
- Chang, M.-F., Baker, S.C., Soe, L.H., Kamahora, T., Keck, J.G., Makino, S., Govindarajan, S. & Lai, M.M.C. (1988) Human hepatitis delta antigen is a nuclear phosphoprotein with RNA-binding activity. *J. Virol.*, **62**, 2403-2410
- Chao, Y.-C., Chang, M.-F., Gust, I. & Lai, M.M.C. (1990) Sequence conservation and divergence of hepatitis delta virus RNA. *Virology*, **178**, 384-392
- Chao, M., Hsieh, S.-Y. & Taylor, J. (1991) The antigen of hepatitis delta virus: examination of in vitro RNA-binding specificity. *J. Virol.*, **65**, 4057-4062

- Chen, D.-S., Lai, M.-Y. & Sung, J.-L. (1984) Delta agent infection in patients with chronic liver diseases and hepatocellular carcinoma—an infrequent finding in Taiwan. *Hepatology*, **4**, 502–503
- Chen, P.-J., Kalpana, G., Goldberg, J., Mason, W., Werner, B., Gerin, J. & Taylor, J. (1986) Structure and replication of the genome of the hepatitis delta virus. *Proc. natl Acad. Sci. USA*, **83**, 8774–8778
- Chen, P.-J., Chen, D.-S., Chen, C.-R., Chen, Y.-Y., Chen, H.-M. H., Lai, M.-Y. & Sung, J.-L. (1988) Delta infection in asymptomatic carriers of hepatitis B surface antigen: low prevalence of delta activity and effective suppression of hepatitis B virus replication. *Hepatology*, **8**, 1121–1124
- Chen, P.-J., Yang, P.-M., Chen, C.-R. & Chen, D.-S. (1989) Characterization of the transcripts of hepatitis D and B viruses in infected human livers. *J. infect. Dis.*, **160**, 944–947
- Chen, P.-J., Kuo, M.Y.-P., Chen, M.-L., Tu, S.-J., Chiu, M.-N., Wu, H.-L., Hsu, H.-C. & Chen, D.-S. (1990) Continuous expression and replication of the hepatitis delta virus genome in Hep G2 hepatoblastoma cells transfected with cloned viral DNA. *Proc. natl Acad. Sci. USA*, **87**, 5253–5257
- Chen, P.-J., Chang, F.-L., Wang, C.-J., Lin, C.-J., Sung, S.-Y. & Chen, D.-S. (1992) Functional study of hepatitis delta virus large antigen in packaging and replication inhibition: role of the amino-terminal leucine zipper. *J. Virol.*, **66**, 2853–2859
- Chu, C.-M. & Liaw, Y.-F. (1988) Acute delta superinfection in a previously unrecognised HBsAg carrier with transient loss of HBsAg simulating acute non-A, non-B hepatitis. *Gut*, **29**, 1013–1015
- Craig, J.R., Govindarajan, S. & DeCock, K.M. (1986) Delta viral hepatitis. Histopathology and course. *Pathol. Ann.*, **21**, 1–21
- Craxì, A., Raimondo, G., Giannuoli, G., Longo, G., Caltagirone, M., Aragona, M., Squadrito, G. & Pagliaro, L. (1983) Delta agent and hepatocellular carcinoma. *Prog. clin. biol. Res.*, **143**, 231–234
- Craxì, A., Tinè, F., Vinci, M., Almasio, P., Cammà, C., Garofalo, G. & Pagliaro, L. (1991) Transmission of hepatitis B and hepatitis delta viruses in the households of chronic hepatitis B surface antigen carriers: a regression analysis of indicators of risk. *Am. J. Epidemiol.*, **134**, 641–650
- Cronberg, S., Hansson, B.-G., Thermos, M., Moestrup, T. & Sow, A.M. (1984) Hepatitis D (delta agent) in primary hepatocellular carcinoma and liver disease in Senegal. *Liver*, **4**, 275–279
- Crovati, P., Santolini, M., Bandettini, R., Bonanni, P., Branca, P. & Coppola, R.C. (1991) Epidemiology of HBV and HDV infections in a rural area of Central African Republic. *Prog. clin. biol. Res.*, **364**, 69–73
- Curran, R.A., O'Neill, H.J. & Connolly, J.H. (1991) Hepatitis delta virus infection in Northern Ireland 1970–1989. *Ulster med. J.*, **60**, 159–163
- Denniston, K.J., Hoyer, B.H., Smedile, A., Wells, F.V., Nelson, J. & Gerin, J.L. (1986) Cloned fragment of the hepatitis delta virus RNA genome: sequence and diagnostic application. *Science*, **232**, 873–875
- Dény, P., Zignego, A.L., Rascalou, N., Ponzetto, A., Tiollais, P. & Bréchet, C. (1991) Nucleotide sequence analysis of three different hepatitis delta viruses isolated from a woodchuck and humans. *J. gen. Virol.*, **72**, 735–739
- Di Bisceglie, A.M. & Negro, F. (1989) Diagnosis of hepatitis delta virus infection. *Hepatology*, **10**, 1014–1016
- Di Bisceglie, A.M., Order, S.E., Klein, J.L., Waggoner, J.G., Sjogren, M.H., Kuo, G., Houghton, M., Choo, Q.-L. & Hoofnagle, J.H. (1991) The role of chronic viral hepatitis in hepatocellular carcinoma in the United States. *Am. J. Gastroenterol.*, **86**, 335–338

