HISTORICAL PERSPECTIVES

COVID-19 and lessons learned from the pandemic wave of meningococcal meningitis (1985–1990)

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ABSTRACT

A novel coronavirus was first identified in late 2019 to cause an outbreak of acute respiratory illness in Wuhan city in China. The disease was designated COVID-19 (coronavirus disease 2019) by the World Health Organization (WHO) in February 2020. Worldwide, the infection spread affecting more than 3 million confirmed cases, mainly in Europe and USA, and was characterised by the WHO as a pandemic in March 2020. During 1985–1990, a similar pandemic wave of meningococcal (MC) meningitis spread over vast territories in Asia (including Saudi Arabia) and Africa (including Sudan and Ethiopia with more than 70,000 cases). The Sudanese Journal of Paediatrics (SJP) is taking the opportunity to document the history of this pandemic in Sudan, which has been successfully managed within Sudan/Sweden scientific link program involving the University of Khartoum, Sudan and Uppsala University, Sweden. This joint research project evaluated a rapid antigen test for the diagnosis of acute bacterial meningitis which later proved to be adaptable to the field situation during the 1988 MC epidemic. It also constituted one of the

pioneering works in molecular epidemiology and proved to be vital in controlling epidemic meningitis worldwide. Based on this and other bacteriologic and epidemiologic data, a new conjugate vaccine was later developed which put an end to Group A meningococcal epidemics. Lessons learnt from this pandemic, which also applied in case of coronavirus disease 2019 (COVID-19), are also highlighted.

KEYWORDS

COVID-19; Meningococcal meningitis; Pandemic; ELISA; Molecular epidemiology; Vaccination.

INTRODUCTION

A zone extending across Africa from Mali in the West to Sudan in the East has been known to have violent epidemics of meningococcal (MC) meningitis that occur every 6–12 years. It has been named the ‘meningitis belt’ by Dr. Léon Lapeyssonnie (1915–2001), the renowned French epidemiologist, in 1963 in a classic monograph [1]. Interestingly, we used to see Dr. Léon Lapeyssonnie, when we were postgraduate students, during the morning clinical round at

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Khartoum Teaching Hospital when he came to visit Prof. Mohamed Ibrahim A. Omer, President of the Scientific Committee, Sudan National Expanded Programme on Immunisation. Dr. Lapeyssonnie frequently visited Sudan as Advisor to the Ministry of Health. Prof. Omer was also Convenor, Master of Paediatrics and Child Health (MPCH) Degree Committee and Head, Department of Paediatrics and Child Health, Faculty of Medicine, University of Khartoum (U of K).

It has been a fortunate coincidence that the peak of the MC pandemic in 1988 occurred while a cooperative project on 'Childhood Acute Bacterial Meningitis in the Sudan' had already been established in 1985, with Prof. Mustafa A. M. Salih [2] as principal investigator. This project was within Sudan/Sweden scientific link involving the University of Khartoum (U of K) and Uppsala University, supported by the Swedish Commission for Technical Co-operation and the Medical Research Council. Professor Yngve Hofvander, Head of the International Child Health Unit, Department of Pediatrics at Uppsala University directed these programs, while Professor Mohamed Ibrahim A. Omer, Head Department of Paediatrics and Child Health, Faculty of Medicine, U of K, has been the Sudan Coordinator. The objectives of the research project were to establish the epidemiology of acute bacterial meningitis (ABM) in Sudanese children, reveal the causative organisms, explore potential rapid diagnostic tests, and ascertain the morbidity, mortality and sequelae of the disease. The idea of the project followed a review article written by Prof. Mustafa A. Salih during a study visit to Uppsala in 1984, within this scientific link program [3].

