Acute Infectious Gastroenteritis

Subjects: Infectious Diseases

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Acute infectious gastroenteritis (AGE) is defined as a diarrhoeal disease of rapid onset presenting with the incidence of three or more soft or liquid stools, or three bouts of vomiting per 24 h, with addition of abdominal pain, or fever.

acute infectious gastroenteritis | aetiological agents | biomarkers

1. Causative Agents of AGE

1.1. Rotavirus

Rotavirus is the most common agent causing AGE in children worldwide [1][2][3][4][5][6]. It has been suggested to be one of the most pathogenic causative agents in AGE which correlates with infectious diarrhoea, vomiting, and higher frequency of fever [4][7][8][9]. It was mostly reported among children aged 0–14 years old, with the highest incidence among children less than 5 years [5][6][7][10][11][12]. The prevalence was highly reported during the dry season [6][12], bottle-fed children [6][13][14], and children with group A blood type [6][15][16]. Moreover, laboratory investigations revealed a significantly high level of serum transaminase among children infected with rotavirus [17][18][19]. Among many studies conducted worldwide, it was found that rotavirus infected children have a high chance of developing dehydration as a complication, and thus, must be closely monitored [20][7][21][22].

1.2. Norovirus

Norovirus is an emerging cause of acute gastroenteritis, responsible for approximately 17–18% of all acute gastroenteritis cases worldwide, especially among developed countries [23][24][25][26][27]. The age group under 1 year old has the highest frequency of norovirus infection with additional risk factors which include male sex [26]. Norovirus is detected throughout the year, with the autumn and winter seasons observed to report a higher frequency of cases [23][28][29]; the detection rate of norovirus cases correlates positively with humidity [29]. Co-infection with rotavirus [30][31], astrovirus [32], and *Salmonella* [31] may occur in certain cases. Norovirus infections are observed to cause more severe symptoms of gastroenteritis in children compared with rotavirus, especially after the introduction of the rotavirus vaccination period [33]. Individuals with AB blood group have less susceptibility towards GII.4 noroviruses, whereas those with the O blood group are more susceptible to GI.4, GII.4, GII.17, and GII.18-Nica viruses [34]. GII.4 is the most common norovirus genotype causing infection in children [26][35][36]. However, recent epidemiological data observed that GII.2[P16] is currently an emerging norovirus strain in East Asia and Europe [37]. Norovirus-infected patients are more likely to have a longer duration of infection and more

frequent vomiting in a day, but less likely to report fever in comparison with other causes of infective gastroenteritis [38].

1.3. Astrovirus

With an astrovirus-causing acute gastroenteritis' global average incidence of 11%, the highest prevalence of human astrovirus (HAstV) infections was in the group of children between 37 and 48 months old [39][40]. HAstV infection mainly occurs during the dry season in the African continent; meanwhile, the highest occurrence reported in the tropical areas is often in the rainy season and winter season in temperate climate countries [39][41]. Patients usually manifested with diarrhoea, fever, vomiting, and abdominal pain [40][42].

1.4. Enteric Adenovirus Serotypes 40 and 41

Between 2.3 and 5% of the diarrhoea cases in children were caused by adenoviruses (AdV) serotypes 40 and 41 [43]. Enteric adenovirus serotypes 40 and 41 account for both sporadic or epidemic gastroenteritis in infants and young children, which are detected throughout the year with a summer peak between May and July [43][44][45]. Those infected with this pathogen will acquire mild fever and vomiting, abdominal pain, bloody diarrhoea, respiratory symptoms such as cough, and/or secondary lactose malabsorption [45][46]. Patients with adenovirus gastroenteritis have a significantly higher CRP (mean 3.4 mg/dL) and ESR value (mean 24 mm/h) compared with other gastroenteritis pathogens, and pulmonary-associated symptoms and vomiting frequency are increased in patients with this infective gastroenteritis [47]. Intravenous cytosine nucleotide analogue (CDV) that inhibits DNA polymerase has the highest in vitro activity against adenovirus, and is the preferred therapeutic agent. Elevation in lymphocyte counts (specifically CD4) were correlated with the clearance of AdV infection and improvement in survival [48][49].

1.5. Salmonella

Salmonella has become a major foodborne pathogen across the globe, causing about 3.4 million cases and 681,316 annual deaths, with 63.7% of cases occurring in children under 5 years of age [50][51][52]. There were at least 150 non-typhoidal *Salmonella* serotypes that can cause gastroenteritis, with *Salmonella* Typhimurium and *Salmonella* Enteritidis being the most common serotypes [51][53][54]. A study in Greece recorded that the highest rate of infection was in August, with infants being the most vulnerable group [55]. The contributing factor of salmonellosis was mainly related to consumption of contaminated food and poor clean water supply [56][57]. Salmonellosis can cause the increase in C-reactive protein values (CRP), erythrocyte sedimentation rate (ESR) and body temperature [58]. In terms of management, the recommended empiric parenteral therapy includes cefotaxime or ceftriaxone, whereas oral therapy includes amoxicillin, trimethoprim-sulfamethoxazole, or azithromycin. *Salmonella* isolates have a high resistance towards at least one antimicrobial agent [53][59], especially towards clindamycin, oxacillin, penicillin, and vancomycin, thus antibiotic susceptibilities of *Salmonella* must be determined for the targeted antibiotic therapy [54].

1.6. Escherichia coli

The WHO Global Burden of Foodborne Diseases report estimates that more than 300 million illnesses and nearly 200,000 deaths are caused by diarrheagenic *Escherichia coli* (DEC) globally each year. DEC is one of the major causal agents of diarrhoea in children under 5 years of age in developing countries [60][61][62], whereas children under 2 years of age are at the highest risk of infection with Enteropathogenic *Escherichia coli* [63][64] and *Escherichia coli* O157:H7 [63][65]. However, the major cause of paediatric infections in certain areas such as Ahvaz, Iran, were non-O157:H7 *E. coli* [66]. The incidence of non-O157 Shiga Toxin-producing *Escherichia coli* has been increasing in recent years, including those caused by serotypes O26, O45, O103, O111, O121, and O145 [67]. Co-infections can occur especially between EPEC and *Campylobacter* spp. [68]. Interestingly, Enteropathogenic *Escherichia coli* cases are less frequently detected in Malaysia and its similar geographical/climatic areas, in comparison with a country such as Iran where it has been reported that acute gastroenteritis was greatly caused by this strain [69]. Most DEC are sensitive to ciprofloxacin and the empirical antibiotic of choice [70][71].

1.7. Entamoeba histolytica

Other than viruses and bacteria, parasites such as *Entamoeba histolytica* also play a role in causing acute gastroenteritis in children [72][73][74]. Children infected with *Entamoeba histolytica* were mostly presented with tenesmus [73][74][75], fever [73][74], vomiting [73][76], abdominal cramps [73][75][76], and bloody diarrhoea [77][74][75]. Through laboratory investigations, it was found that infection with *Entamoeba histolytica* results in leukocytosis [72][73][76][78], elevation of CRP [66][70][71][72][76][78], elevation of ESR [73], elevation of serum alkaline phosphatase, and serum transaminase levels [73][79]. Eating unwashed or raw vegetables [79][80][81][82] and poor water hygiene [74][83][84] were identified to increase the risk of *Entamoeba histolytica* infection.