- Dourakis, S., Karayiannis, P., Goldin, R., Taylor, M., Monjardino, J. & Thomas, H.C. (1991) An in situ hybridization, molecular biological and immunohistochemical study of hepatitis delta virus in woodchucks. *Hepatology*, **14**, 534-539
- Elena, S.F., Dopazo, J., Flores, R., Diener, T.O. & Moya, A. (1991) Phylogeny of viroids, viroidlike satellite RNAs, and the viroidlike domain of hepatitis delta virus RNA. *Proc. natl Acad. Sci. USA*, **88**, 5631-5634
- El Zayadi, A., Ponzetto, A., Selim, O., Forzani, B., Lavarini, C. & Rizzetto, M. (1988) Prevalence of delta antibodies among urban HBsAg-positive chronic liver disease patients in Egypt. *Hepato-gastroenterology*, **35**, 313-315
- Fay, O., Tanno, H., Palazzi, J. & Gatti, H. (1987) Anti-delta antibody in various HBsAg positive Argentine populations. *Prog. clin. biol. Res.*, **234**, 517-518
- da Fonseca, J.C.F. & Simonetti, J.P. (1987) Epidemiology of the hepatitis delta virus (HDV) in Brazil. *Prog. clin. Biol. Res.*, **234**, 507-514
- Garcia, G., Smedile, A., Bergmann, K.F., Gerin, J.L., Gregory, P.B., Merigan, T.C. & Robinson, W.S. (1990) Acute delta hepatitis during treatment with adenosine arabinoside monophosphate with resolution of the HBsAg carrier state. *West. J. Med.*, **153**, 80-82
- Glenn, J.S. & White, J.M. (1991) *trans*-Dominant inhibition of human hepatitis delta virus genome replication. *J. Virol.*, **65**, 2357-2361
- Govindarajan, S., Chin, K.P., Redeker, A.G. & Peters, R.L. (1984a) Fulminant B viral hepatitis: role of delta agent. *Gastroenterology*, **86**, 1417-1420
- Govindarajan, S., Hevia, F.J. & Peters, R.L. (1984b) Prevalence of delta antigen/antibody in B-viral-associated hepatocellular carcinoma. *Cancer*, **53**, 1692-1694
- Govindarajan, S., deCock, K.M. & Redeker, A.G. (1986a) Natural course of delta superinfection in chronic hepatitis B virus-infected patients: histopathologic study with multiple liver biopsies. *Hepatology*, **6**, 640-644
- Govindarajan, S., Fields, H.A., Humphrey, C.D. & Margolis, H.S. (1986b) Pathologic and ultrastructural changes of acute and chronic delta hepatitis in an experimentally infected chimpanzee. *Am. J. Pathol.*, **122**, 315-322
- Gowans, E.J., Baroudy, B.M., Negro, F., Ponzetto, A., Purcell, R.H. & Gerin, J.L. (1988) Evidence for replication of hepatitis delta virus RNA in hepatocyte nuclei after in vivo infection. *Virology*, **167**, 274-278
- Greenfield, C., Farci, P., Osidiana, V., MacPherson, C.N.L., Romig, T., Zeyhle, E., French, M., Johnson, B., Tukei, P., Wankya, B.M. & Thomas, H.C. (1986) Hepatitis delta virus infection in Kenya. Its geographic and tribal distribution. *Am. J. Epidemiol.*, **123**, 416-23
- Hadler, S.C., De Monzon, M., Ponzetto, A., Anzola, E., Rivero, D., Mondolfi, A., Bracho, A., Francis, D.P., Gerber, M.A., Thung, S., Gerin, J., Maynard, J.E., Popper, H. & Purcell, R.H. (1984) Delta virus infection and severe hepatitis. An epidemic in the Yupca Indians of Venezuela. *Ann. intern. Med.*, **100**, 339-344
- Hadziyannis, S.J., Sherman, M., Lieberman, H.M. & Shafritz, D.A. (1985) Liver disease activity and hepatitis B virus replication in chronic delta antigen-positive hepatitis B virus carriers. *Hepatology*, **5**, 544-547
- Hadziyannis, S.J., Hatzakis, A., Papaioannou, C., Anastassakos, C. & Vassiliadis, E. (1987) Endemic hepatitis delta virus in a Greek community. *Prog. clin. biol. Res.*, **234**, 181-202
- Hadziyannis, S.J., Papaioannou, C. & Alexopoulou, A. (1991) The role of the hepatitis delta virus in acute hepatitis and in chronic liver disease in Greece. *Prog. clin. biol. Res.*, **364**, 51-62

- Halpern, M.S., England, J.M., Deery, D.T., Petcu, D.J., Mason, W.S. & Molnar-Kimber, K.L. (1983) Viral nucleic acid synthesis and antigen accumulation in pancreas and kidney of Pekin ducks infected with duck hepatitis B virus. *Proc. natl Acad. Sci. USA*, **80**, 4865-4869
- Hansson, B.G., Moestrup, T., Widell, A. & Nordenfelt, E. (1982) Infection with delta agent in Sweden: introduction of a new hepatitis agent. *J. infect. Dis.*, **146**, 472-478
- Hoofnagle, J.H., Mullen, K.D., Peters, M., Avigan, M.I., Park, Y., Waggoner, J.G., Gerin, J.L., Smedile, A. & Hoyer, B. (1986) Treatment of chronic delta hepatitis with recombinant alpha interferon. In: Stewart, W.E. & Schellekens, H., eds, *The Biology of the Interferon System*, New York, Elsevier, pp. 493-495
