

## THE SECOND PNEUMONIC PLAGUE EPIDEMIC IN MANCHURIA, 1920-21.

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### I. A GENERAL SURVEY OF THE OUTBREAK AND ITS COURSE.

(With Map.)

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#### A. GEOGRAPHICAL.

TRANSBAIKALIA or Zabaikalia is a vast stretch of land lying to the north-west of Manchuria, bounded on the east by River Argun from China and on the west by Lake Irkutsk and Irkutsk Mountains from the Irkutsk region. Its most important cities are Chita (capital), Stretinsk, Nerchinsk, Kiakhta and Borzia. The region around Borzia for a hundred miles is composed of undulating hillocks inhabited by a species of large (cat-size) marmots or tarabagans (*Arctomys bobac*) whose skin is much sought after for the manufacture of imitation sable. The Russians and Buriats find the flesh of these animals wholesome, and often hunt them for the meat and the fat which they use for greasing shoes. It is among the trappers and eaters of tarabagans that the early case of bubonic plague are usually reported.

Manchuria, which receives the brunt of the attack whenever an epidemic of pneumonic plague arises, is known by the Chinese as Tung San Sheng (Three Eastern Provinces). It is the largest and easternmost province of China, containing an area of 363,000 square miles and a population at present of 22 million. Its three constituent provinces are: Fengtien (capital Fengtien or Mukden), Kirin (capital Kirin), Heilungkiang (capital Pukuei or Tsitsihar). Of these, Heilungkiang Province adjoins Transbaikalia, the town of Manchouli being situated only a few miles from the boundary. The large province of Mongolia touches all three parts of Manchuria on the west. The country around Hailar, mostly Mongolian territory, is also a tarabagan-infested region, and hence Manchouli and Hailar are the two principal skin-collecting depots in

Manchuria, and any invasion of plague from the endemic regions is first reported in these two towns.

Beyond the regular caravan and cart routes, there are no proper macadamised roads in the rural parts of Manchuria. The Chinese Eastern Railway begins at Vladivostock (seaport of Maritime Province of East Siberia), enters Manchuria at Pograditchnaya (Suifenho), traverses Kirin and Heilungkiang for 886 miles and leaves Manchuria at Manchoui Station. From Harbin (largest city of Manchuria), the Railway branches southward for 225 miles to Changchun (Kirin), where it joins the main South Manchurian line going to Dairen (436 miles). Other railway lines in or adjoining Manchuria are:

- (a) Ussuri R. from Nikolsk to Habarovsk (410 miles);
- (b) Kirin-Changchun R. from Changchun to Kirin (77 miles);
- (c) Chengchiatun to Szuping kai (55 miles) branch of S.M.R.;
- (d) Tashihchiao to Yinkow (14 miles) branch of S.M.R.;
- (e) Peking-Mukden (523 miles);
- (f) Mukden-Antung (171 miles);
- (g) Antung to Seoul (310 miles) and Fusan (591 miles).

The principal seaports of Manchuria are Dairen and Newchwang (Yinkow), which have regular steamer services with Chefoo, Lungkow, Tsingtau, Weihaiwei (Shantung), Tientsin (Chihli), Shanghai, Canton, Hongkong (south China) as well as with different ports of Japan and Korea.

All these data have an important bearing upon any outbreak of Pneumonic Plague in Siberia.

#### B. GENERAL DESCRIPTION OF THE EPIDEMIC.

For ten years, that is, since the great Plague of 1910-11, Manchuria had been free from the pest, although almost every year, in the intervening period, sporadic cases were reported in some part of Siberia or Mongolia. For instance:

In 1911 Bissemsky registered five bubonic cases at Scharasone.

In 1912 Haffkine reported three pneumonic cases at Chita.

In 1913 some bubonic cases were reported in Kirghia Steppes.

In 1914 we recorded 16 bubonic cases (13 fatal) in Transbaikalia.

In 1917 we recorded bubonic cases at Patebolong (Mongolia) resulting in the Shansi outbreak and 16,000 deaths.

In 1919 we reported two bubonic cases (both fatal) at Ikievskay.

In 1920 (August) six bubonic cases (five fatal) at Abagatui (five miles) occurred. Three at Dauria (40 miles) and four at Kailastu (50 miles).

In the following October, the wife of a Russian guardsman stationed on the railway bridge at Hailar (117 miles from Manchoui) died of bubonic plague. She infected three sons, but two of the sons died much later (see tabulation in clinical article); her husband also sickened but recovered in hospital. These cases were seen at the Railway Hospital and found to be purely bubonic. Three Chinese soldiers living in the same compound also died of the disease. Owing to the free intercourse between the sick and some outside workmen, the infection was distributed in the city, and efforts at segregation met with

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opposition from the soldiers. During our stay at Hailar, we noticed the gradual evolution of the plague from the bubonic through the septicaemic into the pneumonic form, due principally to promiscuous spitting and huddling together of coolies day and night in unventilated inns. Both here and at Dalainor later on, it was common to find all the inmates of one house numbering 4–8 or more dead of the plague within a few days. On December 12th, the Chief of Police at Hailar (Lang), a keen officer, was waylaid by soldiers when driving with our Medical Officer Tang, and had his scalp opened by a knock on the head. In spite of these difficulties, our record at Hailar was good for only 52 cases were altogether reported. Nine contacts then under observation in a large inn were set free by the soldiers and escaped by rail to different parts. Two reached the coal mines of Dalainor (100 miles), where they infected others in the crowded underground dwellings and thus really started the great epidemic of 1920–21. More than 1000 out of the 4000 Chinese miners died of the pest in this Dalainor district as a consequence. From Dalainor, persons incubating the disease escaped to Manchouli (20 miles away) where they were responsible for the deaths of 1141 people including 334 Russians. Contacts also reached Tsitsihar, where 1734 persons lost their lives, and also Harbin, where the deaths totalled 3125. Other towns on the Chinese Eastern Railway received the infection to a greater or lesser extent. Thanks to the rigid measures adopted at Harbin in controlling the regular passenger traffic, limiting the daily sale of third class tickets for each train to 50, medical inspection of all trains arriving and leaving, and quarantining for 5 days of third class passengers at Changchun (225 miles), the epidemic was practically stayed south of Harbin, and only 77 cases were reported altogether at Changchun and four at Mukden, as compared with at least 5000 in each city during the epidemic of 1911. The regular passenger traffic between Manchouli and Harbin was stopped on Feb. 1st, but leakages occurred all along the line (876 miles), and many cases filtered in on freight cars and by road from the infected regions. The addition of a sanitary car to each passenger train perhaps helped in isolating cases found travelling with other passengers. Because of its size and commanding position, Harbin, in 1921 as in 1911, soon became the central focus of infection, but thanks to our early preparations we never lost control of the situation. In spite of the annoying opposition from soldiers and ignorant populace we succeeded in limiting the spread of the epidemic. Beyond Changchun, very few plague cases were reported in Manchuria, four at Kungchuling (picked from South Manchurian trains), four at Mukden, 18 at Koupangtzu (all traced to one family). A limited outbreak in south Chihli and Sangyaun (Shantung) with about 200 deaths, including that of Dr Yu Shu Fen (of our temporary staff) was believed to have arisen from two undetected Tientsin cases (Jan. 22nd). The port of Chefoo was infected from Vladivostock, but all these instances will be described under their separate headings. From Harbin, the epidemic travelled eastwards about middle of February, invading most of the stations of the Railway, and finally reached Vladivostock, where the first case was reported on April 9th.