Children admitted between April 1985 and October 1986 to the Children's Emergency Hospital (currently named Gaafar Ibnauf Children's Hospital [4]) were enrolled in a study to establish the epidemiology, causative organisms and sequelae of endemic ABM [5,6]. The study was done with valuable collaboration of Dr. Ahmed Ibrahim El Hag at the Department of Paediatrics and Child Health, Faculty of Medicine, U of K. An important outcome of this study was the evaluation of a rapid antigen test for the diagnosis of ABM which

later proved to be adaptable to the field situation during the 1988 MC epidemic [7]. This was based on an enzyme immunoassay (ELISA) method for the detection of *Haemophilus influenzae* type b, *Neisseria meningitidis* (serogroups A,B and C) and *Streptococcus pneumoniae* (25 selected types). The ELISA test, which does not need sophisticated equipment, was developed by Pharmacia Diagnostics Corp., Uppsala, Sweden. The test takes only 1 hour to perform, is read by the naked eye, and can be used by any diagnostic laboratory (Figure 1). Of the cerebrospinal fluid (CSF) samples taken on admission during the MC epidemic, 99% were positive with ELISA, 71% with culture and 58% by direct microscopy of Gram stained CSF smears. It's known that DM lacks specificity and culture is time-consuming and may be negative in patients pre-treated with antibiotics. The importance of rapid antigen tests was highlighted during the current COVID-19 pandemic to guide patient management and infection control strategies, and were considered essential for slowing down the pandemic [8].

Figure 1. ELISA test kit (Meningitis EIA-Test, Karo-Bio Diagnostics, Stockholm, Sweden) with four plastic tubes coated with rabbit antisera against *Haemophilus influenzae* type b. Variable dilutions of cerebrospinal fluid (CSF) samples from which *H. influenzae* type b was isolated were added to the tubes. The development of yellow-orange colour observed by the naked eye is considered a positive reaction, as seen in the two tubes in the middle.

EVOLUTION AND MANAGEMENT OF THE EPIDEMIC

An increasing number of meningitis cases were seen at the various emergency clinics in the three cities forming Khartoum State at the end of February 1988. Khartoum Province was declared an epidemic area on 7 March 1988. Using the radio, television and press, information was disseminated highlighting the symptoms and signs of meningitis and where to seek medical attention. Entertainment gathering places (cinemas, theatres and stadiums) as well as schools were closed down. When the cases started flooding the health system in the three cities of Khartoum State, special treatment and isolation units were established in hospitals, including Ibrahim Malik Teaching Hospital (which was still under construction), health centres and schools (Figure 2). Epidemiological surveillance personnel, who worked in shifts on a 24-hour basis, headed by Osman Abu Bakr of Khartoum Commissionary for Health, recorded the relevant demographic as well as morbidity and mortality data at these various special treatment centres.

Over 10,000 meningitis cases, of whom 50% were children (<15-year old), were recorded between February and August 1988 [9]. In Khartoum City, children were received at the Children's Emergency Hospital (currently named Gaafar Ibnauf Children's Hospital [4]), where they were cared for and managed for 2–3 days and thereafter transferred to one of three treatment

centres to stay for about 5–7 days for completion of treatment. These consisted of 1,441 children with laboratory confirmed or clinical diagnosis of MC meningitis. A clinical study subgroup consisting of 118 children (aged between 25 days and 15 years, mean = 78 months) was chosen for a prospective study to investigate the epidemiology, clinical and laboratory features and short-term outcome of MC meningitis [10]. Only five children (4.8%) received MC vaccine between 4 weeks and 1 year before onset of their illness. CSF specimens obtained from this group were examined in Khartoum at the Postgraduate Laboratory, Department of Microbiology, Faculty of Medicine, U of K for cells, bacteria after Gram staining and were cultured. The majority was also examined for bacterial antigens by ELISA, and some of the MC isolates were tested for serogroup and antibiotic sensitivity. All the isolates were stored in liquid nitrogen and transported to Sweden for serogrouping and antibiogram. Further molecular epidemiologic typing was performed by assessing multilocus enzyme genotypes, DNA restriction enzyme patterns, outer membrane proteins, lipopolysaccharides and pilus formation [11]. The needed laboratory logistics and techniques had already been established in 1985 during a visit to Khartoum by Assistant Professor (currently, Emeritus Professor) Per Olcen, Department of Clinical Microbiology and Immunology, Orebro Medical Center Hospital, Orebro, Sweden. This was done in collaboration with Dr Hassan Sid Ahmed who