- Hoofnagle, J.H., Mullen, K., Peters, K., Avigan, M., Park, Y., Waggoner, J., Gerin, J.L., Hoyer, B. & Smedile, A. (1987) Treatment of chronic delta hepatitis with recombinant human alpha interferon. *Prog. clin. biol. Res.*, **234**, 291-298
- Hsieh, S.-Y. & Taylor, J.M. (1991) Regulation of polyadenylation of hepatitis delta virus antigenomic RNA. *J. Virol.*, **65**, 6438-6446
- Hsieh, S.-Y., Chao, M., Coates, L. & Taylor, J. (1990) Hepatitis delta virus genome replication: a polyadenylated mRNA for delta antigen. *J. Virol.*, **64**, 3192-3198
- Imazeki, F., Omata, M. & Ohto, M. (1990) Heterogeneity and evolution rates of delta virus RNA sequences. *J. Virol.*, **64**, 5594-5599
- Imazeki, F., Omata, M. & Ohto, M. (1991) Complete nucleotide sequence of hepatitis delta virus RNA in Japan (Short communication). *Nucleic Acids Res.*, **19**, 5439
- Kanel, G.C., Govindarajan, S. & Peters, R.L. (1984) Chronic delta infection and liver biopsy changes in chronic active hepatitis B. *Ann. intern. Med.*, **101**, 51-54
- Karayiannis, P., Goldin, R., Luther, S., Carman, W.F., Monjardino, J. & Thomas, H.C. (1992) Effect of cyclosporin-A in woodchucks with chronic hepatitis delta virus infection. *J. med. Virol.*, **36**, 316-321
- Ketiladze, E.S., Vyazov, S.O., Chernovetsky, M.A., Mikhailov, M.I., Bugayeva, N.P. & Kozlova, T.P. (1987) Delta infection in patients and HBsAg carriers. *Prog. clin. biol. Res.*, **234**, 461-466
- Kew, M.C., Dusheiko, G.M., Hadziyannis, S.J. & Patterson, A. (1984) Does delta infection play a part in the pathogenesis of hepatitis B virus related hepatocellular carcinoma? *Br. med. J.*, **288**, 1727
- Kos, A., Dijkema, R., Arnberg, A.C., van der Meide, P.H. & Schellekens, H. (1986) The hepatitis delta (δ) virus possesses a circular RNA. *Nature*, **323**, 558-560
- Krogsgaard, K., Kryger, P., Aldershvile, J., Andersson, P., Sørensen, T.I.A., Nielsen, J.O. & the Copenhagen Hepatitis Acuta Programme (1987) Delta-infection and suppression of hepatitis B virus replication in chronic HBsAg carriers. *Hepatology*, **7**, 42-45
- Kumar, P.K.R., Suh, Y.-A., Miyashiro, H., Nishikawa, F., Kawakami, J., Taira, K. & Nishikawa, S. (1992) Random mutations to evaluate the role of bases at two important single-stranded regions of genomic HDV ribozyme. *Nucleic Acids Res.*, **20**, 3919-3924
- Kuo, M.Y.-P., Goldberg, J., Coates, L., Mason, W., Gerin, J. & Taylor, J. (1988a) Molecular cloning of hepatitis delta virus RNA from an infected woodchuck liver: sequence, structure, and applications. *J. Virol.*, **62**, 1855-1861
- Kuo, M.Y.-P., Sharmeen, L., Dinter-Gottlieb, G. & Taylor, J. (1988b) Characterization of self-cleaving RNA sequences on the genome and antigenome of human hepatitis delta virus. *J. Virol.*, **62**, 4439-4444
- Kuo, M.Y.-P., Chao, M. & Taylor, J. (1989) Initiation of replication of the human hepatitis delta virus genome from cloned DNA: role of delta antigen. *J. Virol.*, **63**, 1945-1950

- Lai, M.M.C., Lee, C.-M., Bih, F.-Y. & Govindarajan, S. (1991) The molecular basis of heterogeneity of hepatitis delta virus. *J. Hepatol.*, **13** (Suppl. 4), S121-S124
- Laskus, T., Radkowski, M., Lupa, E., Cianciara, J., Slusarczyk, J., Halama, G. & Horban, A. (1992) Introduction of hepatitis delta virus into Polish drug community. *Infection*, **20**, 43-44
- Lee, C.-M., Bih, F.-Y., Chao, Y.-C., Govindarajan, S. & Lai, M.M.C. (1992) Evolution of hepatitis delta virus RNA during chronic infection. *Virology*, **188**, 265-273
- Lemon, S.M., Becherer, P.R., Wang, J.-C., White, G.C., Lesesne, H., Janco, R.L., Hanna, W.T., Davis, C., Johnson, C.A., Poon, M.C. & Andes, A. (1991) Hepatitis delta infection among multiply-transfused hemophiliacs. *Prog. clin. biol. Res.*, **364**, 351-360
- Lettau, L.A., McCarthy, J.G., Smith, M.H., Hadler, S.C., Morse, L.J., Ukena, T., Bessette, R., Gurwitz, A., Irvine, W.G., Fields, H.A., Grady, G.F. & Maynard, J.E. (1987) Outbreak of severe hepatitis due to delta and hepatitis B viruses in parenteral drug abusers and their contacts. *New Engl. J. Med.*, **317**, 1256-1262
- Liaw, Y.-F., Lin, H.-H., Chu, C.-M., Sheen, I.-S. & Huang, M.-J. (1987) Hepatitis delta virus infection in Taiwan. *Prog. clin. biol. Res.*, **234**, 479-483