2. Biomarkers in the Detection of Common Aetiological Agents of AGE

2.1. Rotavirus

As the most common inflicted pathogen causing AGE in children, several biomarkers have been developed and available commercially for the detection of rotavirus. The widely available biomarker platform utilized is the enzyme immunoassay (EIA) to screen for the rotavirus antigen [1][2][4][6][10][13][17][85][86][87]. Amongst EIA kit used were Premier Rotaclone, Meridian Bioscience Inc., Cincinnati, OH, USA [1][2][3][10][86][87], RIDASCREEN Rotavirus R Biopharm AG, Darmstadt, Germany [6][86], and ProSpect Rotavirus Test, Oxoid Ltd., UK [13][86]. Rotavirus antigens can also be detected by using enzyme-linked immunosorbent assay (ELISA) [3][7][9][11][19][22] which includes ELISA kits such as Premier Rotaclone, Meridian Bioscience, Inc. [3], Fecal Rotavirus Antigen ELISA Kit (EDI, CA, USA) [7], ProSpecTM Rotavirus Microplate Assay, Oxoid [11] and Rota Antigen Test Device, Cambridge [19]. ELISA can also be used in the detection of rotavirus-specific IgM [21]. Other methods in detection of rotavirus antigen were immunochromatography [16][18] and latex agglutination [14][85][88]. In addition, polyacrylamide gel electrophoresis (PAGE) was carried out to determine the electropherotype of rotavirus strains [1][10][85]. Moreover, samples that were rotavirus positive for ELISA or EIA were sent for genotyping using reverse-transcription polymerase chain

reaction (RT-PCR) to determine whether they belong to particular G/P genotypes [2][7][10][11][16][21][89][90]. A multiplex real-time RT-PCR is an advanced approach for a high-throughput rotavirus genotype characterization for monitoring circulating rotavirus wild-type strains, which is more robust in identifying a novel strain [91].

2.2. Norovirus

Viral RNA and antigens are the main biomarkers for detection of norovirus infection. Real-time quantitative polymerase chain reaction, Multiplex Gastrointestinal Platforms, enzyme immunoassays (EIAs) and genotyping are the main methods used in laboratory diagnosis of norovirus [92]. Cepheid Xpert® Norovirus kit automates sample processing, nucleic acid extraction, and real-time reverse transcription polymerase chain reactions (RT-PCRs) for detection and differentiation of norovirus GI and GII, which account for the majority of norovirus infections worldwide [93][94]. Another real-time PCR platform, RIDA®GENE Norovirus, can also be used as an alternative in detecting the virus [95]. Although PCRs are highly sensitive and specific, they are expensive and require specialized techniques and equipment. Rapid diagnostic tests are usually carried out during outbreak screening and patient management, which include immunochromatographic test, enzyme immunoassay (EIA), enzyme-linked immunosorbent assay (ELISA) and fluorescence immunoassay (FIA). RIDA®QUICK Norovirus (R-Biopharm AG, Darmstadt, Germany) is one of the most used rapid immunochromatographic tests to detect norovirus [96][97][98]. Other immunochromatographic tests that are still used include QuickNaviTM—Norovirus 2 [99][100]. RIDASCREEN® Norovirus 3rd Generation is an example of ELISA that is still currently in use [101][102]. For FIA, the Automated Fluorescent Immunoassay System NORO (AFIAS-Noro) assays (Boditech Med Inc, Gangwon-do, South Korea) are newly developed diagnostic tests for norovirus infections [88].

2.3. Astrovirus

Stool samples can be investigated using RT-PCR to detect the presence of human astrovirus (HAstV) [39][40][47]. One of the available kits is the RT-PCR Luminex Assay, with which a portion of the ORF2 capsid region is targeted by using a set of specific reverse primers labeled with biotinTEG at 5′-ends and specific probes sequences [103]. A one-step, accelerated, real-time RT-LAMP (rRTLAMP) assay can also be used by targeting the 5′-end of the capsid gene for rapid and quantitative detection of HAstV [104][105].

2.4. Enteric Adenovirus Serotypes 40 and 41

Adenovirus antigen and hexon-coding gene in enteric adenovirus serotypes 40 and 41 can be recognised and used for screening and detection methods of this pathogenic agent infection. BioNexia RotaAdeno and RIDA Quick Rota-Adeno-Combi R-Biopharm, which are the immunochromatographic tests (ICT) and LIAISON Adenovirus chemiluminescence immunoassays (CLIA) can be utilised to detect enteric adenovirus antigen [106][107]. The samples from ICT and LIAISON CLIA can subsequently undergo RT-PCR for genotyping of hexon-coding genes by using a specific TaqMan Array Card, which is a 384-well singleplex real-time PCR format that has been recognised to detect multiple infection targets [108][109].

2.5. Salmonella

As for *Salmonella* infection, the virulence genes include flagellin (*filcC*), *invA*, *invF*, *sitC*, *hilAgene*, *sipC*, *sipF* genes as well as heat stable enterotoxin gene, *parE* [110]. Multiplex real-time PCR such as RIDA GENE-gastrointestinal kits, EntericBio real-time Gastro Panel I, and Seeplex Diarrhea ACE detection has allowed a more rapid detection of multiple targets in a short period of time and some of the tests was followed by hybridisation to microarray/macroarray to achieve multiparametric detection of AGE aetiological agents [111]. In terms of sensitivity and specificity, RIDA GENE-gastrointestinal kits were reported to have 25% sensitivity and 99.7% specificity [112][113][114]. As for EntericBio real-time Gastro Panel I, its sensitivity and specificity were much higher, which were 100% and 97.8%, respectively [113]. Seeplex Diarrhea ACE has a sensitivity of 40–100% and specificity of 96–100% [112][115][116].

2.6. Escherichia coli

Most of the current omics approaches were focused on the detection of Shiga Toxin-producing *Escherichia coli* (STEC) infections. This is due to the fact that accurate diagnosis of STEC infection is very crucial because appropriate early treatment decreases the risk of serious complications and improves overall patient outcome, especially in children [117][118]. Although non-O157 serotypes account for the majority of STEC infections, they are significantly under-reported because frontline microbiology laboratories mainly focus on the detection of O157 STEC using specific agar-based methods [119]. CHROMagar STEC is a new chromogenic medium invented to improve detection of STEC, which detects O157 and non-O157 STEC through a chromogenic substrate [119][120]. However, PCR is a more sensitive test than culture [119][120]. RIDA®GENE real-time PCR kits EAEC, EHEC/EPEC, and ETEC/EIEC (R-Biopharm, Darmstadt, Germany) all can be used to detect the *aatA* and *aggR*, *eae*, and *elt* and *estA* genes of Enteroaggregative, Enteropathogenic, and Enterotoxigenic *Escherichia coli*, respectively [121]. These will ensure that different pathotypes of diarrheagenic *Escherichia coli* can be detected and differentiated successfully.