Figure 2. When the cases started flooding the health system, tents were erected at Khartoum Teaching Hospital for isolation of adult patients with meningococcal meningitis and for completion of the treatment.

directed the Postgraduate Laboratory in Khartoum and executed, with his team, all the investigations during the inter-epidemic and epidemic periods. It's noteworthy that Prof. Per Olcen was one of the designated Uppsala University tutors for Prof. Mustafa A. Salih. The other two were Prof. Yngve Hofvander and Prof. Dan Danielsson, Orebro Medical Center Hospital, Orebro, Sweden. Prof. Mustafa A. Salih visited Pharmacia Diagnostics, Uppsala, Sweden who manufactured and donated the ELISA rapid diagnostic kits; and during the summer of 1987, used these to investigate the CSF samples at the Department of Clinical Microbiology and Immunology, Orebro Medical Center Hospital, Orebro. The CSF samples had been collected during the inter-epidemic period and transported in liquid nitrogen to Sweden. The Swedish Red Cross offered to carry ELISA diagnostic reagents to Sudan during the 1988 MC epidemic, and several Swedish and Sudanese citizens willingly helped in transporting logistic material between Sudan and Sweden. Dr. Helena Palmgren [12], Department of Infectious Diseases, Umea University, who has been in Khartoum during the epidemic as part of the Sudan/Sweden scientific exchange program, offered a dedicated and noble effort in the management of patients at Gaafar Ibnauf Children's Hospital. Coming from Umea, more than 5,400 km from Khartoum and nearer to the North Pole, she used to carry personally the CSF samples and deliver them to the Postgraduate Laboratory despite the intense hot weather (Figure 3). Establishing a well-equipped diagnostic laboratory proved to be vital for the management of the MC epidemic. For comparison, diagnosis of meningitis in 1,160 children admitted to Khartoum North Hospital (the treatment centre for MC cases in the neighbouring Khartoum North City) was only based on the presence of turbid CSF [13]. Since the clinical study subgroup had solid laboratory confirmation, the findings of this study [10] were used by the World Health Organization (WHO) in the guidelines for the management of common illnesses in hospitals with limited resources [14].

Strategies concerning the handling of MC cases and of the epidemic itself were worked out following a symposium on meningitis on 26 March, 1988 (Figure 4), which was arranged by the Sudan

Figure 3. *Dr. Hassan Sid Ahmed (standing, left) at the Postgraduate Laboratory, Department of Microbiology, Faculty of Medicine, University of Khartoum which proved to be vital for the management of the meningococcal meningitis epidemic. Dr. Helena Palmgren (sitting, right) used to carry personally the cerebrospinal fluid samples and deliver them to the laboratory.*

Association of Paediatricians (SAP). This was attended by Dr. Hussein Suleiman Abusalih, the Minister of Health (1985–1987) who pioneered neurosurgery in Sudan and gave great support to establish sustainable system of vaccination against childhood communicable diseases, and to medical research [15,16]. The symposium convened at the historic Baghdady Lecture Theatre, Faculty of Medicine, U of K [17]. It was chaired by Prof. Mohamed Ibrahim A. Omer, President of SAP and Head Department Paediatrics and Child Health, Faculty of Medicine, U of K [18]. The symposium was attended by national and international health care workers, non-governmental organisations and delegates from the WHO and UNICEF. Dr. Hassan Sid Ahmed presented the laboratory findings regarding the causative organism and the antibiogram. Prof. Mustafa A. Salih highlighted the importance of using penicillin in combination with chloramphenicol, rather than sulphonamides, as empirical treatment since the organism proved to be resistant to sulphonamides. It is noteworthy that sulphonamides have been used in adult patients during the epidemic, being known as the standard treatment during MC epidemics, and