In this city the epidemic raged throughout the summer months and did not terminate until the following October, after causing the death of 520 persons. Altogether the 1920–21 epidemic claimed 9300 lives (including 600 Russians).

The rise and decline of the epidemic form an interesting study. As seen above, the first sporadic cases (bubonic) commenced in August 1920 in different parts of Siberia, *e.g.* Abagatui, Dauria and Kailastu. In October bubonic cases appeared at Hailar, the Russian woman who first caught the disease having made frequent visits to Manchouli near the Russian and Mongolian borders. Practically her whole family was attacked, only two out of five sons escaping. The outbreak was almost confined to this town during the months of November and December. After the attack upon the Chief of Police, cases first appeared at Dalainor early in January, and then rapidly multiplied. Tsitsihar reported its first case on Jan. 18th, the number rapidly increasing. It in turn infected other neighbouring cities. Harbin received its first case from Dalainor—an escaped sick miner, who was diagnosed by us to be true plague on Jan. 22nd. The highest mortality point was reached in Harbin on April 3rd. The last case in Manchuria was recorded before the end of May. With the last Vladivostock case in October, the second Manchurian plague epidemic may be said to have lasted exactly one year. In 1910–11, the first case in Transbaikalia was also recorded about August. Harbin reported its first case in November and its last in the first week of April, but the epidemic stayed on in Mukden until middle of May. On that occasion, Vladivostock was not invaded, but several cities in Chihli and Shantung suffered badly, including Peking, Tientsin, Tsinanfu, Tehchow, etc. Strange to say, the two busy cities of Tongshan (coal mining centre 80 miles from Tientsin) and Yinkow (large Manchurian seaport), which used to be centres of *bubonic* plague arising from cases in Hongkong, entirely escaped in 1911 and 1921.

### C. INDIVIDUAL DESCRIPTION OF INFECTED LOCALITIES.

#### 1. HAILAR.

Hailar being the first focus of infection that our staff visited during the 1920–21 epidemic deserves special attention. It is an interesting town, formerly in Mongolian territory. It consists of three parts: (a) railway settlement including the station and containing about 2000 Russian inhabitants, (b) Mongolian area comprising the famous horse market, and (c) Chinese city, seat of the Taoyin of district. The total population is about 10,000. Since the Bolshevik troubles (1918), the Taoyin's rank has been raised to that of a Director-General (Tupan). At the time of my first visit to Hailar (24 hours by rail from Harbin) on Nov. 28th, 1920, the station area was filled with hundreds of cars, thousands of Russian soldiers and their ponies under Kappel and Semeonoff, who had just been driven away by the Bolsheviks in the west. It was fortunate that these were sent away within three days,

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otherwise some of them might have got infected by the plague and thus spread it broadcast.

It is always difficult to trace the origin of the early cases of an epidemic, but it was particularly so in a wild place like Hailar inhabited as it is by Russians, Chinese and Mongols. As far as I could ascertain, some suspicious deaths occurred on 4–7 October, among seven Chinese coolies working in a small skinning factory situated a mile away on the north side of the railroad. Where these men came from it was impossible to find out but it is known that they had something to do with skins. Their bodies were all voluntarily cremated in the compound occupied by them. The second group of cases was carefully studied by me on the spot. These began with a Russian woman, Tarelkin (died Oct. 22), who was the wife of the Russian signalman on duty at the Hailar Railway bridge. Besides herself and her husband, there were five sons and twenty-one Chinese soldiers living in the same compound. Of these, her husband, three boys, and three soldiers caught plague, all dying except the husband. The last death occurred on Nov. 25th, *i.e.* 34 days after the first infection occurred in the compound. During my investigations, I attempted to secure some rats and fleas from the infected houses, but failed. There was no doubt, however, as seen from the list of cases, that they were of a bubonic type, some being treated in Hospital. The only case that recovered was old Tarelkin, aged 43 years, whose bubo in the left groin was opened.

The following information was supplied me by the soldiers on Nov. 29th, 1920:

Twentynone Chinese soldiers, for duty at the railway bridge, were living in two big rooms in the Tarelkin compound. They had a mutual kitchen shared by the Tarelkin family, the Russians moving freely among the Chinese. The Russian woman used to make regular visits to Manchouli (115 miles away), the last one being on Aug. 13th. She showed signs of plague on Oct. 22nd and died the next day. Her fourth son, aged nine years, got sick the same day and died also on Oct. 23rd. One soldier Chen had fever and rash on body on Oct. 23rd and died two days after. After the woman and her nine year old son died on Oct. 23rd, Tarelkin and four other sons removed to the same room occupied by sick Chen and stayed there for five days. No further cases were reported for 24 days between Oct. 25th and Nov. 15th. Then two Tarelkin boys, aged 18 years, became sick, were admitted to hospital with fever and buboes, and died—one on 17th the other on 21st. A soldier Chang (aged 19) became sick on Nov. 17th with bubo in left axilla and died on the 19th. He was living with five other soldiers, though he used a separate wooden bed. One of these contacts, Chao, developed plague on 21st was admitted into hospital on 24th with bubo in left axilla, and died the following day. It was acknowledged by the soldiers that rats were present in the house, and they were frequently bitten by fleas, but they did not remember seeing any dead rats lying about. Besides their three dead mates at the Tarelkin compound, there were perhaps 15 other soldiers who had died suddenly in Hailar town about that time.