2.7. Entamoeba histolytica

Entamoeba histolytica infection can cause a significant decrease in serum leptin and has been suggested to be a potential biomarker for this pathogenic infection [122], which can be detected using the ELISA technique (kit supplied by RayBiotech.Inc, Guangzhou, China). Moreover, there was also a marked increase in HDL, obestatin, calprotectin and SIgA concentration level with a concurrent decrease in cholesterol, triglyceride, LDL and VLDL concentration levels. All of these serums can be analysed and measured using ELISA techniques [123]. ELISA (Techlab II *Entamoeba histolytica*) can also be used to detect *Entamoeba histolytica* antigen presented in stool with a specificity of 100% but with a low sensitivity of 19.2% [124]. Thus, multiplex PCR is a more favourable option as it has sensitivity of 100% with specificity of 95.8% [125]. During progression of amoebiasis, a small non-coding RNA known as microRNA (miRNA) is involved in promoting apoptosis in epithelial colon cells and comprehensive profiling of miRNA using Taqman Low-Density Arrays showed a significant interaction between miRNA and parasite presented [126]. Taqman Low-Density Arrays has a sensitivity of 92% and a specificity of 100% in diagnosis of *Entamoeba histolytica* infection [127].

References

1. Gupta, S.; Chaudhary, S.; Bubber, P.; Ray, P. Epidemiology and Genetic Diversity of Group A Rotavirus in Acute Diarrhea Patients in Pre-Vaccination Era in Himachal Pradesh, India. Vaccine 2019, 37, 5350–5356.
2. Giri, S.; Nair, N.P.; Mathew, A.; Manohar, B.; Simon, A.; Singh, T.; Suresh Kumar, S.; Mathew, M.A.; Babji, S.; Arora, R.; et al. Rotavirus Gastroenteritis in Indian Children. BMC Public Health 2019, 19, 69.
3. Gopalkrishna, V.; Joshi, M.S.; Chavan, N.A.; Shinde, M.S.; Walimbe, A.M.; Sawant, P.M.; Kalrao, V.R.; Dhongade, R.K.; Bavdekar, A.R. Prevalence and Genetic Diversity of Gastroenteritis Viruses in Hospitalized Children. J. Med. Virol. 2021, 93, 4805–4816.
4. Stanyevic, B.; Sepich, M.; Biondi, S.; Baroncelli, G.I.; Peroni, D.; Di Cicco, M. The Evolving Epidemiology of Acute Gastroenteritis in Hospitalized Children in Italy. Eur. J. Pediatrics 2021.
5. Salim, N.A.B.M.; Naik, D.G.; Fuad, M.D.F. Prevalence of Rotavirus Diarrhea in Children of Perak, Malaysia. Indian J. Public Health Res. Dev. 2017, 8, 285.
6. Ojobor, C.D.; Olovo, C.V.; Onah, L.O.; Ike, A.C. Prevalence and Associated Factors to Rotavirus Infection in Children Less than 5 Years in Enugu State, Nigeria. VirusDisease 2020, 31, 316–322.
7. Dong, S.; Huang, D.; Wang, Z.; Zhang, G.; Zhang, F.; Sai, L. Clinical and Molecular Epidemiological Characterization of Rotavirus Infections in Children under Five Years Old in Shandong Province, China. Arch. Virol. 2021, 166, 2479–2486.
8. Ghoshal, V.; Nayak, M.K.; Misra, N.; Kumar, R.; Reddy, N.S.; Mohakud, N.K. Surveillance and Molecular Characterization of Rotavirus Strains Circulating in Odisha, India after Introduction of Rotavac. Indian J. Pediatrics 2021, 88, 41–46.
9. Zeng, X.-D.; Hu, W.-G. Spontaneous Remission of Infantile Spasms Following Rotavirus Gastroenteritis. Neurol. Sci. 2020, 42, 253–257.
10. Amit, L.N.; Mori, D.; John, J.L.; Chin, A.Z.; Mosiun, A.K.; Jeffree, M.S.; Ahmed, K. Emergence of Equine-like G3 Strains as the Dominant Rotavirus among Children under Five with Diarrhea in Sabah, Malaysia during 2018–2019. PLoS ONE 2021, 16, e0254784.
11. Shrestha, S.; Thakali, O.; Raya, S.; Shrestha, L.; Parajuli, K.; Sherchand, J.B. Acute Gastroenteritis Associated with Rotavirus A among Children Less than 5 Years of Age in Nepal. BMC Infect. Dis. 2019, 19, 456.
12. Ouedraogo, N.; Ngangas, S.M.T.; Bonkoungou, I.J.O.; Tiendrebeogo, A.B.; Traore, K.A.; Sanou, I.; Traore, A.S.; Barro, N. Temporal Distribution of Gastroenteritis Viruses in Ouagadougou, Burkina Faso: Seasonality of Rotavirus. BMC Public Health 2017, 17, 274.

13. Alkoshi, S.I.M.; Miftah, A.; Ernst, K.; Nagib, S. Frequency of Rotavirus Infection among Children in North-Eastern Region of Libya: A Hospital-Based Study from Almarj. Libyan J. Med. Sci. 2017, 1, 76.
14. Abbas, A. Role of rotavirus as the cause of acute pediatric diarrhea in Al-Diwaniyah, Iraq. Al-Qadisiyah J. Vet. Med. Sci. 2019, 18, 1125.
15. Elnady, H.G.; Samie, O.M.A.; Saleh, M.T.; Sherif, L.S.; Abdalmoneam, N.; Kholoussi, N.M.; Kholoussi, S.M.; EL-Taweel, A.N. ABO Blood Grouping in Egyptian Children with Rotavirus Gastroenteritis. Gastroenterol. Rev. 2017, 3, 175–180.
16. Pérez-Ortín, R.; Vila-Vicent, S.; Carmona-Vicente, N.; Santiso-Bellón, C.; Rodríguez-Díaz, J.; Buesa, J. Histo-Blood Group Antigens in Children with Symptomatic Rotavirus Infection. Viruses 2019, 11, 339.
17. Wiegering, V.; Kaiser, J.; Tappe, D.; Weißbrich, B.; Morbach, H.; Girschick, H.J. Gastroenteritis in Childhood: A Retrospective Study of 650 Hospitalized Pediatric Patients. Int. J. Infect. Dis. 2011, 15, e401–e407.
18. Akelma, A.Z.; Kütükoğlu, I.; Köksal, T.; Çizmeci, M.N.; Kanburoglu, M.K.; Çatal, F.; Mete, E.; Bozkaya, D.; Namuslu, M. Serum Transaminase Elevation in Children with Rotavirus Gastroenteritis: Seven Years' Experience. Scand. J. Infect. Dis. 2012, 45, 362–367.
19. Erdogan, S. Serum Transaminase Elevation in Patients with Rotavirus Gastroenteritis. J. Clin. Anal. Med. 2017, 8, 488–491.
20. Parashar, U.D.; Nelson, E.A.S.; Kang, G. Diagnosis, Management, and Prevention of Rotavirus Gastroenteritis in Children. BMJ 2013, 347, f7204.
21. Huyen, D.T.T.; Hong, D.T.; Trung, N.T.; Hoa, T.T.N.; Oanh, N.K.; Thang, H.V.; Thao, N.T.T.; Hung, D.M.; Iijima, M.; Fox, K.; et al. Epidemiology of Acute Diarrhea Caused by Rotavirus in Sentinel Surveillance Sites of Vietnam, 2012–2015. Vaccine 2018, 36, 7894–7900.
22. Bhatnagar, S.; Srivastva, G. Clinical Profile of Children (0–5 Years) with RotaVirus Diarrhea. Int. J. Contemp. Pediatrics 2017, 4, 947.
23. Haddadin, Z.; Batarseh, E.; Hamdan, L.; Stewart, L.S.; Piya, B.; Rahman, H.; Spieker, A.J.; Chappell, J.; Wikswo, M.E.; Dunn, J.R.; et al. Characteristics of GII.4 Norovirus Versus Other Genotypes in Sporadic Pediatric Infections in Davidson County, Tennessee, USA. Clin. Infect. Dis. 2021, 73, e1525–e1531.
24. Nguyen, G.T.; Phan, K.; Teng, I.; Pu, J.; Watanabe, T. A Systematic Review and Meta-Analysis of the Prevalence of Norovirus in Cases of Gastroenteritis in Developing Countries. Medicine 2017, 96, e8139.