Figure 4. Symposium on 26 March 1988 at the historic Baghdady Lecture Theatre, Faculty of Medicine, U of K [17] which outlined strategies concerning the handling of the meningitis cases and of the meningococcal (MC) epidemic. (A) This was attended by Dr. Hussein Suleiman Abusalih (middle), the Minister of Health (1985–1987), and organised by the Sudan Association of Paediatricians (SAP). Prof. Mohamed Ibrahim A. Omer (right), President of SAP and Head Department Paediatrics and Child Health, Faculty of Medicine, U of K [18] chaired the symposium. Dr. Mohamed Sir Elkhatim Hashim (photo, left; Member of the Editorial Board of the Sudanese Journal of Paediatrics [SJP], and Ex-President of the Sudan Association of Paediatricians) was the Secretary of SAP. (B) The symposium was attended by national and international health care workers. Prof. Zein A. Karrar (second row, right; Ex-President of the SAP and Sudan Medical Council, and currently Member of the Editorial Board of SJP) was active in handling the MC epidemic [13]. (C) Dr. Elsadig Mahjoub, Head, Department of Epidemiology, Ministry of Health, presenting at the symposium which was also attended by (D) non-governmental organisations, delegates from the WHO and UNICEF, and (E) Prof. Abdel Rahman El Tom, Head, Department of Community Medicine, Faculty of Medicine, U of K (Ex-President, Sudan Medical Council). (Photos taken by Babikir A. Faragab, Medical Illustration Unit, Faculty of Medicine, U of K).

following its first field application worldwide in Sudan in 1939 [19]. As per request of Dr. Hussein Suleiman Abusalih, the Minister of Health, a treatment protocol for MC meningitis was handed to the Ministry of Health, following the symposium, by Prof. Mohamed Ibrahim A. Omer and Prof. Mustafa A. Salih.

Whereas numerous vaccine candidates are still being evaluated for prevention of COVID-19 [20], the Sudan had one of the first successful field implementation of the first meningococcal polysaccharide vaccine trials in 1973 lead by the late Professor Hashim Hassan Erwa [21,22] and the late Professor Mansour Ali Haseeb [23]. Hence, mass vaccination campaign was

started early during the epidemic using bivalent A/C meningococcal polysaccharide vaccine. The vaccinations were performed at hospitals, health centres and by mobile teams which covered the shanty towns encircling the three cities in Khartoum State. Newcomers arriving through the main routes of entrance to the area were also vaccinated. To avoid needle injections, the vaccine was administered, in most cases, using foot-operated jet injectors (Port-O-Jet and Imojet-M7). A total of 2,390,185 individuals (80% of the estimated population of Greater Khartoum) were vaccinated during the period March to July 1988 [9], proving that mass vaccination can effectively be used within the African meningitis belt to curb epidemics.

Only 389 (2%) of 1,388 children with information about vaccination status, who were admitted to Gaafar Ibnauf Children's Hospital, had received the MC vaccine. Of these, 153 (11.0%) had the vaccine between 4 weeks and 1 year before falling ill, and 123 (8.9%) were, at the time of vaccination, older than 18 months of age. However, satisfactory response to bivalent A/C meningococcal polysaccharide vaccine is only seen in children older than 17 months [24] and was reported to drop significantly in children <4 years following the first year of vaccination [25]. This highlighted the need of developing a more immunogenic vaccine to cover the young children (<2 years) who are mostly involved in MC epidemics [19]. In 2001, the 'Meningitis Vaccine Project' was set as a partnership between WHO and PATH (an international, non-profit global health organisation), with core funding from the Bill & Melinda Gates Foundation. This resulted in the development and implementation of the more immunogenic MenAfriVac vaccine which has nearly eliminated serogroup A meningococcal disease from the countries within the meningitis belt [26]. It has also been integrated into routine national immunisation programs.