On Nov. 13th, one man was reported to have died at Yi Shun Inn after one day's illness. On Dec. 2nd another sick man was admitted into hospital from another Chinese inn (Yu Tai) with signs of plague and died

after 14 hours. At autopsy, both these cases were reported to be septicaemic plague. From this date onwards, the cases seen were few and far between, but whether alive or dead, buboes were rarely seen. In their stead was recorded at p.m. septicemic plague. On Dec. 8th a coolie was found dead of plague in an inn, which was then closed by the police. Nine contacts were isolated. It happened that this inn was partly owned by a local soldier, who resented this interference with his business. He thereupon collected twenty others, and on Dec. 12th waylaid the Chief of Police Lang while driving in a carriage with our Medical Officer Tang. Lang received a severe scalp wound with much bleeding, and the nine contacts were set free. Telegrams were dispatched by us to the Government of Heilungkiang, and the Police, who had up to now done their work splendidly, refused to go out again. The anti-plague work came to a standstill for one week, during which no precautions were taken. Eventually, Police Chief Lang was prevailed upon to resume duties, but the plague had spread to other regions. The two ringleaders of the soldiers were tried by court-martial and shot, while their captain—a wild, uneducated man who at an anti-plague meeting publicly accused the doctors of having brought the plague, was fined and dismissed from the military.

Examination of passengers buying tickets was commenced on Dec. 18th. Inspection of departing and arriving trains continued throughout.

One rat was found on Dec. 23rd and autopsied with negative results. After Dec. 20th cases with cough and bloody sputum were often seen. One report said that a man infected three out of four others in the same house. All the sick died and showed at post-mortem congested trachea and bronchi with plague bacilli but no evident pneumonia. Four patients seen on Dec. 27th had pain in front of chest and epigastrium, dyspnoea, slight cough, bloody sputum, but no headache. On Dec. 28th an excited man rushed into the Police Headquarters and demanded that all anti-plague doctors be sent away from Hailar; the plague would then automatically disappear! After the punishment of the soldiers, our work became considerably easier, and a total of 52 cases was reported. The question of a sanitary cordon was raised and given up at that time. No more plague was reported at Hailar for some time (Jan. 1st to Feb. 23rd) until some reinfections took place from Manchouli and Dalainor about the end of December. This second invasion was however confined to the station area. Drs Chun and Hsieh reported a necropsy on a case seen alive on Jan. 15th with no cough or blood-spitting. The spleen was small and no buboes were noted. Blood and spleen showed *B. pestis* in large numbers. Drs Wu Lien Teh, Chun, Hsieh, Yuan, Tang, Ling and Kwan were at one time or another on duty at Hailar. The unruly soldiers of Hailar might be compared to the wild country folk of Fengchen (Shansi) who surrounded the railway-car occupied by the foreign doctors and nearly murdered them (Shansi Plague, 1917). The two Russian railway doctors Dr Churigan (in charge of Railway Hospital) and Dr Adolph (ambulance), as well as their two bacteriologists Drs Petin and Askanoff gave our staff considerable help. One Russian dresser



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employed in the P.M. room was infected while dissecting, and died three days afterwards. The Chinese Police Chief Lang was a young, active, modern trained man, without whose coopération it would have been most difficult to successfully limit the spread. That he was attacked while on duty by the undisciplined soldiers proved his devotion to the cause.

### 2. DALAINOR.

The outbreak at Dalainor offers an instructive example of the extreme infectiousness of pneumonic plague. Here the coal mine owned by the Chinese Eastern Railway is leased to a Russian Jew. The whole mine is scattered over an area about 3 miles square on flattish land, bounded on one side by low hills. There are five shafts worked by machinery to a depth of 150–200 feet in addition to shallow pits. The coal extracted is lighter and less lustrous than ordinary bituminous coal. It is in large slumps or slabs and does not ignite well, giving comparatively little heat and leaving an ash similar to that of wood. The daily output of a full day is 800,000 pounds. Except in the adjoining village, where a Chinese magistrate officiates, the administration is in the hands of the Russian lessee. The employees number 6000—2000 Russians and 4000 Chinese. The former occupy the higher positions while the latter form the bulk of actual miners. Besides these, there are 2000 dependents in the village. The Russians are housed comfortably in little cottages or open sunlit rooms built round the office building and have a club fitted with a small stage and restaurant.

The Chinese live mostly in semi-underground barracks scattered over the mining area. Each barrack measures 20 by 60 feet with accommodation for 60–80 men. The walls are built with coal-dust bricks, and the floors of mud. From the entrance, some ten steps lead to an underground five foot passage, on either side of which is situated a long *kang*—brick-and-mud hollow structure raised two feet from the floor and heated in winter by a flue within. Four feet above this is a wooden-tier running the whole length of the room, used for sitting, sleeping and eating. In one corner of the passage near the entrance is a small open brick stove where kettles may be placed for heating water. Beyond one or two slits in the roof fitted with glass for the admission of light, these underground dwellings have no sun or ventilation. They keep warm in winter at a minimum expense of fuel, but are stuffy and serve as terrible plague traps whenever an epidemic breaks out. The men usually receive twice the wages prevalent in Harbin. In the adjoining village, brothels, gambling dens, opium resorts and tea houses abound, and as may be expected such a population is not amenable to discipline.

Into this community there arrived from Hailar on Jan. 2nd at 6 a.m. the sick friend of a mining coolie, who was living in a house with 17 other persons. The sick man died at 6 o'clock the same evening. On the 7th one of these 17 coolies was reported dead, on the 8th one, on the 9th two, on the 10th eight, on the 13th two, and on the 14th the remaining three. Not one person in that

unfortunate crowd survived. On Jan. 4th, in another barrack housing 30 men, one man got sick and died. On Jan. 6th, in a third barrack containing 160 men another patient was found sick, sent to hospital and died a few hours afterwards. Of the contacts, over 42 were known to have taken the infection. On Jan. 11th, in a fourth but smaller barrack near the first one, four out of five inmates were taken ill at once, spat blood and died. One man remained healthy. On Jan. 16th one hospital attendant was reported sick, and the next day two more attendants sickened and died. Later on it was ascertained that 61 out of 64 coolies in one barrack died in 3 days as a result of infection from two outsiders. All this time, the medical control was in the hands of a Russian doctor Jejukavitch employed by the mines. The mine manager, Wedenikoff, an active man who had lived in America, appealed to us for help, and we immediately sent Drs Chun and Yuan, and later on Drs Hsieh, Chang and Chao, with sufficient dressers and equipment. I gave instructions that the contacts must not be kept in the infected barracks, but removed to box cars in groups of 6-8, that they should stay out in the sun in the daytime, and that more police be lent to help in house-to-house inspection and to guard the hospital and cars. The rapidity of infection at Dalainor was principally due to the following causes:

(a) Crowded barracks, especially when the men refused to report when sick. By the time a corpse was found, several others had already been infected and some escaped to spread the plague.

(b) Escape of sick and contacts from their places of confinement. Very often they returned again and again to the infected houses. Even in our Harbin Hospital we have seen one delirious patient trying to scale the wall and escape.

