Scarlet Fever: An Exploration Based on Characteristics, History and The Intervention

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Abstract. Scarlet Fever, a fever that has strong infectious ability, has caused many outbreaks in decades, grabbing people's attention and awareness in the past ten years. A high density of the population is disturbed by this disease until today's world. Outbreaks and cases mainly present in cohorts under 13, increasing the burden of infectious diseases on children and adolescents. Potential outbreak places for scarlet fever are intensive working or living places such as school, hospital or neighborhood. Historically, a high proportion of scarlet fever outbreaks take place in school. Understanding the epidemic history of scarlet fever still has important reference value and enlightenment significance for preventing and controlling modern scarlet fever outbreak. This article is aimed to spread awareness and educate the public about scarlet fever based on existing research and publication of the characteristics of scarlet fever, diagnosis, treatment, statistics of past outbreaks and existing interventions to let the public have an objective view of the disease.

Keywords: Scarlet Fever, Epidemiological Characteristics, Intervention.

1. Introduction

Scarlet fever, obtained by bacteria named group A Streptococcus, had been an infection that had high mortality and morbidity in the population, most common in children under age of 10 during the 18th and 19th century [1]. It was a disease being highly concerned of risking children's health and also one of the most contagious diseases that cause lots of epidemics [2]. But through the development of technology, the promotion of society awareness and medical education, more and more measures and defenses are being published and implemented. The crisis posed by this disease is far less severe than in the previous two centuries. With the death rate decreasing from approximately 48% in the 18th down to 3% in modern day [3,4]. Even though this disease does not cause lots of fluctuation in modern society compared to the 18s and 19s, several countries still experienced the re-emergence and risk brought by scarlet fever. 620 cases were reported in England in 2016, between 2013-2017 Scarlet fever admission rate increased by 97% between these four years [4]. This paper summarizes the incidence trend, clinical characteristics and prevention measures of scarlet fever, providing theoretical support for further research and implementation of regulation and avoidance measures.

2. History of scarlet fever

Streptococcus was first isolated by Viennese surgeon Theoder Billroth in 1874, but that s treptococcus could cause scarlet fever was not confirmed until 1884, and the specific symptoms and causes of the infection were subsequently outlined by Georgae and Gladys Dick only in 1924 [5].It usually appeared on the skin or in the throat, which usually have no threat to asymptomatics carrie. A recently published Chinese study demonstrated that GAS is generally highly durable to macrolides and tetracyclines, but GAS has a more sensitive response to penicillin, chloramphenicol, cefradine, and ofloxacin [6].

Scarlet fever is also one of the most contagious diseases, and common disease that can be spread by receiving bacteria from the air, such as droplets from coughing and sneezing or directly through physical contact with a patient that presents streptococcal skin. [1].Unpasteurized milk passed by infected line workers has been a major cause of outbreaks of this virus throughout history [5]. Some of these virulent streptococcus pyogenes may carry genes encoding streptococcal superantigens that

could be a potential factor of non-invasive case, for example scarlet fever. [6]. Streptococcus pyogenes is the prototypical bacterium that causes exotoxin-mediated infections and is one of the most virulent diseases that can be transmitted to humans. The large number of exotoxins, cell wall-associated proteins and superantigens produced after infection cause widely varying clinical manifestations. Sepsis infections, TSS and post-infection sequelae of immune system functioning are some of the common effects. Meningitis and endocarditis, two example of methodical infections, although they are rarer than the first three, streptococcus pyogenes continues to pose a significant global disease burden [7].

3. The Outbreaks and consequences of scarlet fever

The spread of scarlet fever remained rampant into the 20th century, frequently causing widespread epidemics or localized outbreaks worldwide, often accompanied by extremely high mortality rates, which not only has an impact on the infected person, but also has an impact on families and communities due to its high level of contagion [8].