25. Lopman, B.A.; Steele, D.; Kirkwood, C.D.; Parashar, U.D. The Vast and Varied Global Burden of Norovirus: Prospects for Prevention and Control. PLoS Med. 2016, 13, e1001999.
26. Farahmand, M.; Moghoofei, M.; Dorost, A.; Shoja, Z.; Ghorbani, S.; Kiani, S.J.; Khales, P.; Esteghamati, A.; Sayyahfar, S.; Jafarzadeh, M.; et al. Global Prevalence and Genotype Distribution of Norovirus Infection in Children with Gastroenteritis: A Meta-analysis on 6 Years of Research from 2015 to 2020. Rev. Med. Virol. 2021, e2237.
27. Ahmed, S.M.; Hall, A.J.; Robinson, A.E.; Verhoef, L.; Premkumar, P.; Parashar, U.D.; Koopmans, M.; Lopman, B.A. Global Prevalence of Norovirus in Cases of Gastroenteritis: A Systematic Review and Meta-Analysis. Lancet Infect. Dis. 2014, 14, 725–730.
28. Fang, Y.; Dong, Z.; Liu, Y.; Wang, W.; Hou, M.; Wu, J.; Wang, L.; Zhao, Y. Molecular Epidemiology and Genetic Diversity of Norovirus among Hospitalized Children with Acute Gastroenteritis in Tianjin, China, 2018–2020. BMC Infect. Dis. 2021, 21, 682.
29. Cao, R.-R.; Ma, X.-Z.; Li, W.-Y.; Wang, B.-N.; Yang, Y.; Wang, H.-R.; Kuang, Y.; You, J.-Z.; Zhao, Z.-Y.; Ren, M.; et al. Epidemiology of Norovirus Gastroenteritis in Hospitalized Children under Five Years Old in Western China, 2015–2019. J. Microbiol. Immunol. Infect. 2021, 54, 918–925.
30. Mikounou Louya, V.; Nguekeng Tsague, B.; Ntoumi, F.; Vouvoungui, C.; Kobawila, S.C. High Prevalence of Norovirus and Rotavirus Co-infection in Children with Acute Gastroenteritis Hospitalised in Brazzaville, Republic of Congo. Trop. Med. Int. Health 2019, 24, 1427–1433.
31. Li, L.L.; Liu, N.; Humphries, E.M.; Yu, J.M.; Li, S.; Lindsay, B.R.; Stine, O.C.; Duan, Z.J. Aetiology of Diarrhoeal Disease and Evaluation of Viral–Bacterial Coinfection in Children under 5 Years Old in China: A Matched Case–Control Study. Clin. Microbiol. Infect. 2016, 22, 381.e9–381.e16.
32. Barsoum, Z. Pediatric Norovirus Gastroenteritis in Ireland: Seasonal Trends, Correlation with Disease Severity, Nosocomial Acquisition and Viral Co-Infection. Indian J. Pediatrics 2020, 88, 463–468.
33. Rönnelid, Y.; Bonkoungou, I.J.O.; Ouedraogo, N.; Barro, N.; Svensson, L.; Nordgren, J. Norovirus and Rotavirus in Children Hospitalised with Diarrhoea after Rotavirus Vaccine Introduction in Burkina Faso. Epidemiol. Infect. 2020, 148, e245.
34. Bucardo, F.; Kindberg, E.; Paniagua, M.; Vildevall, M.; Svensson, L. Genetic Susceptibility to Symptomatic Norovirus Infection in Nicaragua. J. Med. Virol. 2009, 81, 728–735.
35. Mallory, M.; Lindesmith, L.; Graham, R.; Baric, R. GII.4 Human Norovirus: Surveying the Antigenic Landscape. Viruses 2019, 11, 177.
36. Bucardo, F.; Reyes, Y.; Becker-Dreps, S.; Bowman, N.; Gruber, J.F.; Vinjé, J.; Espinoza, F.; Paniagua, M.; Balmaseda, A.; Svensson, L.; et al. Pediatric Norovirus GII.4 Infections in Nicaragua, 1999–2015. Infect. Genet. Evol. 2017, 55, 305–312.