(c) The ignorance and lawlessness of the miners in opposing all anti-plague measures.

(d) The mistake made by the Russians in the early part of the epidemic in *shutting* up all contacts inside a barrack once a sick man was found, and only opening next day to sort out any further cases. A more crude way of isolation could not be imagined, but evidently this was done because of lack of spare buildings. (It was because of this that after the epidemic I insisted upon a Chinese doctor being associated with a Russian in the mines and the establishment of suitable blocks for isolation purposes.)

The mortality quickly rose. In the third week of January over 30 deaths were reported daily, and in the fourth week nearly 40. The highest point was reached on Feb. 6th when 80 was recorded. By Feb. 10th 491 deaths had occurred. When I visited the mines on Feb. 11th all work had stopped, the dead were everywhere, and the population was well scared and more amenable to reason. In one house, eleven corpses were dragged out, but the friends still insisted upon going in to look over the papers left by the dead. The sanitary attendants while attending to the removal of the sick were often assailed, but fortunately the police was efficient and serious encounters did not take place. Under these conditions, the work of Dr E. T. Hsieh who



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arrived on Jan. 21st and his assistants (Drs Chang, Chao, etc.) deserves every praise. Soon after arrival he fitted up a disinfecting and bath wagon, dressing room, with shower bath, and provided new clothes for patients and contacts. Contaminated clothes were disinfected in a special steam car. Assisting him were one *ying* of soldiers (90), 98 policemen and a staff of 4 doctors, 11 dressers and 8 disinfecting assistants. The temperature in February was  $-20$  to  $-25^{\circ}$  C. Twenty-five wagons were used for isolation. Steam from a small locomotive was used for disinfecting railway cars. The dead were cremated in an old brick-kiln. As coal was free, large quantities were used. At one time when the epidemic seemed very serious, it was thought that the whole mining population of Dalainor might be induced to live in the open air for a full week, warming to be effected by large coal fires, while the infected quarters were being disinfected. This open-air existence would also prevent further infections, and the epidemic would automatically subside. But the cold was too severe and not many dared to brave the ordeal. However, this method of prophylaxis should be undertaken in all tropical or subtropical countries, where the weather conditions are favourable. The epidemic commenced to decline from Feb. 10th, but fresh cases arrived from Manchouli. The last plague death at Dalainor was reported on May 19th, the total number registered having been 1017 (all Chinese except four Russians and one Japanese) out of a population of about 6000. *Per capita* of population, Dalainor was the hardest hit of all places during the 1920–21 epidemic. In the outbreak of ten years ago, the mortality was insignificant, being 120 out of a population of 4000. On the staff, eight soldiers, one Russian and two Chinese attendants died of plague.

### 3. MANCHOULI.

Manchouli or Manchuria Station is the western boundary town of Manchuria. Here the Chinese Eastern Railway ends, and the Trans-Siberian line begins. Mongolia is close by. The population numbers 21,000, of whom nearly half are Chinese, the rest being mostly Russians. The recent political troubles in Russia have driven thousands of families into China by way of Manchouli, and the most destitute Russians may be found in this town. The plague epidemic of 1910–11 entered China from Dauria (Siberia) by way of Manchouli and claimed 400 victims locally. The outbreak of 1920–21 also started in Dauria and Abagatui and the first Manchurian infections were reported at Manchouli. On this occasion, owing to the presence of thousands of poor Russians, who often lived underground with Chinese, the number of deaths among Russians was one-third of the total (334 out of 1141). In 1910, the Russian authorities took a leading part in the anti-plague work in this city; in 1920–21, owing to their disorganization and lack of funds, our Service undertook the responsible share.

The first case was reported on Jan. 12th, though a month previously rumours had been spread of its occurrence in this city. On the 17th two more deaths occurred, and on the 21st, one. The total for January was 36. In February

it had reached 475, in March it decreased to 318 and in April to 164. The highest point was reached on Feb. 20th, with a figure of 70 (including 25 sick and 15 corpses found in one house). On Jan. 31st eight sick were found among 38 persons in a small inn, where one man had died of plague nine days previously. As at Dalainor in the early stages of the epidemic, no accommodation was available for the contacts who were either not isolated at all or were confined in the house where the sick had been. Hence the enormous number of sick and dead occasionally found in one building. After 40 wagons had been obtained from the Railway, matters improved considerably, but the multiplicity of interests present was a great hindrance to efficiency. The mortality reached zero point on April 22nd and stayed so for five days, but fresh infections were discovered on April 27th, leading to a second small rise which continued until the 22nd of May. Dr Kastorsky, a local Russian physician employed by the municipality, gave the following reasons for the slow improvement: improper organization, no wagons at first for housing contacts, cold weather, fresh infections from Dalainor, Siberia and Mongolia, failure to report cases by Chinese, shortness of equipment, and the morphine habits of the Russian doctor in charge. The gentleman in question was dismissed in May.

The Russians had five doctors, six nurses, and 15 sanitary attendants on their staff. Our Plague Service personnel consisted of three doctors and four nurses among others. On the Russian side, there died of plague three nurses (including one woman), 15 sanitary attendants and one policeman. We lost none. The Russian sanitary staff was mostly untrained, very careless about wearing masks in the presence of the sick and dead. They smoked cigarettes while handling the dead, drank more alcohol than was good for them, and many were struck down unnecessarily. It was a sad story.

#### 4. TSITSIHAR.

Tsitsihar consists of two parts—the station town on the main Harbin-Manchouli line and the Chinese capital city (Pukuei) joined to the station by a light twelve mile railway. The station town has a population of some 5000 people, while Pukuei contained about 90,000. It lies about one-third the distance from Harbin on the Harbin-Manchouli Railway, being 253 miles from Harbin and 623 miles from Manchouli. The journey from Harbin usually takes eight hours. At Tsitsihar Station are large railway workshops, half the population being Russian. Pukuei is the seat of the Governor, who is supreme in all affairs of the Province. The modern hospital there was built by me in 1911 with funds provided by the local Governor, but since the opening its connection with the Plague Prevention Service has been indirect only, the annual expenses being defrayed by that city. On urgent occasions, I was consulted, as in February when General Sun Lieh Chen wired for me to see him and suggest the most appropriate measures for controlling the plague, then rather threatening in the capital. The locations of the plague and isolation hospitals were excellent, the patients being housed in the commodious quarters

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formerly allotted to German prisoners. Dr Hsieh Chiu Kuan, a graduate of Formosa Medical College, was in charge, assisted by a staff of able young men. The Police were active and made regular house-to-house inspection. As was usual in capital cities, much obstruction came from the influential classes in defying preventive measures, and the epidemic was unduly prolonged and claimed more victims than was necessary. The first case occurred in a petty shop assistant who escaped from Dalainor and lived in the house of a friend, who was infected and died on Jan. 18th. The wife followed and then five children, making a total of seven. These cases were hidden from the authorities, and when discovered other infections had already taken place. The Governor reported eleven cases (four males and seven females) up to Jan. 23rd. The mortality records were as follows: for January, 124; for February, 661; for March, 899; for April, 44; total, 1728. The males numbered 1390 and the females 338. The number of females was considerable because of the presence of many families in this city. Several deaths also occurred in the station area, corpses being actually thrown out of the passenger cars on two occasions. Some of the Chinese employees in the workshops also succumbed. At Tsitsihar station medical inspection of passengers was introduced from Feb. 1st, but this did not prevent some persons in the early stage of incubation from taking the train and then falling ill in their homes after arrival.