At the beginning of the 20 centuries, major outbreaks were reported in several countries. For example, Vietnam identified more than 23,000 cases in 2009 and mainland China had an outbreak of more than 100,000 cases [9]. Between 2004-2016, 502723 cases were reported by more than ten facilities in China. There were 10 deaths and 28,807 /100,000 was the average annual incidence rate. The average annual incidence rate increased over time instead of receding, rising from 1457/100,000 in 2004 to 47,638/100,000 in 2011. And the average annual incidence, probably related to temperature, peaked in 2015 at 50,092/100,000 people. Massive outbreaks of scarlet fever in China is starting from 2011 is evident because the fact that scarlet fever annual incidence from 2011 to 2016 was double the prevalence per year from 2004 to 2010. The northern, northeastern, and northwestern parts of the country are the locations where most of the cases are concentrated [10].

Taking England and Wales in the last century as an example, scarlet fever epidemics occurred in 5-6 years cycles, and outbreaks appear to be associated with years and months of low rainfall, according to disease data provided by the Department of Health. In temperate countries, on the other hand, outbreaks are usually in the fall and winter months. Schools are an important site and cause of scarlet fever outbreaks, with incidence rates exceeding 20-30% in previous years, and as what are mentioned before, this species of virus is relatively prone to outbreaks in more closed environments. In the pre-antibiotic era, the highest outbreak duration recorded had lasted for about 10 months [4,11-13].

Based on a chart indicating the notifications of scarlet fever during 2013-2014 in England. As the outbreak was associated with the rainfall, England during March was moist which caused a huge increase in the cases threatening the public. In 2014, Scarlet fever surged through the entire England in spring, causing the country to experience the largest scarlet fever outbreak in 45 years. [4,11]

In the following year, in the United Kingdom, during September 2014 and April 2015 12,906 cases were reported by Public Health England. This outbreak was acknowledged as the most wided outbreak in the UK after 1969[6,11]. Health protection organizaion in the UK, Wales and Northern Ireland are obliged to submit together a confirmed diagnosis and statutory report of scarlet fever. The diagnosis depends on is there a presence of clinical signs identical with scarlet fever, as well as scientific confirmation (laboratory confirmation) of the occurrence of group A streptococcal (GAS) infection. From week 37 of 2013 to week 11 of 2014, 3,752 cases were identified in Britain; the totals for the years 2008 to 2019, and also 2012 to 2013, were 1,565 and 2,868 cases. In just one week of the 11 weeks in 2014, 635 confirmed notifications were sent to England, Wales and Northern Ireland in the UK [4,9].

According to official UK illness reports, "Cheshire and Merseyside (13.0), the East Midlands (11.9), Avon Gloucestershire and Wiltshire (10.6), the Thames Valley (9.5), the North East (9.7) and Northern Ireland (9.2)" per 100,000 population, these areas above had the highest. (The age and sex

distribution of those reporting illness during this year was similar to previous outbreaks, 87% of cases present in patient between 1 to 10 years old age and 5% in adults, 36% of whom were male) [4,9,11].

4. The Clinical symptoms of scarlet fever

4.1. The common clinical manifestations

Scarlet fever is probably the most known streptococcus pyogenes, this particular sort of disease is recognized as the streptococcal species that most often causes epidemics, and the diversity of clinical syndromes is the distinguishing feature of outbreaks, making this disease more difficult to diagnose. It tends to occur in closed and interacted locations such as homes, schools, day care centers and prisons [12,13]. Scarlet fever could be hard to diagnose in the start of the infection, as the symptoms are not specific and hard to distinguish, which could include sore throat, fever and vomiting. When the infection is present, the symptoms can vary greatly. From asymptomatic, to severe systemic infections may occur in the same family. Take, for example, President Abraham Lincoln and his son Ted, one developed a severe infection and the other a migraine during a presidential election [13-15].

After 12-48 hours of infection, a typical symptom is the appearance of exudative pharyngitis and a pinpoint rash that usually spreads from the chest and stomach to the entire body, giving the patient's skin a sandpaper-like texture. Patients usually have shortness of breath and red cheeks, with pallor around the mouth; may present with tongue peels initially with white coating but turn into dark red [8,9]. Desquamation at top part of tips and toes, small area on trunks and body may occur after the persistent rash for weeks [15]. Scarlet fever would be infectious if not treated after symptoms appear for 2 and 3 weeks, but asymptomatic carriers are at a very low degree of infection [8,16].

