COMMENTARY

Viral Infections and Orthopaedics – Counting the Cost

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Members of the ASEAN Orthopaedic Association are no strangers to infection involving the musculoskeletal system. Acute and chronic bacterial and fungal infections form a majority impact on our everyday practice, ranging from post-trauma complications to diabetic feet to endemic communicable diseases such as tuberculosis. We however seldom see any significant effect of viral diseases in our clinical experience. In recent months, Singapore faced a critical situation where a viral infection had a dramatic impact on the workload of our orthopaedic surgeons. In the usual state of affairs, one's workload would be expected to increase when an infection struck; the prescription of antibiotics would have jumped; repeat drainage and washout surgeries would overload operating lists; and morbidity and mortality would have peaked. In truth, between the 7th of March 2003 and the beginning of July, the exact opposite happened. What was this virus that overwhelmed us?

Singapore was gripped in the saga of SARS, a new and mutated virus of the Coronavirus (CoV) family. Severe Acute Respiratory Syndrome did not infect a single orthopaedic patient in Singapore, and yet caused never-before-seen effects on our orthopaedic practice. Not only did orthopaedic surgery lists dwindle but surgeons were placed on two-weekly rotations with two weeks at home, orthopaedic training stopped, weekly interactions between hospitals were banned, large fully-subscribed AO courses were postponed, and the date of the Annual Scientific Meeting of the Singapore Orthopaedic Association moved to November for the first time in its history.

Singapore was the worst hit of our ASEAN neighbours with 206 confirmed cases and 32 deaths that included a junior medical officer and a senior vascular surgeon. Vietnam had 63 cases and 5 deaths including the WHO specialist who first recognised SARS. In contrast there were a smattering of suspected cases in the other ASEAN countries. How did Singapore with arguably the most comprehensive, developed and expensive healthcare system in the region have such runaway numbers? The same question was asked of Canada with its 251 cases and 37 deaths. The epidemiology of the disease is still being defined as are reliable tests and vaccines being developed to counter his first new virus of the millennium. As of July 5th, the last affected country, Taiwan, has been taken off the list by WHO and the world declared free of SARS – at least for now. The time has come to learn a lesson, and to anticipate the possible effects should SARS re-emerge in our region in the winter.

In an attempt to present an overview of how Singapore coped with the disease, and how orthopaedic practice changed, one must first understand the nature of SARS as we *did not know it*. This is a critical point to grasp because the epidemic that shut down a first-world island state and caused untold damage to economy and pride not seen in our 38 years of independence happened because of what we did *not* know of the virus. In hindsight it is now easy to see how this could have been avoided, since only 3 index cases caused the epidemic.

By way of epidemics, it was nowhere near those that caused polio in 1950 and the pandemic of influenza in 1918. Indeed we still have senior AOA members who actually were involved in these former epidemic when they happened. Yet in way of macroeconomics, there was no equal to SARS in affected countries of Asia. The impact is still being felt long after the virus was last isolated in a patient or animal. Some national GDP figures were predicted to drop by 1-3 percentage points and mooted to be equal to the Asian financial crises of the late 90s. Singapore's Health Ministry calculated the direct costs of SARS to be S$300 million, with S$192 million spent on healthcare operations such as consumables, and another S$105 million on infrastructure development such as isolation rooms and ventilation systems. That works out to almost S$150,000 per SARS case. The story must be told so that the vigilance in our fellow member states is heightened about this virus. Many of our neighbours cannot afford this quantum of financial "whammy" on their emerging economies. This story comes from Singapore's Ministry of Health (MOH) and the pages of the World Health Organisation.

The saga begins

On 6 March 2003, Singapore's MOH was notified about three persons who had travelled to Hong Kong Special Administrative Region of China (Hong Kong SAR) during late February and were admitted during a 5-day period to local hospitals there for pneumonia. These patients included Case 1 and a travelling companion. They had been guests staying on the 9th floor of Hotel Metropole in Kowloon, Hong Kong SAR, on 20 and 21 February coinciding with the stay of a 64-year old renal physician in Room 911 from Guangzhou city, PRC. He had treated patients with atypical pneumonia in his hospital since November 2002. He was in HK to attend a family wedding and eventually transmitted the disease to at least 16 guests, including hotel guests from Toronto and Singapore, as well as an American businessman who brought the disease to Hanoi, Vietnam. Surprisingly, no hotel staffs were infected. Two Hongkongers brought the disease to two local hospitals that resulted in

the chain of transmissions in the country.

On 14 March, MOH was notified about six persons, including two health-care workers (HCWs), who were admitted to Tan Tock Seng Hospital (TTSH) for atypical pneumonia; all had close contact with Case 1. Case 1 was a "super-spreader" who directly infected 21 persons including 9 HCWs, of which 1 was a young doctor who died. Another was the second "super-spreader", a nurse who transmitted to 23 persons, including 11 HCWs. TTSH had a third "super-spreader" who infected 23 persons of which 18 were HCWs. Eventually, a staggering total of 172 probable cases are linked through chains of transmission to Case 1.