### 5. HARBIN.

As in the previous epidemic of 1910-11, Harbin was the headquarters of the anti-plague organisation, from which all instructions and reports were sent. For ten years this city had been growing in size and population until in 1921 the latter reached a total of 300,000, including 100,000 Russians, 2000 other Westerners and 4000 Japanese. Harbin is the central station for trains proceeding to Changchun and the south; to Manchouli, Russia and the west; to Suifenho (Pogranitchnaya), Vladivostock and East Siberia. It is also the starting place for all river steamers plying on the Sungari and Amur. It collects grain, beans, oil, timber, skins, furs, etc., from the neighbouring districts for export, and is the main distributing centre for imported goods destined for North Manchuria and Siberia. It owns nearly 50 flour mills, 20 oil mills, 10 spirit distilleries and many breweries. Its Chinese merchants, mostly from Shantung, are, next to the Cantonese, perhaps the most forward in new enterprises of every description. Its regular lines of fine many-storied buildings along the main streets of the Chinese city (formerly a mass of mudsheds) are a lesson even to Shanghai. In fact, the city has grown ahead of the sanitary requirements, for there are no waterworks, no proper sewage systems, no systematic collection of garbage and house wastes. The richer Russians use water closets, but their municipal engineers do not yet understand the principle of septic tanks, still practise the cesspool method, and cart away the dejecta in iron tanks often to be conveniently dumped on to unoccupied fields near by. The Chinese city health work is still in the

hands of untrained police officers, who only seek expert advice when a serious epidemic like plague threatens. Fortunately, the Plague Prevention Service, with its largest hospital and principal laboratory situated in Harbin, has established a wide reputation throughout China, and by its successful control of epidemic and other diseases in the past has won the confidence of officials and merchants alike. When plague broke out in 1921, the ignorant classes were only half convinced, but they showed no open hostility. The real opposition came from the unruly soldiers, but even the hearts of these men were touched when they saw the tenderness and fearlessness with which Chinese doctors and nurses attended their friends in this most dangerous of all diseases.

As soon as the plague at Hailar showed signs of spreading, I called on Dec. 19th a meeting of the Chinese community at the Hospital attended by leading officials and representatives of the city. It was decided to start a local Plague Prevention Committee, to prepare 20 railway wagons for purposes of isolation, to establish a special detention house for the Chinese city, and to wire the Governor of Kirin for \$10,000 initial expenses. On Dec. 21st a meeting of Chinese and foreign residents was held at the Custom House "to help in devising preventive and other measures against a possible epidemic in Harbin and surroundings." An International Committee was forthwith organised with Mr R. C. L. d'Anjou (Customs Commissioner) as Chairman. This Committee included all the consuls, higher Chinese officials, heads of the Railway, members of the Technical Board, business men, in addition to Chinese and Russian medical officers in charge of anti-plague work. This Committee was mainly advisory, and besides receiving reports rendered much useful service in obtaining the co-operation and assistance of those who might be unwilling when approached individually. This Committee held altogether 18 meetings between Dec. 21st and May 23rd after which it was dissolved.

The first plague case in Harbin was recorded on Jan. 22nd, when an examiner died suddenly in a house near the hospital after having arrived from Dalainor the previous day. Among four contacts (mother, sister, sister-in-law and male friend) who were admitted into our Hospital, only the sister-in-law took the disease on 26th, and died the next day. This patient had fever, fast pulse and tightness in chest the first day, developed cough, later on spat blood, and died in the evening. Her sputum and blood showed the plague bacilli in large numbers.

In a small village four miles from the Chinese city, another miner from Dalainor died of plague on Jan. 26th. Three men living in the same room with him also died, and in addition members of three neighbouring families, with the result that in this small village of 73 huts and 400 souls, eleven persons died of plague between Jan. 26th and Feb. 6th. Fortunately owing to the early precautions taken at Harbin, all cases found were at once admitted into hospital, while the contacts were received in box-cars, each holding the members of one household (average six). It was evident that a trying time lay in front of us, and the whole efforts of the Service were concentrated upon

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limiting the outbreak to the smallest possible proportion. The plague wards could accommodate 60 sick, while the suspect wards had 50 beds. It was found that plague patients rarely survived beyond the second day after admission. Sixty wagons were run on to a convenient siding easily approached from the New Town, Pristan or Fuchiatien—the three main divisions of Harbin. These wagons included a sanitary car, a kitchen car, a supply car; the rest were for accommodation of the many contacts. We had at one time over 400 persons to look after. The work was under the supervision of Dr Chapplick, who had a Chinese colleague as well as several assistants and a full sanitary staff. This was one cheerful spot in our daily duties, for upon its efficiency depended the saving of the lives of contacts. The temperatures were taken morning and evening. As soon as any one showed signs of fever, especially with fast pulse, he or she was at once isolated and if necessary sent to the suspect ward of the hospital. Sometimes the rise in temperature was only temporary, and the patient was returned to the wagon. More often, the fever was followed by cough, red sputum and death. The 24 hours interval, usual between commencement of fever and cough, was most important, for at this stage the infective droplets had not appeared, and patient could be removed from his friends without any fear of their becoming infected. Should any carelessness or oversight take place, and the cough appear, then the inmates of the same car would run a serious risk of catching infection. The fact that the percentage of plague cases in the isolation cars reached only 8 out of 2021 admissions during the whole four months' epidemic showed that the work of Chapplick and his staff deserved every commendation. At Dalainor, where the same discipline was not maintained, 144 out of 655 contacts (21.9 per cent.) died. The Russian settlement, comprising a larger area of land but much less crowded population, had a separate sub-office where the routine work of house inspection, diagnosis and disinfection was carried out, and the daily report sent to headquarters. All suspects and plague cases were sent to our Hospital in Fuchiatien, only the few Russian sick (eight) being cared for in the Municipal Hospital. The Chinese city was divided into five districts, each with its corps of police, dressers, inspectors, sanitary attendants, and disinfection squads. Patients were at once removed to hospital. From suspected corpses or dead found in the streets cultures from the spleen were obtained. A simple method was employed: skin over spleen was painted with tincture of iodine, and a short sharp knife sterilised with iodine was inserted and some contents withdrawn. Cultures on agar were made, and the knife rubbed on two glass slides for microscopic examination. The whole operation usually took two minutes. In view of the very cold weather, strong wind and frequent exposure of corpses in the street, such quick operations were necessary. All cadavers found in the streets were sent to the common cremation pit to be burnt. Well-to-do and educated persons were sometimes thrown into the streets unclaimed, because the relatives after hiding them during sickness were afraid to report after death for fear of being isolated in the wagons. One of the most difficult problems of plague-prevention