The population at high risk for the development of septic bacteria is drug users, with symptoms ranging from dermatitis to pneumonia and more common invasive diseases. The frequency of outbreaks of septic bacteria is significant in military facilities and usually manifests as vulvovaginitis, dermatitis, acute rheumatic fever, streptococcal pharyngitis, and pneumonia. In facilities requiring long-term care, the vast majority of residents may also carry and have other diseases. It is important to note that while such outbreaks have a potential duration, when they do occur they can be particularly devastating, accompanied by a high mortality rate and may last for several months [12,17].

In the 3-8 years old cohort, where scarlet fever is mainly transmitted, the presenting symptoms of the infection are similar to those caused by other prevalent infectious viruses, such as Epstein-Barr virus and adenovirus [16,18].

4.2. The representative presentation

A representative presentation of scarlet fever is showing below:

“An 8-year-old girl is brought to you by their parents at to your practice. She has a sore throat, abdominal pain and has been vomiting. Her general health has been fine until two days ago. Initially, she noticed pain on swallowing and had a temperature of 38 °C. Her parents decided to take her to the GP once they noticed the ‘sandpaper-like’ rash on her trunk and the inside of her elbows. When you ask to examine her tongue, the enlarged papillae become immediately obvious giving it a ‘strawberry’ like appearance. Petechiae are also visible on her soft palate. Her anterior-cervical nodes are swollen and tender.” [1].

In this example, the patient shows the typical symptoms of the disease, a sandpaper-like rash, a red strawberry-like tongue, and a sore throat, which are identical to the symptoms described earlier in the article. Although scarlet fever can be transmitted at any age in the population, it mainly breaks out in the 3-8 age cohort in the populationso screening for this age group is very rigorous and careful. And based on reports of prevalence and illness in previous years, as well as outbreak over the years, scarlet fever is usually more prevalent in males than females [1,12].

5. The diagnosis of scarlet fever

Disparity between fever and rash is difficult to determine, and the clinical response to many conditions is fever and rash, making it more difficult to locate the detailed pathogenesis. The diagnosis of scarlet fever should be considered if there is a sandpaper rash, painful areas appearing along the throat and a rise in body temperature [15,17]. Scarlet fever can also cause common complications like rheumatic fever, pneumonia, and meningitis [19].The development of parapharyngeal and retropharyngeal abscesses is a typical local complication that can develop into airway involvement [18]. The consequences of inappropriate and untimely treatment are irreversible and unaffordable, and can cause airway damage, for example.

The investigate and confirm of scarlet fever is primarily based on clinical symptoms. One known diagnostic systems is the McIsaac score, which is very similar to the centor diagnostic system. The difference is that McIsaac also measures the age of the patient as a criterion. A study that analyzed data from more than 200,000 visits to children aged 3 years or older who were seen at retail health care chains in the United States concluded that the likelihood of being positive for septic bacteria in the pharynx was 8% among those with a McIsaac score of 0, and a staggering 55% among those with a score of 4 or 5 [14]. The goal of this scoring system is to reduce the probability of using laryngeal cultures or rapid antigen testing in patients with low infection rates [14,17,19].The US Disease Control Center recommend that if people above and at 18 have a score below one, they should not be tested in the absence of specific factors [14,20].

Centor score (modified version of the McIsaac score) is also a commonly used method in clinical diagnosing [13]. The four clinical signs and symptoms are the assessment maneuvers taken to estimate the likelihood of the onset of GAS pharyngitis. The ≥3 signs or symptoms represent the likelihood that the patient is infected by streptococci with a reasonable presumption of infection specificity (0.82), whereas when the patient presents with ≥4 signs or symptoms, the physician can determine that the patient has a very high degree of infection specificity (0.95). The reason for using this score is that the performance of this score is stable and consistent across countries, medical settings, and levels of medicine. [12-14,17]

Traditional testing involves physicians swabbing the top of both tonsils, avoiding the lips and tongue to take a sample, and then performing a positive culture to detect septic bacteria. In recent decades, faster and more convenient tests have become widely available for medical use. These tests are 95% or more accurate and specific, thus allowing for timely diagnosis and avoiding the need to culture bacteria [17]. However, in children and adolescents, it is still necessary to take a negative throat culture to confirm the results, as cultures are more sensitive than rapid tests. In adults, routine negative antigen testing is not usually recommended because of the low incidence of rheumatic disease in the absence of disease [17,20].