- Liaw, Y.-F., Chiu, K.-W., Chu, C.-M., Sheen, I.-S. & Huang, M.-J. (1990) Heterosexual transmission of hepatitis delta virus in the general population of an area endemic for hepatitis B virus infection: a prospective study. *J. infect. Dis.*, **162**, 1170-1172
- Lok, A., Lindsay, I., Scheuer, P.J. & Thomas, H.C. (1985) Clinical and histological features of delta infection in chronic hepatitis B virus carriers. *J. clin. Pathol.*, **38**, 530-533
- Luo, G., Chao, M., Hsieh, S.-Y., Sureau, C., Nishikura, K. & Taylor, J. (1990) A specific base transition occurs on replicating hepatitis delta virus RNA. *J. Virol.*, **64**, 1021-1027
- MacNaughton, T.B., Gowans, E.J., McNamara, S.P. & Burrell, C.J. (1991) Hepatitis δ antigen is necessary for access of hepatitis δ virus RNA to the cell transcriptional machinery but is not part of the transcriptional complex. *Virology*, **184**, 387-390
- Maddrey, W.C. & Van Thiel, D.H. (1988) Liver transplantation: an overview. *Hepatology*, **8**, 948-959
- Makino, S., Chang, M.-F., Shieh, C.-K., Kamahora, T., Vannier, D.M., Govindarajan, S. & Lai, M.M.C. (1987) Molecular cloning and sequencing of a human hepatitis delta (δ) virus RNA. *Nature*, **329**, 343-346
- McCrudden, E.A.B. & Follett, E.A.C. (1989) Hepatitis delta virus infections in intravenous drug abusers with hepatitis B in the west of Scotland. *J. med. Virol.*, **29**, 59-62
- Mele, A., Franco, E., Caprilli, F., Gentili, G., Stazi, M.A., Zaratti, L., Capitano, B., Crescimbeni, E., Corona, R., Pana, A. & Pasquini, P. (1988) Hepatitis B and delta virus infection among heterosexuals, homosexuals and bisexual men. *Eur. J. Epidemiol.*, **4**, 488-491
- Mijch, A.M., Barnes, R., Crowe, S.M., Dimitrakakis, M. & Lucas, C.R. (1987) An outbreak of hepatitis B and D in butchers. *Scand. J. infect. Dis.*, **19**, 179-184
- Nath, N., Mushahwar, I.K., Fang, C.T., Barberian, H. & Dodd, R.Y. (1985) Antibodies to delta antigen in asymptomatic hepatitis B surface antigen-reactive blood donors in the United States and their association with other markers of hepatitis B virus. *Am. J. Epidemiol.*, **122**, 218-225
- Negro, F., Bergmann, K.F., Baroudy, B.M., Satterfield, W.C., Popper, H., Purcell, R.H. & Gerin, J.L. (1988) Chronic hepatitis D virus (HDV) infection in hepatitis B virus carrier chimpanzees experimentally superinfected with HDV. *J. infect. Dis.*, **158**, 151-159
- Negro, F., Korba, B.E., Forzani, B., Baroudy, B.M., Brown, T.L., Gerin, J.L. & Ponzetto, A. (1989) Hepatitis delta virus (HDV) and woodchuck hepatitis virus (WHV) nucleic acids in tissues of HDV-infected chronic WHV carrier woodchucks. *J. Virol.*, **63**, 1612-1618

- Neurath, A.R., Kent, S.B.H., Strick, N. & Parker, K. (1986) Identification and chemical synthesis of a host cell receptor binding site on hepatitis B virus. *Cell*, **46**, 429–436
- Neurath, A.R., Strick, N., Sproul, P., Ralph, H.E. & Valinsky, J. (1990) Detection of receptors for hepatitis B virus on cells of extrahepatic origin. *Virology*, **176**, 448–457
- Okoth, F.A., Kobayashi, M., Kaptich, D.C., Kaiguri, P.M., Tukei, P.M., Takayanagi, T. & Yamanaka, T. (1991) Seroepidemiological study for HBV markers and anti-delta in Kenya. *East Afr. med. J.*, **68**, 515–525
- Oliveri, F., Brunetto, M.R., Baldi, M., Piantino, P., Ponzetto, A., Forzani, B., Smedile, A., Verme, G. & Bonino, F. (1991) Hepatitis delta virus (HDV) infection and hepatocellular carcinoma (HCC). *Prog. clin. biol. Res.*, **364**, 217–222
- Ottobrelli, A., Marzano, A., Smedile, A., Recchia, S., Salizzoni, M., Cornu, C., Lamy, M.E., Otte, J.B., de Hemptinne, B., Geubel, A., Grendele, M., Colledan, M., Galmarini, D., Marinucci, G., di Giacomo, C., Agnes, S., Bonino, F. & Rizzetto, M. (1991) Patterns of hepatitis delta virus reinfection and disease in liver transplantation. *Gastroenterology*, **101**, 1649–1655
- Perrotta, A.T. & Been, M.D. (1991) A pseudoknot-like structure required for efficient self-cleavage of hepatitis delta virus RNA. *Nature*, **350**, 434–436
- Ponzetto, A., Cote, P.J., Popper, H., Hoyer, B.H., London, W.T., Ford, E.C., Bonino, F., Purcell, R.H. & Gerin, J.L. (1984a) Transmission of the hepatitis B virus-associated delta agent to the eastern woodchuck. *Proc. natl Acad. Sci. USA*, **81**, 2208–2212