in China is this passive opposition of the populace in not reporting cases when alive and then throwing the bodies out when dead. If there had been co-operation between the public and the authorities at the beginning, the epidemic would have been more confined, but the cases were hidden and the families or friends were thus infected. This fear of isolation is prevalent in North and South China alike, and used to be the same in Japan until the new universal education of the masses produced its beneficial results. The dead in the plague-hospital, numbering 1312, were all cremated in two pits dug within its precincts. Each pit measured 12 by 12 by 10 feet deep. Large pieces of firewood were laid at the bottom, some bodies uncoffined were thrown in, then more wood, and so on. The fire was started by pouring two gallons of kerosene on the pile, and then lighting it. The masses burnt fiercely in the open, because of the confined space, and even on cold windy days no difference was observed. In this way 80 to 100 bodies could be economically cremated every day with slight attention from two attendants. The fatty constituents of the cadavers helped to keep up the fire once it was lit, and at the end of the day only white crumbled bones were left as residue. Out of 1461 admissions into Harbin Hospital, 1312 were true plague cases, all died and were cremated. The remainder were cases of such diseases as pneumonia, typhus, typhoid fever, tuberculosis with haemoptysis, influenza, bronchitis, catarrhal fever, etc.

Because of the large percentage of deaths, it was not surprising that rumours began to spread that we *took in* patients but did *not let them out*, and that something uncanny therefore happened within the hospital compounds. Stories were current that our staff poisoned wells, flour, and food in order to obtain a reward of \$3 for each corpse. My bulletin of March 13th contained the following:

“The past week has been a very anxious one for our anti-plague staff for the concentrated suspicion of and prejudice against our policy of removal of the sick to hospital, isolation of contacts, systematic inspection of inns and other sources of infection, closing of theatres, low brothels, etc., coupled with the restriction of railway traffic and our inability to cure the plague victims resulted in numerous rumours to discredit our dangerous and humane mission and in some instances to actual threats of physical violence to our members. For instance, the Chief Medical Officer was accused of shooting the sick in the plague compound and was threatened with a similar fate should an opportunity offer itself, our house-to-house inspection doctors were on several occasions faced with revolvers and knives in the course of their duty, while the disinfection assistants were almost obliged to swallow some of the disinfectants used in the disinfected houses.

“At Asheho a mob of sixty visited the isolation station, set free the two contacts confined there and chased the doctor in charge. It speaks well for the discipline of our staff that in the presence of so much provocation and the loss by plague of one of their leaders they have stuck to their duty and not resigned *en masse*.”

To counteract these evil influences, we issued thousands of circulars, published a daily newspaper containing particulars about the sick and dead, reports



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from other infected localities, articles dealing with plague and health matters, etc. Our assistants also gave public lectures whenever possible and answered any questions that might be asked them by their audience. In fact our staff were faced with open attack from resentful and frightened persons as well as unseen danger from the plague germ. But all stuck to their duties with cheerful hearts. The masses refused to take sanitary precautions and yet expected to escape infection. But the time came when our efforts succeeded, the mortality curve showed a steady decline from April 10th and finally reached zero point on May 15th. The Harbin epidemic thus lasted nearly four months and claimed 3125 deaths out of a population of 300,000 as compared with over 7000 out of a population of 70,000 in the previous outbreak (1910-11). The death list might have been 30,000 or ten times greater if energetic measures had not been taken from the beginning. As it was, the epidemic was prevented from seriously invading the populous towns of South Manchuria and North China, less than 400 dying from plague in these latter regions as compared with 35,000 in 1910-11.

The daily ration of each contact kept in the isolation wagon consisted of: meat  $\frac{1}{2}$  lb.; potatoes  $\frac{1}{2}$  lb.; carrots  $\frac{1}{4}$  lb.; white and black bread 2 lb; rice  $\frac{1}{4}$  lb.; sugar 4 lumps; tea twice daily. As the rice, though expensive, was not filling enough for the northerners, Chinese bread (*mantou*) was afterwards substituted.

The Railway area employed 11 physicians (mostly Russians), 40 dressers, 60 special police and 125 attendants. Our Service deputed for special duty in Fuchiatien 8 doctors, 14 dressers, 50 special police, 20 hospital attendants and 42 sanitary attendants. Out of these there died of plague: one Russian doctor (Sinitzin), one Chinese doctor (Yuan Teh Mao), one Russian dresser, five hospital attendants in plague compounds, and one police sergeant. Seven burial coolies, out of 18 employed in the public cemetery, died of plague.

The River Sungari was opened for navigation on April 15th after all arrangements had been made with the Customs for medical inspection of passengers before purchase of tickets. Each steamer was obliged to carry a ship's surgeon on board. One suspected case of plague died on the first ship which left Harbin on April 16th, but no further incidents occurred, and the river traffic was practically not interrupted.

A few interesting, sometimes humorous, episodes may now be related in connection with our anti-plague experience:

(a) Some of the most noisy detractors of our work were the native quacks who persisted in beguiling the public as to their ability to cure the disease. When patients came with fever and cough, they always gave hopeful prognoses. If the sickness was not infectious, the patient got well and the quack's reputation jumped skywards; should it turn out to be true plague, both patient and quack often died. In Harbin alone, we recorded seven deaths among the old-style practitioners; one was the "vice-president of the medical research society" whose body was thrown out into the street by his wife in order to escape the isolation of the family. At Dalainor one quack after catching the disease passed it on to his wife and all four children. None survived.