In case of respiratory distress, video laryngoscopy performed with awareness is the first step in intubation. It is a technique that can be performed without much skill or training and with a high degree of safety. In addition, video laryngoscopy is very accommodating and allows the use of tracheal tubes of different diameters [18].

Hospitals should train healthcare professionals working in the emergency department to improve their proficiency in the use of video laryngoscopy [14]. The use of video laryngoscopy covers assessment of the trachea, education on airway care and forensic intubation documentation and is used as an important tool in these three areas. Specialized education and practice of urgency department physicians in respiratory system management and emergency care, and the monitor of more experienced physicians who have extensive intubation knowledge, like anesthesiologists, can have a huge influence on the determination, also treatment of these patients and can greatly increase the probability of successful intubation [17,19].

6. The treatment and prevention of scarlet fever

In clinical practice, if patients suffer from scarlet fever, they must be treated with antibiotics as early as possible. The excellent clinical efficacy of β-lactam antibiotics, their effectiveness and percentage of safety and cure after use in children, and their low price put them on the first considere of treating abbreviation for group A streptococci .infections. Penicillin, on the other hand, is seen as the preferred treatment for group A hemolytic streptococci because of its superior clinical efficacy over cephalosporins and macrolides. Macrolides can produce greater effects and adverse reactions in humans than penicillin [17,19].

The trend toward over-prescription has led to increased reports of resistance to macrolides. This has led to increased pressure to diagnose the causative agent because of the drug's qualities of a long half-life as well as broad antimicrobial action. It is worth mentioning that educating patients and spreading awareness is an exercisable measure. For example, informing patients why they need to complete the prescribed regimen and educating them on how to address concerns, such as contacting their clinician, reduces the likelihood of patients taking too many antibiotics leading to antibiotic resistance [19,20].

Finally, phenoxymethylpenicillin should also be prescribed to patients by their physicians. The duration of administration is four times a day for ten days [14].

Humans are the only ones found in nature that can be parasitized by S. pyogenes and treated as hosts. When infected, asymptomatic phenomena occur and are mainly host in the upper part of the throat tract. Therefore, the solution and goal of preventing all types of septic bacterial diseases is usually considered to prevent the carriage of S. pyogenes. For example, many vaccine studies against septicemia have been developed with the surface-anchored M protein as a target. There are multiple barriers in vaccine development that hinder the development of vaccines for commercial use. For example, antigenic variation, the different types and numbers of serotypes distributed through out the world, with issues about vaccine safety due to immune system sequelae triggered by M protein antigens. Therefore, the development and application of such surface molecule-based vaccines as well as stay in an immature stage [21].

7. Conclusions

Infectious bacteria group A Streptococcus (GAS) was the culprit of scarlet fever. This disease was discovered by Viennese surgeon Theoder Billroth in 1874. During the 18 and 19 century, scarlet fever brought terror and huge death to the human society. Now, scarlet fever in the modern world does not bring that much mortality and morbidity, with the death rate decreasing from almost 50% in the 18th down to 3% today. However, there must still be attention being brought to the crisis of potential scarlet fever outbreak, especially in the moist rainy season. Many countries are still suffering from the disturbance of scarlet fever, such as the UK and certain countries in Africa are facing major outbreaks in the past five to ten years. The general public should be educated about scarlet fever. In the face of a scarlet fever outbreak, government, medical, public welfare, and community organizations should be educated about the dangers of scarlet fever and protective measures. Relevant departments should provide timely testing stations, or real-time attention to hospital patients, such as the discovery of relevant symptoms should be raised alert. A scarlet fever vaccine is still on the way, and most scientists agree that the development of a vaccine is still at a more nascent stage. On behalf of the public, it is all the more important to be prepared for prevention in case another outbreak occurs.

In the future, clinical medical personnel should continue to pay attention to the dynamic changes of the scarlet fever epidemic, do a good job in case and etiology monitoring, improve the diagnostic criteria of scarlet fever, and develop technical standard for the preventing and controlling scarlet fever; Conduct a comprehensive and in-depth study to provide a feasible basis and approach for scarlet fever prevention and control.

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