37. Ahmed, K.; Dony, J.J.F.; Mori, D.; Haw, L.Y.; Giloi, N.; Jeffree, M.S.; Iha, H. An Outbreak of Gastroenteritis by Emerging Norovirus GII.2 in a Kindergarten in Kota Kinabalu, Malaysian Borneo. Sci. Rep. 2020, 10, 7137.
38. Wikswo, M.E.; Desai, R.; Edwards, K.M.; Staat, M.A.; Szilagyi, P.G.; Weinberg, G.A.; Curns, A.T.; Lopman, B.; Vinjé, J.; Parashar, U.D.; et al. Clinical Profile of Children with Norovirus Disease in Rotavirus Vaccine Era. Emerg. Infect. Dis. 2013, 19, 1691–1693.
39. Arowolo, K.O.; Ayolabi, C.I.; Adeleye, I.A.; Lapinski, B.; Santos, J.S.; Raboni, S.M. Molecular Epidemiology of Astrovirus in Children with Gastroenteritis in Southwestern Nigeria. Arch. Virol. 2020, 165, 2461–2469.
40. Lu, L.; Zhong, H.; Xu, M.; Su, L.; Cao, L.; Jia, R.; Xu, J. Molecular and Epidemiological Characterization of Human Adenovirus and Classic Human Astrovirus in Children with Acute Diarrhea in Shanghai, 2017–2018. BMC Infect. Dis. 2021, 21, 713.
41. Mozhgani, S.H.R.; Samarbafzadeh, A.R.; Makvandi, M.; Shamsizadeh, A.; Parsanahad, M. Jalilian, S.H. Relative Frequency of Astrovirus in Children Suffering from Gastroenteritis Referred to Aboozar Hospital, Ahvaz. Jundishapur J. Microbiol. 2011, 4, 67–70.
42. Alsuwaidi, A.R.; Al Dhaheri, K.; Al Hamad, S.; George, J.; Ibrahim, J.; Ghatasheh, G.; Issa, M.; Al-Hammadi, S.; Narchi, H. Etiology of Diarrhea by Multiplex Polymerase Chain Reaction among Young Children in the United Arab Emirates: A Case-Control Study. BMC Infect. Dis. 2021, 21, 7.
43. Moyo, S.J.; Hanevik, K.; Blomberg, B.; Kommedal, O.; Nordbø, S.A.; Maselle, S.; Langeland, N. Prevalence and Molecular Characterisation of Human Adenovirus in Diarrhoeic Children in Tanzania; a Case Control Study. BMC Infect. Dis. 2014, 14, 666.
44. La Rosa, G.; Della Libera, S.; Petricca, S.; Iaconelli, M.; Donia, D.; Saccucci, P.; Cenko, F.; Xhelilaj, G.; Divizia, M. Genetic Diversity of Human Adenovirus in Children with Acute Gastroenteritis, Albania, 2013–2015. BioMed Res. Int. 2015, 2015, 142912.
45. Nahar, S.; Akter, T.; Sultana, H.; Akter, A.; Sarkar, O.; Ahmed, M.; Talukder, A.; Ahmed, F.; Dey, S. A Retrospective Analysis of Viral Gastroenteritis in Asia. J. Pediatric Infect. Dis. 2015, 9, 53–65.
46. Pabbaraju, K.; Tellier, R.; Pang, X.-L.; Xie, J.; Lee, B.E.; Chui, L.; Zhuo, R.; Vanderkooi, O.G.; Ali, S.; Tarr, P.I.; et al. A Clinical Epidemiology and Molecular Attribution Evaluation of Adenoviruses in Pediatric Acute Gastroenteritis: A Case-Control Study. J. Clin. Microbiol. 2020, 59, e02287-20.
47. Kweon, O.J.; Lim, Y.K.; Kim, H.R.; Kim, T.-H.; Lee, M.-K. Fecal Respiratory Viruses in Acute Viral Respiratory Infection and Nasopharyngeal Diarrheal Viruses in Acute Viral Gastroenteritis: Clinical Impact of Ectopic Viruses Is Questionable. J. Microbiol. Biotechnol. 2018, 28, 465–472.
48. Santos-Ferreira, N.; Van Dycke, J.; Neyts, J.; Rocha-Pereira, J. Current and Future Antiviral Strategies to Tackle Gastrointestinal Viral Infections. Microorganisms 2021, 9, 1599.

49. Kajon, A.; Lynch, J., III. Adenovirus: Epidemiology, Global Spread of Novel Serotypes, and Advances in Treatment and Prevention. Semin. Respir. Crit. Care Med. 2016, 37, 586–602.
50. Balasubramanian, R.; Im, J.; Lee, J.-S.; Jeon, H.J.; Mogeni, O.D.; Kim, J.H.; Rakotozandrindrainy, R.; Baker, S.; Marks, F. The Global Burden and Epidemiology of Invasive Non-Typhoidal Salmonella Infections. Hum. Vaccines Immunother. 2018, 15, 1421–1426.
51. Pui, C.F.; Wong, W.C.; Chai, L.C.; Tunung, R.; Jyaletchuemi, P.; Noor Hidayah, M.S.; Ubong, A.; Farinazleen, M.G.; Cheah, Y.K.; Son, R. Salmonella: A Foodborne Pathogen. Int. Food Res. J. 2011, 18, 465–473.
52. Chung, N.; Wang, S.-M.; Shen, C.-F.; Kuo, F.-C.; Ho, T.-S.; Hsiung, C.A.; Mu, J.-J.; Wu, F.-T.; Huang, L.-M.; Huang, Y.-C.; et al. Clinical and Epidemiological Characteristics in Hospitalized Young Children with Acute Gastroenteritis in Southern Taiwan: According to Major Pathogens. J. Microbiol. Immunol. Infect. 2017, 50, 915–922.
53. Wu, L.; Luo, Y.; Shi, G.; Li, Z. Antibiotic Resistance in Nontyphoidal Salmonella Infection. Infect. Drug Resist. 2021, 14, 1403–1413.
54. Wen, S.C.; Best, E.; Nourse, C. Non-Typhoidal Salmonella Infections in Children: Review of Literature and Recommendations for Management. J. Paediatr. Child Health 2017, 53, 936–941.
55. Grivas, G.; Lagousi, T.; Mandilara, G. Epidemiological Data, Serovar Distribution and Antimicrobial Resistance Patterns of Salmonella Species in Children, Greece 2011-2017: A Retrospective Study. Acta Med. Acad. 2021, 49, 255.
56. Barrett, J.; Fhogartaigh, C.N. Bacterial Gastroenteritis. Medicine 2017, 45, 683–689.
57. Jain, P.; Chowdhury, G.; Samajpati, S.; Basak, S.; Ganai, A.; Samanta, S.; Okamoto, K.; Mukhopadhyay, A.K.; Dutta, S. Characterization of Non-Typhoidal Salmonella Isolates from Children with Acute Gastroenteritis, Kolkata, India, during 2000–2016. Braz. J. Microbiol. 2020, 51, 613–627.
58. Singh, R.; Yadav, A.S.; Tripathi, V.; Singh, R.P. Antimicrobial Resistance Profile of Salmonella Present in Poultry and Poultry Environment in North India. Food Control 2013, 33, 545–548.
59. Deng, X.; Ran, L.; Wu, S.; Ke, B.; He, D.; Yang, X.; Zhang, Y.; Ke, C.; Klena, J.D.; Yan, M.; et al. Laboratory-Based Surveillance of Non-Typhoidal Salmonella Infections in Guangdong Province, China. Foodborne Pathog. Dis. 2012, 9, 305–312.
60. Zhou, Y.; Zhu, X.; Hou, H.; Lu, Y.; Yu, J.; Mao, L.; Mao, L.; Sun, Z. Characteristics of Diarrheagenic Escherichia coli among Children under 5 Years of Age with Acute Diarrhea: A Hospital Based Study. BMC Infect. Dis. 2018, 18, 63.
61. GebreSilasie, Y.M.; Tullu, K.D.; Yeshanew, A.G. Resistance Pattern and Maternal Knowledge, Attitude and Practices of Suspected Diarrheagenic Escherichia coli among Children under 5

Years of Age in Addis Ababa, Ethiopia: Cross Sectional Study. Antimicrob. Resist. Infect. Control 2018, 7, 110.