(b) As it was easy for any one who could read a few ancient books on medical practice to hang out a signboard, there was no lack of practitioners, and one influential group managed to persuade the Taoyin to hand over \$4000 of government money for the establishment of a plague house where native treatment could be undertaken. This house was opened on April 1st (Fool's Day) with twelve native physicians on the consulting staff, each drawing a salary of \$100. At their request we sent ten certified plague cases to them between April 1st and 4th, but all died. On the 5th a letter was received from these worthies begging us not to send any more patients, as they had discovered that plague was incurable! The \$4000 had been absorbed.

(c) The inspection parties sometimes made mistakes. One man was sent in from the city because he had a fast pulse and had spat up something red. At hospital, we learnt that he had been eating crab apples and the red spit was due to them. Needless to say, the man went home delighted.

(d) Most coolies were credulous and intensely ignorant about matters hygienic, but Dr Chun (our senior medical officer) got into conversation on April 9th with a Chinese carriage driver on his way home. The driver was young and pleasant and informed the doctor that on the previous day he was driving a fare when a policeman suddenly stopped his carriage and demanded where he was driving a *corpse* to. His live fare of fifteen minutes before had died of plague while in the carriage! The driver also said that he did not believe the rumours about doctors poisoning wells, food, etc., for he knew from experience that they were kind-hearted and treated all the poor well.

(e) Ten years ago the plague reached its zenith at the end of January. Chinese New Year happened to fall on the 31st and the firecrackers burnt on this occasion seemed to have a marvellous effect in ridding the city of pest. In 1921 the plague *began* in January, and no amount of firecrackers on Chinese New Year seemed to stay its virulence.

(f) Many Chinese firmly believed in the efficacy of opium in keeping off plague, so much so that non-smokers were induced to try it during the epidemic. At Dalainor, a Japanese woman openly maintained an opium smoking and morphine establishment. Her business was most prosperous at the height of the epidemic. One day three plague corpses were found in her opium den. That served as an excellent reason for closing altogether her nefarious business, which at ordinary times might have required the co-operation of her consul.

Besides routine work, our laboratory in Harbin produced 60,000 cotton-and-gauze masks and 8000 doses of anti-plague vaccine which were distributed throughout Manchuria and Siberia. Our research work is described in separate articles.

Some important instructions to the staff are appended.

#### ANTI-PLAGUE MEASURES I (issued Jan. 21st, 1921).

##### (1) *Sick.*

1. As soon as a suspicious case is reported, the Med. Officer must be informed, who will examine patient, and, if the case be plague, remove him to Hospital.

2. Every one in contact with a sick patient must wear a mask and hood to prevent infection. This can only come by nose and mouth. No antiseptics necessary for mask. Rinse mouth with warm thymol, water afterwards.

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3. No patient can be moved to Hospital without a certificate from Med. Officer. Police take note.

### (2) *Contacts.*

1. For the contacts the greatest care must be exercised, for it is these people who may later develop the disease and spread the epidemic. As soon as a person sick of plague is ascertained, all other persons in contact with him must be removed to the Railway wagon under escort to prevent escape. Inform them that they need not fear, for every care will be taken of them.

2. The contacts of one house must not be mixed with those of another. It is best not to have more than five persons in one car.

3. Watch contacts every day and have temperature and pulse taken morning and evening. Persons showing the disease will develop quick pulse and high temperature after 2-4 days. Report such cases at once to M.O. and later, if confirmed, remove to Hosp. Patients are not infectious until cough develops. Remove rest into new wagon.

4. Save every contact possible by watching them day and night. The greatest responsibility for this work falls upon the Police and staff in charge of the wagons, and no one must be allowed to escape or visit another car.

5. While under quarantine, the contacts had best be exposed to the sun in day-time to allow them to breathe fresh air and have their face exposed to the sun. At night they can sleep inside.

6. Excellent nourishing food is provided from car kitchen.

### (3) *Dead.*

1. All persons dead of plague must be cremated in the pits dug for the purpose. By using the pit, the fire will be concentrated, and the bodies and wood will help one another. Bodies found in city are cremated in public burial ground; those who die in hospital have a special pit inside compound.

2. Do not be afraid of dead bodies, for once the sick cease to breathe the germs cannot escape from bodies. The danger from clothes of newly dead is great. To avoid danger from sputum, such bodies should be first covered with lime or sprayed with disinfectants, *e.g.* sublimate solution 1 in 2000 or cresol 1 in 2000.

3. Those helping in post mortems must take the greatest care. All working in the room must use masks and rubber gloves, and any superficial wound must be attended to before going into room. Use gauze and collodion for surface wounds.

4. In case of well-to-do persons, who can afford proper burial, bodies must be covered with *raw* lime, placed in coffin, and buried in pit 7 feet deep.

### (4) *Suspected cases.*

1. Spleen Puncture. Provide spirit lamp, slides, agar tubes, knife, platinum needle, etc., in proper tray.

2. Paint region with Tr. Iodine. Plunge sterile knife through 9th left space axill. region, downwards and backwards. Pulp obtained will be dark red.

3. Make cultivations in agar tubes.

4. Make 2 smears on slides.

5. Sterilise knife.

## ANTI-PLAGUE MEASURES II (issued Jan. 21st, 1921).

### DISINFECTION.

#### (1) *Of Sanitary Staff.*

1. Always wear mask properly over nostrils and mouth. One slip above and one slip below ear. Tie two ends behind neck.

2. Put on rubber gloves and white overalls before commencing work.

3. In the open air, masks are not necessary. The danger lies in rooms occupied by sick persons and when speaking to sick persons.

4. Throw away mask after using into disinfectant tub placed outside each ward. Do not drop this mask indiscriminately.
5. Wear long boots; rub soles of boots on disinfectant matting outside rooms.
6. After work, gargle mouth and throat with thymol water or potassium chlorate solution.
7. Take a fresh bath whenever possible.
8. Do not visit unknown places.
9. In plague wards, wear in addition goggles.
10. For gloves, hands, delicate instruments, etc., use methylated spirit.

(2) *Of Sick Rooms.*

1. Spray floor of room and lower walls with cresol 1 in 200. Cover floor with lime.
2. Spread out as much as possible all sleeping clothes and bedding so as to expose them to action of 4.
3. Close windows and crevices of doors and partitions with paper.
4. Disinfect with formalin gas made as follows: (each 1000 c. ft.) 200 kal. permang., 200 water, 400 formalin. Warm if necessary with spirit lamp or candle until room is saturated with formalin gas. This is the best way of disinfecting rooms in plague times.
5. Sulphur Fumigation. In place of 4. Sulphur powdered (2 lbs. for every 1000 ft.) may be burnt in an earthenware pot after walls and floors have been sprayed with water. Use lime always for floors.
6. No use wasting money upon carbolic acid, which can do very little harm to the plague germ in the room.
7. Repeat this disinfection a second time if needed.
8. Scrub floor with 1 in 4000 sublimate, and cover with lime.