The role of population movement was evident in the epidemiology of COVID-19. In China, the spread of COVID-19 outbreak followed the beginning of the Spring Festival migration, the largest annual episode of migration in China [27]. Measures to limit population movement were, thereafter, applied internationally to curb the pandemic [28]. Such role of population movement was also clear in the study of the 1988 MC epidemic. During the first 2 weeks of the epidemic, 78% of the children admitted to Gaafar Ibnauf Children's Hospital (n = 1,441) came from one of the shanty dwellings around Khartoum city, whereas admissions from Khartoum City constituted only 13% during this period. The reverse of these proportions started to show during the third and fourth weeks of the epidemic [9]. These shanty dwellings were the result of recent influx of people from within and refugees from outside Sudan.

The impact of weather on COVID-19 epidemiology also received wide attention [29,30]. Similarly, the epidemiology of MC epidemics has been known to be closely related to climatic

factors [12]. The study of the 1988 MC epidemic affirmed these previous observations. Data from Sudan Metreological Department, Khartoum was obtained during the epidemic regarding the mean temperature, humidity and rain fall. Peak levels of admission to Gaafar Ibnauf Children's Hospital occurred when the mean maximum temperature ranged between 38.0°C and 40.7°C and mean relative humidity dropped from 21% to 15%. A falling mean maximum temperature and a rising relative humidity, associated with only scanty rains (<1 mm) at the start of the rainy season in May and June 1988, marked the beginning of a decline in the number of admitted cases [9].

MOLECULAR EPIDEMIOLOGY

The molecular epidemiology of COVID-19 and the characterisation of the causative virus SARS-CoV-2 proved to be vital to inform public health strategies and guide therapeutic and vaccine development [31]. The study of the Sudan 1988 MC epidemic constituted one of the pioneering works in molecular epidemiology and also proved to be vital in controlling epidemic meningitis worldwide. These molecular studies were mainly done in Orebro, Sweden within a sabbatical leave of 6 months granted by the U of K to Prof. Mustafa A. Salih starting in the autumn of 1989. Isolates of *Neisseria meningitidis* which has been transported to Sweden before and within the epidemic period were subjected to clone analysis using DNA restriction enzyme patterns. Strains were also transported in dry ice for clonal assignment, using an enzyme electrophoresis (ET) method, to Dr. Dominique A. Caugant at the National Institute of Public Health, Oslo, Norway. Isolates of MC strains were also sent to Prof. Mark Achtman, a world authority in bacterial population genetics, at The Max Planck Institute for Molecular Genetics, Berlin, Germany. The laboratory work at the Department of Clinical Microbiology and Immunology, Orebro Medical Center Hospital was supervised by Prof. Per Olcen and Prof. Dan Danielsson. It was funded by Orebro County council and the philanthropist Mr. Birger Gustavsson (The Maud and Birger Gustavsson Fund). The work attracted the press in Orebro, being an international scientific work (Figure 5). Prof. Mustafa A. Salih also travelled

Figure 5. The laboratory work pertaining to the 1988 meningococcal meningitis epidemic in Sudan—at the Department of Clinical Microbiology and Immunology, Örebro Medical Center Hospital, attracted the press. An article in ALLEHANDA newspaper reflected on the epidemic (left photo) and showed Prof. Per Olcen at work in the laboratory (right photo).

in the winter of 1989 to Norway to learn the technique of ET method from Dr. Dominique A. Caugant at the National Institute of Public Health, Oslo.

These molecular studies revealed that all Sudanese 1988 MC epidemic isolates corresponded to the sulphonamide resistant clone III-1 [11]. The Sudanese pre-epidemic isolates (1985) were clone IV-1 (sulfonamide susceptible) which has been resident in the meningitis belt for 25 years and caused a widespread epidemic in West Africa (1981 to 1984). Clone III-1 caused a pandemic meningitis wave which started in China in 1982, and was brought to Mecca by South Asian pilgrims attending the Hajj pilgrimage in August 1987. It was introduced into Sudan and Chad through the returning Hajjis resulting in large