62. Saka, H.K.; Dabo, N.T.; Muhammad, B.; García-Soto, S.; Ugarte-Ruiz, M.; Alvarez, J. Diarrheagenic Escherichia coli Pathotypes From Children Younger Than 5 Years in Kano State, Nigeria. Front. Public Health 2019, 7, 348.
63. Mare, A.; Man, A.; Toma, F.; Ciurea, C.N.; Coșeriu, R.L.; Vintilă, C.; Maier, A.C. Hemolysin-Producing Strains among Diarrheagenic Escherichia coli Isolated from Children under 2 Years Old with Diarrheal Disease. Pathogens 2020, 9, 1022.
64. Amisano, G.; Fornasero, S.; Migliaretti, G.; Caramello, S.; Tarasco, V.; Savino, F. Diarrheagenic Escherichia coli in acute gastroenteritis in infants in North-West Italy. New Microbiol. 2011, 34, 45–51.
65. Kargar, M.; Homayoon, M. Prevalence of Shiga Toxins (Stx1, Stx2), EaeA and Hly Genes of Escherichia coli O157:H7 Strains among Children with Acute Gastroenteritis in Southern of Iran. Asian Pac. J. Trop. Med. 2015, 8, 24–28.
66. Khosravi, A.D. Prevalence of Escherichia coli O157:H7 in Children with Bloody Diarrhea Referring to Abuzar Teaching Hospital, Ahvaz, Iran. J. Clin. Diagn. Res. 2018, 10, 13–15.
67. Farrokh, C.; Jordan, K.; Auvray, F.; Glass, K.; Oppegaard, H.; Raynaud, S.; Thevenot, D.; Condron, R.; De Reu, K.; Govaris, A.; et al. Review of Shiga-Toxin-Producing Escherichia coli (STEC) and Their Significance in Dairy Production. Int. J. Food Microbiol. 2013, 162, 190–212.
68. Pérez-Corrales, C.; Leandro-Sandí, K. Diarrheagenic Escherichia coli in Costa Rican Children: A 9-Year Retrospective Study. BMC Res. Notes 2019, 12, 297.
69. Shunmugam, P.; Kanapathy, S.; Chan, S.-E.; Singh, K.-K.B. Long-Term Trends in the Epidemiology of Human Enteropathogens in Malaysia. Braz. J. Infect. Dis. 2012, 16, 603–604.
70. Konaté, A.; Dembélé, R.; Guessennd, N.K.; Kouadio, F.K.; Kouadio, I.K.; Ouattara, M.B.; Kaboré, W.A.D.; Kagambèga, A.; Cissé, H.; Ibrahim, H.B.; et al. Epidemiology and Antibiotic Resistance Phenotypes of Diarrheagenic Escherichia coli Responsible for Infantile Gastroenteritis in Ouagadougou, Burkina Faso. Eur. J. Microbiol. Immunol. 2017, 7, 168–175.
71. Mahdavi Broujerdi, S.; Roayaei Ardakani, M.; Rezatofighi, S.E. Characterization of Diarrheagenic Escherichia coli Strains Associated with Diarrhea in Children, Khouzestan, Iran. J. Infect. Dev. Ctries. 2018, 12, 649–656.
72. Celik, T.; Guler, E.; Atas Berksoy, E.; Sorguc, Y.; Arslan, N. Mean Platelet Volume in Children with Acute Gastroenteritis Caused by Entamoeba histolytica. Turk. J. Parasitol. 2015, 39, 205–208.
73. El-Dib, N.A. Entamoeba histolytica: An Overview. Curr. Trop. Med. Rep. 2017, 4, 11–20.

74. Ibraheem, F. Etiology and Clinical Manifestations of Infectious Bloody Diarrhea in Children Welfare Teaching Hospital. Iraqi Postgrad. Med. J. 2016, 15, 35–39.
75. Nair, G.; Rebolledo, M.; White, A.C.; Crannell, Z.; Richards-Kortum, R.R.; Pinilla, A.E.; Ramírez, J.D.; López, M.C.; Castellanos-Gonzalez, A. Detection of Entamoeba histolytica by Recombinase Polymerase Amplification. Am. J. Trop. Med. Hyg. 2015, 93, 591–595.
76. Hegazi, M.A.; Patel, T.A.; El-Deek, B.S. Prevalence and Characters of Entamoeba histolytica Infection in Saudi Infants and Children Admitted with Diarrhea at 2 Main Hospitals at South Jeddah: A Re-Emerging Serious Infection with Unusual Presentation. Braz. J. Infect. Dis. 2013, 17, 32–40.
77. Loganathan, T.; Lee, W.S.; Lee, K.F.; Jit, M.; Ng, C.W. Household catastrophic healthcare expenditure and impoverishment due to rotavirus gastroenteritis requiring hospitalization in Malaysia. PLoS ONE 2015, 10, e0125878.
78. Naous, A.; Naja, Z.; Zaatari, N.; Kamel, R.; Rajab, M. Intestinal Amebiasis: A Concerning Cause of Acute Gastroenteritis among Hospitalized Lebanese Children. North Am. J. Med. Sci. 2013, 5, 689–698.
79. Khan, B.; Afshan, K.; Firasat, S.; Qayyum, M. Seroprevalence and Associated Risk Factors of Entamoeba histolytica Infection among Gastroenteritis Patients Visited in Public Healthcare System, Pakistan. J. Pak. Med. Assoc. 2019, 69, 1777–1784.
80. Enogiomwan, I.E.; Ikponmwosa, E.O.; Chinyere, O.-A.; Christopher, A.B. Evaluation of Vegetable Contamination with Medically Important Helminths and Protozoans in Calabar, Nigeria. J. Adv. Biol. Biotechnol. 2020, 23, 10–16.
81. Yones, D.; Othman, R.; Hassan, T.; Kotb, S.; Mohamed, A. Prevalence of Gastrointestinal Parasites and its Predictors among Rural Egyptian School Children. J. Egypt. Soc. Parasitol. 2019, 49, 619–630.
82. Shahrul Anuar, T.; Al-Mekhlafi, H.M.; Abdul Ghani, M.K.; Osman, E.; Mohd Yasin, A.; Nordin, A.; Nor Azreen, S.; Md Salleh, F.; Ghazali, N.; Bernadus, M.; et al. Prevalence and Risk Factors Associated with Entamoeba histolytica/Dispar/Moshkovskii Infection among Three Orang Asli Ethnic Groups in Malaysia. PLoS ONE 2012, 7, e48165.
83. Maçin, S.; Kaya, F.; Ergüven, S.; Akyön, Y. Akut Gastroenterit Salgınının Mikrobiyolojik Değerlendirmesi. Cukurova Med. J. 2017, 42, 617–622.
84. Simon Oke, I.A.; Ogunleye, E. Prevalence of Entamoeba histolytica among Primary School Children in Akure, Ondo State, Nigeria. J. Public Health Epidemiol. 2015, 7, 346–351.
85. Pereira, L.A.; Raboni, S.M.; Nogueira, M.B.; Vidal, L.R.; de Almeida, S.M.; Debur, M.C.; Cruz, C. Rotavirus Infection in a Tertiary Hospital: Laboratory Diagnosis and Impact of Immunization on Pediatric Hospitalization. Braz. J. Infect. Dis. 2011, 15, 215–219.