- Ponzetto, A., Seeff, L.B., Buskell-Bales, Z., Ishak, K.G., Hoofnagle, J.H., Zimmerman, H.J., Purcell, R.H., Gerin, J.L. & the Veterans Administration Hepatitis Cooperative Study Group (1984b) Hepatitis B markers in United States drug addicts with special emphasis on the delta hepatitis virus. *Hepatology*, **4**, 1111–1115
- Ponzetto, A., Forzani, B., Smedile, A., Hele, C., Avanzini, L., Novara, R. & Canese, M.G. (1987a) Acute and chronic delta infection in the woodchuck. *Prog. clin. biol. Res.*, **234**, 37–46
- Ponzetto, A., Rapisetta, M., Forzani, B., Smedile, A., Hele, C., Morace, G., di Rienzo, A.M., Palladino, P., Avanzini, L., Gerin, J.L. & Verme, G. (1987b) Hepatitis delta virus infection in Pekin ducks chronically infected by the duck hepatitis B virus. *Prog. clin. biol. Res.*, **234**, 47–49
- Ponzetto, A., Hoyer, B.H., Popper, H., Engle, R., Purcell, R.H. & Gerin, J.L. (1987c) Titration of the infectivity of hepatitis D virus in chimpanzees. *J. infect. Dis.*, **155**, 72–78
- Ponzetto, A., Negro, F., Popper, H., Bonino, F., Engle, R., Rizzetto, M., Purcell, R.H. & Gerin, J.L. (1988a) Serial passage of hepatitis delta virus in chronic hepatitis B virus carrier chimpanzees. *Hepatology*, **8**, 1655–1661
- Ponzetto, A., Forzani, B., Hele, C., Negro, F., Avanzini, L., Callea, F., Bonetti, M.G., Rapisetta, M., Gerin, J.L. & Verme, G. (1988b) Hepatocellular carcinoma and hepatitis delta virus in the woodchuck animal model (Abstract). *Gastroenterology*, **94**, A583
- Ponzetto, A., Negro, F., Gerin, J.L. & Purcell, R.H. (1991) Experimental hepatitis delta virus infection in the animal model. *Prog. clin. biol. Res.*, **364**, 147–157
- Purcell, R.H., Satterfield, W.C., Bergmann, K.F., Smedile, A., Ponzetto, A. & Gerin, J.L. (1987) Experimental hepatitis delta virus infection in the chimpanzee. *Prog. clin. biol. Res.*, **234**, 27–36
- Raimondo, G., Craxi, A., Longo, G., Giannuoli, G., Caltagirone, M., Aragona, M., Pecoraro, G., Squadrito, G. & Pagliaro, L. (1984) Delta infection in hepatocellular carcinoma positive for hepatitis B surface antigen (Brief report). *Ann. intern. Med.*, **101**, 343–344
- Ramia, S. & Bahakim, H. (1988) Perinatal transmission of hepatitis B virus-associated hepatitis D virus. *Ann. Inst. Pasteur/Virol.*, **139**, 285–290

- Ranger, S., Mounier, M., Denis, F., Alain, J., Baudet, J., Tabaste, J.L., Delpyroux, C. & Roussanne, M.C. (1990) Prevalence of markers for hepatitis B (HBsAg, HBeAg, DNA) and delta viruses in about 10 000 pregnant women in Limoges (France). *Pathol. biol.*, **38**, 694-699 (in French)
- Ratnam, S., Head, C.B. & Butler, R.W. (1986) Lack of evidence of hepatitis D (delta) infection in Newfoundland and Labrador. *Can. med. Assoc. J.*, **134**, 905-907
- Rezvan, H., Forouzandeh, B., Taroyan, S., Fadaiee, S. & Azordegan, F. (1990) A study on delta virus infection and its clinical impact in Iran. *Infection*, **18**, 34-36
- Rizzetto, M. (1983) The delta agent. *Hepatology*, **3**, 729-737
- Rizzetto, M., Canese, M.G., Aricò, S., Crivelli, O., Trepo, C., Bonino, F. & Verme, G. (1977) Immunofluorescence detection of new antigen-antibody system (δ /anti- δ) associated to hepatitis B virus in liver and in serum of HBsAg carriers. *Gut*, **18**, 997-1003
- Rizzetto, M., Canese, M.G., Gerin, J.L., London, W.T., Sly, D.L. & Purcell, R.H. (1980a) Transmission of the hepatitis B virus-associated delta antigen to chimpanzees. *J. infect. Dis.*, **141**, 590-602
- Rizzetto, M., Hoyer, B., Canese, M.G., Shih, J.W.-K., Purcell, R.H. & Gerin, J.L. (1980b) Delta agent: association of delta antigen with hepatitis B surface antigen and RNA in serum of delta-infected chimpanzees. *Proc. natl Acad. Sci. USA*, **77**, 6124-6128
- Rizzetto, M., Canese, M.G., Purcell, R.H., London, W.T., Sly, L.D. & Gerin, J.L. (1981a) Experimental HBV and delta infections of chimpanzees: occurrence and significance of intrahepatic immune complexes of HBcAg and delta antigen. *Hepatology*, **1**, 567-574
- Rizzetto, M., Morello, C., Mannucci, P.M., Gocke, D.J., Spero, J.A., Lewis, J.H., Van Thiel, D.H., Scaroni, C. & Peyretti, F. (1981b) Delta infection and liver disease in hemophilic carriers of hepatitis B surface antigen. *J. infect. Dis.*, **145**, 18-22