epidemics in the dry season (February to July) of 1988, extending thereafter to Ethiopia and Kenya in 1988 to 1989. This documentation of a change of the MC clone offered one—but not the only—explanation for the cyclic pattern of MC epidemics in the meningitis belt. It also highlighted and recommended intervention with MC carriage—during MC outbreaks—in pilgrims before leaving Saudi Arabia to their home countries. Bivalent (serogroups A and C) meningococcal vaccination became mandatory in Saudi Arabia for all pilgrims from 1987, and helped for more than a decade to bring the disease under control [32,33]. The implementation of the quadrivalent vaccine (serogroups A, C, W and Y) since 2002 to all local and international pilgrims, coupled with chemoprophylaxis at the port of entry for pilgrims from the African meningitis belt, succeeded in

stopping Hajj-related meningococcal outbreaks [32,33].

DATA ANALYSIS, THESIS EXAMINATION AND GRADUATION CEREMONY

The last months of the sabbatical leave in Orebro were spent by Prof. Mustafa A. Salih in the final data analysis, writing of manuscripts and submission to medical periodicals and writing the thesis. The data entry, computation and main analysis were done in collaboration with Dr. Izzeldin A. Kamil at the School of Mathematical Sciences, U of K. Since the material was extensive and the computer system at that time was Disk Operating System, Dr. Izzeldin A. Kamil worked with a whole class of students at the School of Mathematical Sciences to enter the data.

The thesis examination for the Doctor of Medical Sciences (Dr. Med Sci, Uppsala University, Sweden) took place on 16 May 1990, and the External Examiner (Opponent) was Professor Bjarne Bjorvatn from Norway. An interesting historic note is that during the presentation and discussion of the thesis, Prof. Mustafa A. Salih was in the traditional Arabic Dress, the *Kaftan* (a variant of the robe) which was adopted by the International Child Health Unit at Uppsala University to be dressed by Sudanese students during doctoral thesis defense (Figure 6). In Sudan, the *Kaftan* is viewed as academic dress (a traditional form of clothing for academic settings), and is vividly shown in a photo taken during the inauguration of the Gordon Memorial College (The University of Khartoum) in 1902 [34]. It is thought that the *Kaftan* is the origin of the current academic dress in many ancient universities (including The University of Oxford and The University of Cambridge). As a sign of acquiring high universities education, Europeans who got University Education in Andalusia region of Spain (including Córdoba, a world leading centre of education and learning during the 9th to 11th century), went home wearing the *kaftan*. The trend then followed in Oxford, and other universities in Europe.

The Doctoral Conferment Ceremony (graduation ceremony) of Uppsala University—which was first held in the year 1600—has a different dress, with a Doctoral Hat offered as a symbol of honour. This is followed in the evening by the Conferment Banquet in the Hall of State at Uppsala Castle which played a major role in the early history of Sweden (Figure 7). Of historic interest is that the former Secretary-General of the United Nations, Dag Hammarskjöld, spent his childhood in the castle when his father, Hjalmar Hammarskjöld, Prime Minister of Sweden from 1914 to 1917, was governor of Uppsala County. Prof. Mustafa A. Salih used a quotation from Dag Hammarskjöld at the begging of the thesis: *‘Between the nation in history and the individual, the family is the primary tie’*.

THE THESIS AND OTHER PUBLICATIONS

The resulting doctoral thesis was published by Uppsala University as a supplement in the Scandinavian Journal of Infectious Diseases [19]. The bacterial strains collected from Sudan and the patient material formed the basis of two other doctoral theses by Swedes namely, Hans Fredlund at Uppsala University [35] and Anders Backman at Linköping University [36]. A novel polymerase chain reaction (PCR) strategy for the simultaneous detection in CSF of *N. meningitides*, *H. influenza*, *S. pneumonia*, *S. agalactiae*, and bacteria in general was pioneered by Anders Backman in his thesis [37]. It became part of the practice guidelines for the management of bacterial meningitis [38].