86. Gautam, R.; Lyde, F.; Esona, M.D.; Quaye, O.; Bowen, M.D. Comparison of PremierTM Rotaclone®, ProSpecTTM, and RIDASCREEN® Rotavirus Enzyme Immunoassay Kits for Detection of Rotavirus Antigen in Stool Specimens. J. Clin. Virol. 2013, 58, 292–294.
87. Philip, C.O.; Koech, M.; Kipkemoi, N.; Kirera, R.; Ndonye, J.; Ombogo, A.; Kirui, M.; Kipkirui, E.; Danboise, B.; Hulseberg, C.; et al. Evaluation of the Performance of a Multiplex Reverse Transcription Polymerase Chain Reaction Kit as a Potential Diagnostic and Surveillance Kit for Rotavirus in Kenya. Trop. Dis. Travel Med. Vaccines 2019, 5, 12.
88. Ha, C.; Yoo, I.Y.; Yun, S.A.; Chung, Y.N.; Huh, H.J.; Lee, N.Y. Performance Evaluation of Automated Fluorescent Immunoassay System ROTA and NORO for Detection of Rotavirus and Norovirus: A Comparative Study of Assay Performance with RIDASCREEN® Rotavirus and Norovirus. J. Clin. Lab. Anal. 2020, 35, e23585.
89. El-Ageery, S.M.; Ali, R.; Abou El-Khier, N.T.; Rakha, S.A.; Zeid, M.S. Comparison of Enzyme Immunoassay, Latex Agglutination and Polyacrylamide Gel Electrophoresis for Diagnosis of Rotavirus in Children. Egypt. J. Basic Appl. Sci. 2020, 7, 47–52.
90. Moutelíková, R.; Sauer, P.; Dvořáková Heroldová, M.; Holá, V.; Prodělalová, J. Emergence of Rare Bovine–Human Reassortant DS-1-Like Rotavirus A Strains with G8P Genotype in Human Patients in the Czech Republic. Viruses 2019, 11, 1015.
91. Gautam, R.; Mijatovic-Rustempasic, S.; Esona, M.D.; Tam, K.I.; Quaye, O.; Bowen, M.D. One-Step Multiplex Real-Time RT-PCR Assay for Detecting and Genotyping Wild-Type Group A Rotavirus Strains and Vaccine Strains (Rotarix® and RotaTeq®) in Stool Samples. PeerJ 2016, 4, e1560.
92. Norovirus Laboratory Diagnosis. Available online: https://www.cdc.gov/norovirus/lab/diagnosis.html (accessed on 29 September 2021).
93. Wong, R.S.-L.; Yeo, F.; Chia, W.T.; Lee, C.K.; Leong, M.H.; Ng, C.W.-S.; Poon, K.S.; Yan, G.Z.; Chiu, L.-L.; Yan, B.J.; et al. Performance Evaluation of Cepheid Xpert Norovirus Kit with a User-Modified Protocol. J. Med. Virol. 2017, 90, 485–489.
94. Gonzalez, M.D.; Langley, L.C.; Buchan, B.W.; Faron, M.L.; Maier, M.; Templeton, K.; Walker, K.; Popowitch, E.B.; Miller, M.B.; Rao, A.; et al. Multicenter Evaluation of the Xpert Norovirus Assay for Detection of Norovirus Genogroups I and II in Fecal Specimens. J. Clin. Microbiol. 2016, 54, 142–147.
95. Dunbar, N.L.; Bruggink, L.D.; Marshall, J.A. Evaluation of the RIDAGENE Real-Time PCR Assay for the Detection of GI and GII Norovirus. Diagn. Microbiol. Infect. Dis. 2014, 79, 317–321.
96. Kumthip, K.; Khamrin, P.; Saikruang, W.; Supadej, K.; Ushijima, H.; Maneekarn, N. Comparative Evaluation of Norovirus Infection in Children with Acute Gastroenteritis by Rapid

Immunochromatographic Test, RT-PCR and Real-Time RT-PCR. J. Trop. Pediatrics 2017, 63, 468–475.

97. Jonckheere, S.; Botteldoorn, N.; Vandecandelaere, P.; Frans, J.; Laffut, W.; Coppens, G.; Vankeerberghen, A.; De Beenhouwer, H. Multicenter Evaluation of the Revised RIDA® QUICK Test (N1402) for Rapid Detection of Norovirus in a Diagnostic Laboratory Setting. Diagn. Microbiol. Infect. Dis. 2017, 88, 31–35.
98. Bruggink, L.D.; Dunbar, N.L.; Marshall, J.A. Evaluation of the Updated RIDA®QUICK (Version N1402) Immunochromatographic Assay for the Detection of Norovirus in Clinical Specimens. J. Virol. Methods 2015, 223, 82–87.
99. Ranuh, R.G.; Athiyyah, A.F.; Pa, D.A.; Darma, A.; Rahardjo, D.; Shirakawa, T.; Sudarmo, S.M. Assessment of the Rapid Immunochromatographic Test as a Diagnostic Tool for Norovirus Related Diarrhea in Children. Folia Med. Indones. 2019, 55, 48.
100. Thangjui, S.; Sripirom, N.; Titichoatrattana, S.; Mekmullica, J. Accuracy and Cross-Reactivity of Rapid Diagnostic Tests for Norovirus and Rotavirus in a Real Clinical Setting. Infect. Chemother. 2020, 52, 360.
101. Geginat, G.; Kaiser, D.; Schrempf, S. Evaluation of Third-Generation ELISA and a Rapid Immunochromatographic Assay for the Detection of Norovirus Infection in Fecal Samples from Inpatients of a German Tertiary Care Hospital. Eur. J. Clin. Microbiol. Infect. Dis. 2011, 31, 733–737.
102. Kirby, A.; Gurgel, R.Q.; Dove, W.; Vieira, S.C.F.; Cunliffe, N.A.; Cuevas, L.E. An Evaluation of the RIDASCREEN and IDEIA Enzyme Immunoassays and the RIDAQUICK Immunochromatographic Test for the Detection of Norovirus in Faecal Specimens. J. Clin. Virol. 2010, 49, 254–257.
103. Liu, J.; Kibiki, G.; Maro, V.; Maro, A.; Kumburu, H.; Swai, N.; Taniuchi, M.; Gratz, J.; Toney, D.; Kang, G.; et al. Multiplex Reverse Transcription PCR Luminex Assay for Detection and Quantitation of Viral Agents of Gastroenteritis. J. Clin. Virol. 2011, 50, 308–313.
104. Yang, B.-Y.; Liu, X.-L.; Wei, Y.-M.; Wang, J.-Q.; He, X.-Q.; Jin, Y.; Wang, Z.-J. Rapid and Sensitive Detection of Human Astrovirus in Water Samples by Loop-Mediated Isothermal Amplification with Hydroxynaphthol Blue Dye. BMC Microbiol. 2014, 14, 38.
105. Wei, H.; Zeng, J.; Deng, C.; Zheng, C.; Zhang, X.; Ma, D.; Yi, Y. A Novel Method of Real-Time Reverse-Transcription Loop-Mediated Isothermal Amplification Developed for Rapid and Quantitative Detection of Human Astrovirus. J. Virol. Methods 2013, 188, 126–131.
106. Bonura, F.; Mascarella, C.; Filizzolo, C.; Bonura, C.; Ferraro, D.; Di Bernardo, F.; Collura, A.; Martella, V.; Giammanco, G.M.; De Grazia, S. Evaluation of the Diagnostic Performances of Two Commercially Available Assays for the Detection of Enteric Adenovirus Antigens. Diagn. Microbiol. Infect. Dis. 2021, 101, 115459.