- Rizzetto, M., Verme, G., Recchia, S., Bonino, F., Farci, P., Aricò, S., Calzia, R., Picciotto, A., Colombo, M. & Popper, H. (1983) Chronic hepatitis in carriers of hepatitis B surface antigen, with intrahepatic expression of the delta antigen. An active and progressive disease unresponsive to immunosuppressive treatment. *Ann. intern. Med.*, **98**, 437-441
- Rizzetto, M., Ponzetto, A. & Forzani, I. (1991) Epidemiology of hepatitis delta virus: overview. *Prog. clin. biol. Res.*, **364**, 1-20
- Rizzetto, M., Hadziyannis, S., Hansson, B.G., Toukan, A. & Gust, I. (1992) Hepatitis delta virus infection in the world: epidemiological patterns and clinical expression. *Gastroenterol. int.*, **5**, 18-32
- Roggendorf, M., Gmelin, K., Zoulek, G., Wolf, P., Schlipkötter, U., Jilg, W., Theilmann, L. & Deinhardt, F. (1986) Epidemiological studies on the prevalence of hepatitis delta virus infections in the Federal Republic of Germany. *J. Hepatol.*, **2**, 230-236
- Roggendorf, M., Mai, K., Thian, G., Hu, M., Zhuang, C., Gmelin, K., Bernhardt, R. & Deinhardt, F. (1987) Prevalence of hepatitis delta virus infection in different provinces of China. *Prog. clin. biol. Res.*, **234**, 487-491
- Rosenblum, L., Darrow, W., Witte, J., Cohen, J., French, J., Gill, P.S., Potterat, J., Sikes, K., Reich, R. & Hadler, S. (1992) Sexual practices in the transmission of hepatitis B virus and prevalence of hepatitis delta virus infection in female prostitutes in the United States. *J. Am. med. Assoc.*, **267**, 2477-2481
- Rosina, F. & Rizzetto, M. (1989) Treatment of chronic type D (delta) hepatitis with alpha interferon. *Semin. Liver Dis.*, **9**, 264-266
- Rosina, F., Saracco, G. & Rizzetto, M. (1985) Risk of post-transfusion infection with the hepatitis delta virus: a multi-centre study. *New Engl. J. Med.*, **312**, 1488-1491

- Rosina, F., Saracco, G., Lattore, V., Quartarone, V., Rizzetto, M., Verme, G., Trincherò, P., San Salvatore, F. & Smedile, A. (1987) Alpha-2 recombinant interferon in the treatment of chronic delta virus (HDV) hepatitis. *Prog. clin. biol. Res.*, **234**, 299-303
- Rosina, F., Pintus, C., Meschievitz, C. & Rizzetto, M. (1991) A randomized controlled trial of a 12-month course of recombinant human interferon-alfa in chronic delta (type D) hepatitis: a multicenter Italian study. *Hepatology*, **13**, 1052-1056
- Roumeliotou-Karayannis, A., Tassopoulos, N., Karpodini, E., Trichopoulou, E., Kotsianopoulou, M. & Papaevangelou, G. (1987) Prevalence of HBV, HDV and HIV infections among intravenous drug addicts in Greece. *Eur. J. Epidemiol.*, **3**, 143-146
- Ryu, W.-S., Mayer, M. & Taylor, J. (1992) Assembly of hepatitis delta virus particles. *J. Virol.*, **66**, 2310-2315
- Sagnelli, E., Stroffolini, T., Ascione, A., Bonino, F., Chiaramonte, M., Colombo, M., Craxì, A., Giusti, G., Manghisi, O.G., Pastore, G., Piccinino, E., Rizzetto, M., Stazi, M.A., Loti, M. & Verme, G. (1992) The epidemiology of hepatitis delta infection in Italy. *J. Hepatol.*, **15**, 211-215
- Salassa, B., Daziano, E., Bonino, F., Lavarini, C., Smedile, A., Chiaberge, E., Rosina, F., Brunetto, M.R., Pessione, E., Spezia, C., Bramato, C. & Soranzo, M.L. (1991) Serological diagnosis of hepatitis B and delta virus (HBV/HDV) coinfection. *J. Hepatol.*, **12**, 10-13
- Saldanha, J.A., Thomas, H.C. & Monjardino, J.P. (1990) Cloning and sequencing of RNA of hepatitis delta virus isolated from human serum. *J. gen. Virol.*, **71**, 1603-1606
- Scott, D.A., Burans, J.P., Al-Ouzeib, H.D., Arunkumar, B.K., Al-Fadeel, M., Nigad, Y.R., Al-Hadad, A., Elyazeed, R.R.A., Hyams, K.C. & Woody, J.N. (1990) A seroepidemiological survey of viral hepatitis in the Yemen Arab Republic. *Trans. R. Soc. trop. Med. Hyg.*, **84**, 288-291
- Sharmeen, L., Kuo, M. Y.-P., Dinter-Gottlieb, G. & Taylor, J. (1988) Antigenomic RNA of human hepatitis delta virus can undergo self-cleavage. *J. Virol.*, **62**, 2674-2679
- Sharmeen, L., Kuo, M.Y.-P. & Taylor, J. (1989) Self-ligating RNA sequences on the antigenome of human hepatitis delta virus. *J. Virol.*, **63**, 1428-1430
- Shobokshi, O.A. & Serebour, F.E. (1987) Prevalence of delta antigen/antibody in various HBsAg positive patients in Saudi Arabia. *Prog. clin. biol. Res.*, **234**, 471-475
- Siebke, J.C., von der Lippe, B., Hansson, B.-G., Nordenfelt, E. & Degré, M. (1986) Prevalence and clinical effects of delta agent. Infections in Norwegian population subgroups. *Scand. J. infect. Dis.*, **18**, 33-36