CONCLUDING LESSONS

The visit of Prof. Mustafa A. Salih to Dr. Dominique A. Caugant at the National Institute of Public Health, Oslo, Norway gave him also the chance to visit the Kon-Tiki Museum [39]. The Kon-Tiki Museum in Oslo exhibits objects from Thor Heyerdahl’s world famous expeditions, the Kon-Tiki raft, and the papyrus boat Ra II. Thor Heyerdahl, one of history’s most famous explorers, crossed the Pacific

Research

Research at ICH concentrates on the determinants of nutrition and health, and on the development of infants and young children in different socio-economic and cultural environments. Three main areas of research can be identified:

1. Breastfeeding and young child nutrition

ICH has taken special interest in the mother/child dyad, in breastfeeding and in weaning under optimal and sub-optimal conditions. Another area of interest is the effect of breastfeeding on maternal fertility in a historical perspective, in Sweden today and in the Sudan.

2. Child health, nutrition and development

ICH has conducted several studies of the positive and negative effects on growth and development in children adopted from Third world countries, especially regarding catch-up growth, pubertal development and final height.

An example of this is studies of undernourished infants and young children from India who have been followed to adolescence.

3. Cassava and health

Due to high yields, cassava roots are a major staple crop in tropical countries but low protein content may contribute to malnutrition and its toxic contents may induce specific disorders. In collaboration with institutions in developing countries ICH has studied such effects of cassava in order to advise on preventive measures which could ensure a safe consumption of the root.

For list of publications see appendix.

Doctoral dissertations

During 1989/90 the following dissertation was presented:

- *Cerebrospinal meningitis in Sudanese children*. Mustafa Abdalla Salih. In collaboration with the Department of Clinical Microbiology, Örebro. (May 1990).

Dr Mustafa Abdalla Salih, Professor Agne Larsson, Head of the Department of Pediatrics and Professor Bjarne Bjorvatn, opponent, after the oral defence of the doctor's thesis, May 16, 1990. Photo: Y Hofvander.

Figure 6. Copied page of the Annual Report (1989/1990) of the International Child Health Unit, Uppsala University. The photo shows Prof. Mustafa A. Salih during the thesis examination dressed in the traditional Arabic Dress, the Kaftan (a variant of the robe) which was adopted by the International Child Health Unit at Uppsala University to be dressed by Sudanese students during doctoral thesis defense. It is thought that the Kaftan is the origin of the current academic dress in many ancient universities (including The University of Oxford and The University of Cambridge).

Ocean in 1947 on the balsawood raft Kon-Tiki from Peru to Polynesia. He also sailed the Ra II from North Africa to the Caribbean following failure of a previous attempt with the reed boat Ra I. One of the displayed posters in the museum (Figure 8) dictates that the voyages in Ra I and Ra II were intended 'to give insight into the present and the future' by proving that

'people with different coloured skins, religious and political beliefs' can 'work towards a common objective'. 'Because of this, the crew was of a highly varied international nature'. The spirit of Thor Heyerdahl was vividly depicted in the control of the 1988 MC epidemic, and is also reflected in the global efforts to control COVID-19.

Figure 7. The Doctoral Conferment Ceremony (graduation ceremony) of Uppsala University is followed in the evening by the Conferment Banquet. Prof. Mustafa A. Salih (left) outside Uppsala Castle where the Conferment Banquet (right) took place in the Hall of State.

Figure 8. The spirit of Thor Heyerdahl, one of history's most famous explorers, was vividly depicted in the control of the 1988 MC epidemic, and is also reflected in the global efforts to control COVID-19. A poster in the Kon-Tiki Museum in Oslo, which exhibits objects from Thor Heyerdahl's world famous expeditions, the Kon-Tiki raft, and the papyrus boat Ra II, clearly displays this. It dictates that the voyages in Ra I and Ra II were intended 'to give insight into the present and the future' by proving that 'people with different coloured skins, religious and political beliefs' can 'work towards a common objective'. 'Because of this, the crew was of a highly varied international nature'. (Photo taken by Prof. Mustafa A. Salih, 1989).

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