107. Unal, N.; Yanik, K.; Aydogdu, S.; Eroglu, C.; Gunaydin, M.; Hokelek, M. An Evaluation of Rotavirus and Adenovirus Antigens by the Immunochromatographic Method in Samples with an Initial Diagnosis of Acute Gastroenteritis. Acta Med. Mediterr. 2016, 32, 81–85.

108. Liu, J.; Gratz, J.; Amour, C.; Nshama, R.; Walongo, T.; Maro, A.; Mduma, E.; Platts-Mills, J.; Boisen, N.; Nataro, J.; et al. Optimization of Quantitative PCR Methods for Enteropathogen Detection. PLoS ONE 2016, 11, e0158199.

109. Liu, J.; Gratz, J.; Amour, C.; Kibiki, G.; Becker, S.; Janaki, L.; Verweij, J.J.; Taniuchi, M.; Sobuz, S.U.; Haque, R.; et al. A Laboratory-Developed TaqMan Array Card for Simultaneous Detection of 19 Enteropathogens. J. Clin. Microbiol. 2012, 51, 472–480.

110. Meena, B.; Anburajan, L.; Selvaganapathi, K.; Vinithkumar, N.V.; Dharani, G. Characteristics and Dynamics of Salmonella Diversity and Prevalence of Biomarker Genes in Port Blair Bays, South Andaman, India. Mar. Pollut. Bull. 2020, 160, 111582.

111. Reddington, K.; Tuite, N.; Minogue, E.; Barry, T. A Current Overview of Commercially Available Nucleic Acid Diagnostics Approaches to Detect and Identify Human Gastroenteritis Pathogens. Biomol. Detect. Quantif. 2014, 1, 3–7.

112. Amjad, M. An Overview of the Molecular Methods in the Diagnosis of Gastrointestinal Infectious Diseases. Int. J. Microbiol. 2020, 2020, 8135724.

113. Maldonado-Garza, H.J.; Garza-González, E.; Bocanegra-Ibarias, P.; Flores-Treviño, S. Diagnostic Syndromic Multiplex Approaches for Gastrointestinal Infections. Expert Rev. Gastroenterol. Hepatol. 2021, 15, 743–757.

114. Biswas, J.S.; Al-Ali, A.; Rajput, P.; Smith, D.; Goldenberg, S.D. A Parallel Diagnostic Accuracy Study of Three Molecular Panels for the Detection of Bacterial Gastroenteritis. Eur. J. Clin. Microbiol. Infect. Dis. 2014, 33, 2075–2081.

115. Zboromyrska, Y.; Vila, J. Advanced PCR-Based Molecular Diagnosis of Gastrointestinal Infections: Challenges and Opportunities. Expert Rev. Mol. Diagn. 2016, 16, 631–640.

116. Zhang, H.; Morrison, S.; Tang, Y.-W. Multiplex Polymerase Chain Reaction Tests for Detection of Pathogens Associated with Gastroenteritis. Clin. Lab. Med. 2015, 35, 461–486.

117. Amézquita-López, B.A.; Soto-Beltrán, M.; Lee, B.G.; Yambao, J.C.; Quiñones, B. Isolation, Genotyping and Antimicrobial Resistance of Shiga Toxin-Producing Escherichia coli. J. Microbiol. Immunol. Infect. 2018, 51, 425–434.

118. Gould, L.H. Update: Recommendations for Diagnosis of Shiga Toxin-Producing Escherichia coli Infections by Clinical Laboratories. Clin. Microbiol. Newsl. 2012, 34, 75–83.

119. Parsons, B.D.; Zelyas, N.; Berenger, B.M.; Chui, L. Detection, Characterization, and Typing of Shiga Toxin-Producing Escherichia coli. Front. Microbiol. 2016, 7, 478.

120. Jenkins, C.; Perry, N.T.; Godbole, G.; Gharbia, S. Evaluation of Chromogenic Selective Agar (CHROMagar STEC) for the Direct Detection of Shiga Toxin-Producing Escherichia coli from Faecal Specimens. J. Med. Microbiol. 2020, 69, 487–491.
121. Hahn, A.; Luetgehetmann, M.; Landt, O.; Schwarz, N.G.; Frickmann, H. Comparison of One Commercial and Two In-House TaqMan Multiplex Real-Time PCR Assays for Detection of Enteropathogenic, Enterotoxigenic and Enteroaggregative Escherichia coli. Trop. Med. Int. Health 2017, 22, 1371–1376.
122. Khteer Al-Hadraawy, S.; Hussein Abod Al-Khafaji, K.; Deqeem, F.M.; Jawad Kadhim, N. Study Role of Hematological and Leptin Biomarkers in Human Infected with Entamoeba histolytica Parasite. J. Phys. Conf. Ser. 2019, 1294, 062032.
123. Khteer Al-Hadraawy, S.; AL-Shebly, F.H.; Abood, A.H.; Khadim, N.J. Correlation Study Between Biological Markers In Patients With Entamoeba histolytica Parasite. Biochem. Cell. Arch. 2019, 19, 125–129.
124. Saidin, S.; Yunus, M.H.; Othman, N.; Lim, Y.A.-L.; Mohamed, Z.; Zakaria, N.Z.; Noordin, R. Development and Initial Evaluation of a Lateral Flow Dipstick Test for Antigen Detection Of Entamoeba histolyticain Stool Sample. Pathog. Glob. Health 2017, 111, 128–136.
125. Mero, S.; Kirveskari, J.; Antikainen, J.; Ursing, J.; Rombo, L.; Kofoed, P.-E.; Kantele, A. Multiplex PCR Detection Of Cryptosporidium sp, Giardia Lamblia and Entamoeba histolytica Directly from Dried Stool Samples from Guinea-Bissauan Children with Diarrhoea. Infect. Dis. 2017, 49, 655–663.
126. López-Rosas, I.; López-Camarillo, C.; Salinas-Vera, Y.M.; Hernández-de la Cruz, O.N.; Palma-Flores, C.; Chávez-Munguía, B.; Resendis-Antonio, O.; Guillen, N.; Pérez-Plasencia, C.; Álvarez-Sánchez, M.E.; et al. Entamoeba histolytica Up-Regulates MicroRNA-643 to Promote Apoptosis by Targeting XIAP in Human Epithelial Colon Cells. Front. Cell. Infect. Microbiol. 2019, 8, 437.
127. Lappan, R.; Henry, R.; Chown, S.L.; Luby, S.P.; Higginson, E.E.; Bata, L.; Jirapanjawat, T.; Schang, C.; Openshaw, J.J.; O'Toole, J.; et al. TaqMan Array Cards Enable Monitoring of Diverse Enteric Pathogens across Environmental and Host Reservoirs; Cold Spring Harbor Laboratory: Cold Spring Harbor, NY, USA, 2020.