- Smedile, A., Dentico, P., Zanetti, A., Sagnelli, E., Nordenfeldt, E., Actis, G.C. & Rizzetto, M. (1981) Infection with the delta agent (δ) in chronic HBsAg carriers. *Gastroenterology*, **81**, 992-997
- Smedile, A., Farci, P., Verme, G., Caredda, F., Cargnel, A., Caporaso, N., Dentico, P., Trepo, C., Opolon, P., Gimson, A., Vergani, D., Williams, R. & Rizzetto, M. (1982) Influence of delta infection on severity of hepatitis B. *Lancet*, **ii**, 945-947
- Smedile, A., Rizzetto, M., Denniston, K., Bonino, F., Wells, F., Verme, G., Consolo, F., Hoyer, B., Purcell, R.H. & Gerin, J.L. (1986) Type D hepatitis: the clinical significance of hepatitis D virus RNA in serum as detected by a hybridization-based assay. *Hepatology*, **6**, 1297-1302
- Smedile, A., Freni, M.A., Caruso, L., Ajello, A., Trischitta, C., Resta, M.L., Bertino, G., Berlinghieri, G., Rapisarda, S., Di Geronimo, L., Spadaro, A. & Ferrau, O. (1987) Delta infection in eastern Sicily. *Eur. J. Epidemiol.*, **3**, 386-389
- Smedile, A., Rosina, F., Saracco, G., Chiaberge, E., Lattore, V., Fabiano, A., Brunetto, M.R., Verme, G., Rizzetto, M. & Bonino, F. (1991a) Hepatitis B virus replication modulates pathogenesis of hepatitis D virus in chronic hepatitis D. *Hepatology*, **13**, 413-416

- Smedile, A., Rosina, F., Chiaberge, E., Lattore, V., Saracco, G., Brunetto, M.R., Bonino, F., Verme, G. & Rizzetto, M. (1991b) Presence and significance of hepatitis B virus replication in chronic type D hepatitis. *Prog. clin. biol. Res.*, **364**, 185–195
- Solomon, R.E., Kaslow, R.A., Phair, J.P., Lyter, D., Visscher, B., Lyman, D., Vanraden, M.T. & Gerin, J. (1988) Human immunodeficiency virus and hepatitis delta virus in homosexual men. *Ann. intern. Med.*, **108**, 51–54
- Suh, Y.-A., Kumar, P.K.R., Nishikawa, F., Kayano, E., Nakai, S., Odai, O., Uesugi, S., Taira, K. & Nishikawa, S. (1992) Deletion of internal sequence on the HDV-ribozyme: elucidation of functionally important single-stranded loop regions. *Nucleic Acids Res.*, **20**, 747–753
- Tagawa, M., Omata, M., Yokosuka, D., Uchiumi, K., Imazeki, F. & Okuda, K. (1985) Early events in duck hepatitis B virus infection. Sequential appearance of viral deoxyribonucleic acid in liver, pancreas, kidney and spleen. *Gastroenterology*, **89**, 1224–1229
- Tapalaga, D., Forzani, B., Hele, C., Paravacini, P., Ponzetto, A. & Theilmann, L. (1987) HDV infection in Romania. *Prog. clin. biol. Res.*, **234**, 425
- Tassopoulos, N.C., Theodoropoulos, G., Sjogren, M.H., Engle, R. & Purcell, R.H. (1989) Serological markers of hepatitis B virus and hepatitis D virus infections in Greek adults with primary hepatocellular carcinoma. *Infection*, **17**, 17–19
- Tassopoulos, N.C., Koutelou, M.G., Macagno, S., Zorbas, P. & Rizzetto, M. (1990) Diagnostic significance of IgM antibodies to hepatitis delta virus in fulminant hepatitis B. *J. med. Virol.*, **30**, 174–177
- Taylor, J.M. (1990) Hepatitis delta virus: *cis* and *trans* functions required for replication. *Cell*, **61**, 371–373
- Taylor, J.M. (1992) The structure and replication of hepatitis delta virus. *Ann. Rev. Microbiol.*, **46**, 253–276
- Taylor, J., Mason, W., Summers, J., Goldberg, J., Aldrich, C., Coates, L., Gerin, J.L. & Gowans, E. (1987) Replication of human hepatitis delta virus in primary cultures of woodchuck hepatocytes. *J. Virol.*, **61**, 2891–2895
- Taylor, J., Negro, F. & Rizzetto, M. (1992) Hepatitis delta virus: from structure to disease expression. *Rev. med. Virol.*, **2**, 161–167
- Thomas, H.C., Farci, P., Shein, R., Karayiannis, P., Smedile, A., Caruso, L. & Gerin, J.L. (1987) Inhibition of hepatitis delta virus (HDV) replication by lymphoblastoid human alpha interferon. *Prog. clin. biol. Res.*, **234**, 277–290
- Toukan, A.U., Abu-El-Rub, O.A., Abu-Laban, S.A., Tarawneh, M.S., Kamal, M.F., Hadler, S.C., Krawczynski, K., Margolis, H.S. & Maynard, J.E. (1987) The epidemiology and clinical outcome of hepatitis D virus (delta) infection in Jordan. *Hepatology*, **7**, 1340–1345
- Trichopoulos, D., Day, N.E., Tzonou, A., Hadziyannis, S., Kaklamani, E., Sparos, L., Muñoz, N. & Hatzakis, A. (1987a) Delta agent and the etiology of hepatocellular carcinoma. *Int. J. Cancer*, **39**, 283–286