Since late March, the outbreak was characterized by nosocomial transmission within Singapore General (SGH), National University Hospital (NUH) and Changi General (CGH) caused by persons who were not immediately recognized as having SARS. In SGH, a patient – the fourth "super-spreader"- who had unrecognised contact with a SARS case in TTSH was admitted with complications of diabetic nephropathy. As a result, 62 unprotected healthcare workers and patients were affected. At CGH, a four-person cluster resulted from an elderly patient treated in TTSH and transferred to an old-folks' home and who infected 2 HCWs, of whom 1 was admitted to CGH.

The first major extension of this illness outside the health-care setting was from a SARS patient in the largest vegetable wholesale market in Singapore. He was a relative of the "super-spreader" in SGH and subsequently affected only 15 persons, but they included patients, visitors and HCWs in NUH, two taxi drivers and two colleagues at the wholesale market, resulting in a 20-day closure and a vegetable shortage for a few days in Singapore. He was the fifth and final "super-spreader" in Singapore.

Disease statistics

The median age of probable cases was 36 years (range: 4–90 years); 132 (66%) are female. Twenty-two (11%) patients have required mechanical ventilation, and 32 have died (case-fatality proportion: 15.5%). Of the deceased, the median age was 53 years (range: 24–90 years) and 56% were male. A total of 26 persons with probable SARS have had virus, viral nucleic acid, or antibody to SARS CoV detected in body fluids. Of the 84 HCWs with probable SARS, 49 were nurses, 13, physicians; and 22, persons with other occupations (attendants, radiographers, housekeepers, a porter, and a cleaning supervisor); no SARS cases have been reported among laboratory workers or pathologists. For 21 probable cases with well-defined point exposures, the median incubation period was 5 days (range: 1–10 days; 95th percentile = 9 days). On the basis of surveillance reports, 153 (76%) infections were acquired in a health-care facility; the remainder either have household, multiple, or unknown exposures.

Control measures

On 22 March, TTSH/ Communicable Disease Center was designated as the hospital for intake and solitary isolation of all suspected and probable SARS cases. All HCWs attending to patients with suspected or probable SARS cases are required to wear gloves, gowns, goggles, and N95 or equivalent respirators; positive air purifying respirators (PAPR) are required for high-risk or aerosol-generating procedures. All elective surgery and non-urgent outpatient appointments were cancelled. Orthopaedic patients who were well were discharged, and only emergency admissions (mainly trauma and sepsis cases) were admitted.

By 9 April, elective surgery and non-urgent outpatient appointments were also cancelled. All staff at SGH were required to adhere to temperature checks for fever twice daily; this initiative eventually being extended to all HCWs in Singapore. Other measures include stopping hospital visitations, except for paediatric, obstetric, and selected other patients. For these patients, visitors are limited to a single person who must wear a mask and pass a temperature check; all other visits are by videoconference. Orthopaedic Departments in SGH, TTSH and NUH were split into two teams, each working continuously for two weeks, and then rotated to stay at home for the next two weeks. This was to avoid having the whole department being quarantined for 10 days should they come into contact with a SARS patient, as happened to the General Surgery department of SGH. This rostering reverted to normal only in early July.

Quarantine

On 24 March, MOH invoked the Infectious Diseases Act to quarantine all contacts who have been exposed to SARS patients. This legislation allows mandatory home quarantine for 10 days, which is now enforced by a security agency. This agency serves the quarantine order and installs an electronic picture (ePIC) camera at the home of each contact. They will call and visually check at random times the presence of the said person in front of the camera. All inpatients who are discharged from a hospital with previous SARS cases are under telephone surveillance for 21 days; all probable SARS inpatients and selected suspect SARS inpatients who have recovered and are discharged are on home quarantine for 14 days. Patients requiring readmission are admitted only to the same hospital of original admission. A dedicated private ambulance service was sanctioned to transport all suspect or probable cases to the SARS designated hospital, including all febrile persons on home quarantine or from the airport or seaports. After the identification of a cluster of illness among employees at the large wholesale market, the market was closed for 20 days and almost 2000 vendors placed in home quarantine. More than 3000 persons were quarantined at home at the peak of the disease.