- Trichopoulos, D., Day, N.E., Kaklamani, E., Tzonou, A., Muñoz, N., Zavitsanos, X., Koumantaki, Y. & Trichopoulou, A. (1987b) Hepatitis B virus, tobacco smoking and ethanol consumption in the etiology of hepatocellular carcinoma. *Int. J. Cancer*, **39**, 45–49
- Tzonou, A., Trichopoulos, D., Kaklamani, E., Zavitsanos, X., Koumantaki, Y. & Hsieh, C.-C. (1991) Epidemiologic assessment of interactions of hepatitis-C virus with seromarkers of hepatitis-B and -D viruses, cirrhosis and tobacco smoking in hepatocellular carcinoma. *Int. J. Cancer*, **49**, 377–380

- Ueda, K., Tsurimoto, T. & Matsubara, K. (1991) Three envelope proteins of hepatitis B virus: large S, middle S, and major S proteins needed for the formation of Dane particles. *J. Virol.*, **65**, 3521-3529
- Verme, G., Brunetto, M.R., Oliveri, F., Baldi, M., Forzani, B., Piantino, P., Ponzetto, A. & Bonino, F. (1991) Role of hepatitis delta virus infection in hepatocellular carcinoma. *Dig. Dis. Sci.*, **36**, 1134-1136
- Vranckx, R., Reniers, J., Alisjahbana, A., Ngantung, W., Sugita, E. & Meheus, A. (1988) Prevalence of anti-delta antibodies in pregnant women in Bandung, Indonesia. *Trop. geogr. Med.*, **40**, 17-19
- Wang, K.-S., Choo, Q.-L., Weiner, A.J., Ou, J.-H., Najarian, R.C., Thayer, R.M., Mullenbach, G.T., Denniston, K.J., Gerin, J.L. & Houghton, M. (1986) Structure, sequence and expression of the hepatitis delta viral genome. *Nature*, **323**, 508-514
- Wang, D.-Q., Cheng, H.-H., Minuk, G.Y., Liu, L.-H., Anand, C.M., Stowe, T.C., Wang, H.-X., Ying, D.-C., Tu, Y.-R. & Buchan, K.A. (1987) Delta hepatitis virus infection in China. *Int. J. Epidemiol.*, **16**, 79-83
- Wang, C.-J., Chen, P.-J., Wu, J.-C., Patel, D. & Chen, D.-S. (1991) Small-form hepatitis B surface antigen is sufficient to help in the assembly of hepatitis delta virus-like particles. *J. Virol.*, **65**, 6630-6636
- Weiner, A.J., Choo, Q.-L., Wang, K.-S., Govindarajan, S., Redeker, A.G., Gerin, J.L. & Houghton, M. (1988) A single antigenomic open reading frame of the hepatitis delta virus encodes the epitope(s) of both hepatitis delta antigen polypeptides p24^δ and p27^δ. *J. Virol.*, **62**, 594-599
- Weisfuse, I.B., Hadler, S.C., Fields, H.A., Alter, M.J., O'Malley, P.M., Judson, F.N., Ostrow, D.G. & Altman, N.L. (1989) Delta hepatitis in homosexual men in the United States. *Hepatology*, **9**, 872-874
- Wu, H.-N. & Lai, M.M.C. (1989) Reversible cleavage and ligation of hepatitis delta virus RNA. *Science*, **243**, 652-654
- Wu, H.-N. & Lai, M.M.C. (1990) RNA conformational requirements of self-cleavage of hepatitis delta virus RNA. *Mol. cell. Biol.*, **10**, 5575-5579
- Wu, H.-N., Lin, Y.-J., Lin, F.-P., Makino, S., Chang, M.-F. & Lai, M.M.C. (1989) Human hepatitis delta virus RNA subfragments contain an autocleavage activity. *Proc. natl Acad. Sci. USA*, **86**, 1831-1835
- Wu, J.-C., Lee, S.-D., Govindarajan, S., Kung, T.-W., Tsai, Y.-T., Lo, K.-J. & Ting, L.-P. (1990a) Correlation of serum delta RNA with clinical course of acute hepatitis delta virus superinfection in Taiwan: a longitudinal study. *J. infect. Dis.*, **161**, 1116-1120
- Wu, J.-C., Lee, S.-D., Govindarajan, S., Lin, H.-C., Chou, P., Wang, Y.-J., Lee, S.-Y., Tsai, Y.-T., Lo, K.-J. & Ting, L.-P. (1990b) Sexual transmission of hepatitis D virus infection in Taiwan. *Hepatology*, **11**, 1057-1061
- Wu, J.-C., Chen, P.-J., Kuo, M.Y.-P., Lee, S.-D., Chen, D.-S. & Ting, L.-P. (1991) Production of hepatitis delta virus and suppression of helper hepatitis B virus in a human hepatoma cell line. *J. Virol.*, **65**, 1099-1104
- Yoffe, B., Burns, D.K., Bhatt, H.S. & Combes, B. (1990) Extrahepatic hepatitis B virus DNA sequences in patients with acute hepatitis B infection. *Hepatology*, **12**, 187-192
- Yong-Yuan, Z., Rizzetto, M., Bonino, F., Verme, G. & Lien-Jie, H. (1990) Immunohistochemical research of HDV infection in Chinese patients with chronic liver disease. *Hepato-gastroenterology*, **37**, 411-412
- Zheng, H., Fu, T.-B., Lazinski, D. & Taylor, J. (1992) Editing on the genomic RNA of human hepatitis delta virus. *J. Virol.*, **66**, 4693-4697

Zignego, A.L., Deny, P., Gentilini, P. & Bréchet, C. (1992) Polymerase chain reaction for hepatitis delta virus RNA identification and characterization In: Becker, Y. & Darai, G., eds, *Frontiers of Virology*, Berlin, Springer Verlag, pp. 101-116