Effect on Singapore's orthopaedic surgeons

The weekly SOA Saturday Clinical Conferences were suspended after 29th March and only restarted in July. The Combined AO/ASIF Courses (Spine, MIPO and Vet) scheduled for 2nd April was promptly postponed. On 29th April, hospital-based doctors were prohibited from crossing from one institution to another, something that affected mainly the private orthopaedic surgeons. This restriction was only lifted on 16th of June. The Annual Scientific Meeting of the SOA scheduled for August was postponed to November. Even the organising committee meetings were suspended as members came from different

hospitals. In clinical practice, patient consultations required both doctors and patients to wear masks, with HCWs needing the expensive N95 or N99 anti-particulate types. Disposable gowns and gloves were also mandated, but in most government hospitals, operating theatre scrubs became the daily working attire. This was significant operating cost increase given the drastic reduction of patient attendance. With the suspension of elective cases, those who dealt mainly with paediatrics, spine, adult reconstruction, sports, and other elective work took on only trauma and infective cases for more than 3 months. Concomitantly, orthopaedic companies dealing heavily in these conditions felt a massive impact from near-zero surgeries in the government hospitals. Private hospitals had no similar restrictions, but patient numbers dwindled due to lack of foreign patients from Asia and the 30% load-carrying factor of Singapore Airlines, as well as the fear of Singaporeans stepping into any hospital. Doctors' lounges and eating-places were closed, and for most orthopaedic surgeons, playing golf became a regular affair given the healthy outdoor environment. However, awareness also meant not playing with friends still working in affected hospitals. E-mail communications jumped.

It can never be estimated as to how much SARS has cost the orthopaedic community in Singapore. Those in the institutions have the buffer of a fixed salary, but the variable patient-based bonuses inherent to the MOH renumeration system were drastically cut. Such variable bonuses may amount to more than 50% of the monthly pay of a successful surgeon. In July, the two healthcare clusters covering all public hospitals announced a S$1000 plus 10% of basic salary payout to those involved directly in caring for patients in public institutions. However, it is not unexpected that year-end bonuses will be cut. It is estimated that the income of private surgeons could have dropped by 25-33% in the 3 months that WHO designated Singapore a SARS-affected country.

Lessons learnt

Modern medicine has not rid the world of infectious diseases, and civilization has spawned newer and ever-more virulent strains, and will probably continue to do so. HIV, Ebola, Legionnaire's disease, Nile Valley fever and now SARS CoV are but a few in recent years. In most, hardly an eyebrow is raised in the orthopaedic community. Not so with SARS. In Singapore, both doctors and patients faced a true crisis. General orthopaedic care was essentially suspended as non-emergency cases in all public hospitals were turned away. All non-critical orthopaedic patients in the wards were quickly discharged. Initially, those from Tan Tock Seng Hospital had their follow-up in SGH and other hospitals. When it was suspected that probable SARS patients could bring the disease to other hospitals, cross-transfers were stopped. It was also discovered that suspected SARS patients themselves intentionally denied their contact with probable patients so as to gain access to other hospitals. Finally, it was healthcare personnel who perpetuated the transmission to others when they continued to work and ignored symptoms and signs of SARS in themselves. Here was the creed of Hippocrates gone awry.

Finally it was realised that the only reliable symptom was fever, initially thought to be in excess of 39°C, then reduced to 38°C, but was later cut-off at 37.5°C. Coryza was initially thought to be a cardinal sign, but this was changed to dry unproductive cough. Diarrhoea with faecal transmission was also a lately recognised major sign. All this happened because there was no reliable test for detecting SARS. The polymerase chain reaction (PCR) test is now known to have a high sensitivity and specificity, but it is still being detected in patients who have long recovered, and the significance of this as to the infective potential of these patients is unknown.

With such imponderables, it has been decided country-wide that fever is an important sign of disease, and fever screening is being carried out not only in health institutions, but in areas where many congregate such as in concert halls, restaurants, shopping complexes, cinemas, and in ports of entry and exit of the country. This is being done either manually by ear thermometer or by infrared thermal scanning machines. HCWs are mandated to submit twice-daily temperatures to their administration. It was also determined that high-risk areas keep a contact list of people entering them, so that contact-tracing can be initiated when a new case is discovered. The two main reasons for success in combating SARS in Singapore was the "ring-fencing" of infected institutions, and the isolation of possible contacts by hospitalisation or quarantine.

It is most likely that the virus in its original or more likely a mutated form still resides in the country. It has been kept at bay by constant country-wide surveillance and by greater awareness in both HCWs and the public not to ignore the early general symptoms of any viral infection. Steps are being taken to determine the significance of persistent sero-positivity in affected persons. Administrative measures are also in place to quickly isolate affected work zones by first creating "fever wards", and to build more isolation rooms with negative-pressure ventilation and mandatory barrier nursing. Whilst these have shown to be effective in the institutions, it is the community measures that are not so foolproof. A high level of public education is required, starting with children, who have to record their temperatures before school starts, and who have to report any travel outside Singapore and have their passports available for verification. By legislation, it is a crime to sign a false declaration, punishable by jail and fine.

Looking at the positive side, it was lucky for Singapore that we are a small country with a government and public infrastructure that is easy to control. Measures can be effected within hours instead of days. Yet there was a time of confusion and contradictory actions mainly because of a lack of useable knowledge about the disease in its early days. Singapore was also lucky in that it had only 5 "super-spreaders" accounting for all two imported cases. Never before had 200-odd persons caused direct and indirect financial losses to a country to the tune of billions of dollars. Are we ready for the next round?