INSTRUCTIONS TO MEDICAL OFFICERS ON DUTY AS PORT HEALTH OFFICERS  
DURING TIME OF PLAGUE (issued April 13th, 1921).

1. Be ready for duty from 6 a.m. to 6 p.m.
2. Wear Red Cross Yellow Quarantine badge over coat on left arm.
3. Inspect all incoming and outgoing steamers plying on the Rivers Sungari and Amur with Customs Officers. Health Officers should search for all suspicious plague cases on board steamers after taking all precautions, like masks, disinfection, etc.
4. Obtain help of at least two policemen if possible when examining steamers. All to be provided with masks made according to pattern sent herewith.
5. During the prevalence of the epidemic, the Hospital should be closed for ordinary cases, so that all your time may be devoted to anti-plague work. In the case of Sansing, Medical Officer should live for the time being at or near the Customs premises so as to be within call on arrival of steamer.
6. For disinfection of hands and thermometers, use only spirit, placed with cotton wool in a small wide-mouthed bottle with cover. Do not use carbolic acid, as this is useless against plague.
7. Prepare your Hospital for all emergencies as if a plague epidemic were prevalent. Reserve wards for actual plague cases, suspect cases and contacts.
8. Work in harmony with Customs Officers and be courteous to all people in the course of your duty.
9. For details follow instructions written on separate sheet.

PORT HEALTH REGULATIONS FOR STEAMERS PLYING ON SUNGARI  
AND AMUR RIVERS (issued April 11th, 1921).

1. During the prevalence of the plague, all passenger steamers plying on the Sungari and Amur from Harbin to Sansing or any port beyond Sansing must carry a qualified doctor or trained dresser approved by the Director of the Plague Prevention Service.

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2. Such doctor or trained dresser will receive a certificate from the Director, P.P.S. authorising him to act as ship's surgeon.
3. Duties of the ship's surgeon:
  - (a) To examine, on behalf of the company to whose ship he belongs, all passengers on board, and to reject any one suspicious of carrying disease.
  - (b) To notify the Port Health Officer appointed by the Government of any suspected case of plague and to carry out quarantine instructions as provided by Customs.
  - (c) In case of death on board to supervise burial of corpse at nearest landing place after all anti-plague precautions. Namely: sprinkle raw lime over corpse, bury corpse at least seven feet deep in dry land, cover corpse up completely with earth.
  - (d) To notify Port Health Officer at nearest port of any case of death or sickness.
  - (e) To give facilities to Port Health Officer in the examination of passengers and other necessary information.
4. In Harbin the Port Health Officers will be specially appointed; at Sansing, Lahasusu and Tabeiho the Medical Officers of the Plague Prevention Service will undertake their duties.
5. Before the departure of any steamer, Customs Officers and Port Health Officers will board such steamer. No vessel will be allowed to leave port until permission has been given by Customs and Health Officers.
6. On arrival of a steamer in port no passengers will be allowed to land until medical and Customs examination has been completed and the necessary permission given.
7. Vessel may only leave ports between 6 a.m. and 6 p.m.
8. Police specially deputed for the purpose will assist the Port Health Officers in their duties.
9. For infraction of the above regulations, fines will be inflicted according to Customs regulations.
10. The different shipping companies will be duly notified as soon as the plague terminates and these regulations are withdrawn.

### 6. CHANGCHUN.

Changechun is an important grain centre, the southern terminus of the Chinese Eastern Railway (Russian-managed) and the northern point of the South Manchurian Railway (Japanese-managed). It is also the starting point of the Kirin-Changechun Railway (77 miles). It has a population of nearly 100,000 and is the seat of the Taoyin serving under the Governor of Kirin Province. In 1911 Changechun was one of the worst infected towns and lost more than 5000 persons from plague. In those days it became also a great distributing centre of the epidemic, and the majority of infections in the southern localities could be traced directly to this source. When cases occurred in Harbin in January 1921, it was therefore most essential to keep Changechun as free as possible. Entire prohibition of railway traffic being impossible, the third class passengers were limited to a certain number each day. The limit for each train was fixed at 50. The three daily trains thus conveying besides 1st and 2nd class passengers, one hundred and fifty third class passengers from Harbin to Changechun after undergoing medical inspection at the former station. Only persons with medical certificates could buy tickets. Medical Officers also boarded the train at big stations and examined would-be travellers at intervening places. When the trains arrived at the Kwangchengtzu station (Erh Tao Kao), anti-plague officers examined all passengers, and removed those in the third class cars to special observation depots where they were quarantined





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for five days, after which they were liberated if found healthy. For this purpose, the Chinese authorities had prepared ten different inns and houses with large courtyards and the Japanese two places (used by them in 1919) for cholera cases), each accommodating about 150 persons. Railway cars were also utilised when accommodation was insufficient. Although leakages happened along the 225 mile journey, especially at Misatzu station (20 miles north of Changchun) where the clever ones dropped off and completed the rest of the journey on foot or in carts, this system worked fairly well, and only 77 cases of plague were recorded in Changchun during the whole epidemic. Here as elsewhere, some of the military hindered our work by unlocking the railway cars and allowing the passengers to escape before the quarantine station was reached. The Taoyin distributed money among these worthies and implored them not to break our rules. Our work at Changchun was rendered much simpler by the co-operation of the Japanese authorities, with whom we had our first meeting on Feb. 24th and fixed the quarantine arrangements. The first Chinese doctor sent to organise the sanitary arrangements was Dr Yu Shu Fen (a former student of Kitasato Institute, Tokio), who afterwards died of plague at Sangyuan, Shantung (March 24th). The local plague hospital was situated near the Chinese Railway station (Erh Tao Kao). The commandeered inns were found ample for our quarantine purposes. On March 14th a fire occurred in one of the S.M.R. cars used for detaining two plague patients, one of whom had died and the other was unconscious. It appeared that the clothes of the latter caught fire from the small iron stove as he dropped down. The woodwork of the car was completely burnt. After Dr Yu left, other physicians were sent by the Ministry of Interior to take charge of the work at Changchun.

### 7. SUIFENHO.

Suifenho or Pogranitchnaya lies on the eastern extremity of Manchuria, where the Chinese Eastern Railway leaves Chinese territory and enters Eastern Siberia. The town is situated on a beautiful plain surrounded by high hills. Chinese and Russian Customs officiate here. When plague from Harbin threatened to invade the eastern regions, I proceeded to this town on Feb. 16th and helped to organise the local International Anti-Plague Committee on the lines of the Harbin one. Drs Ling Ting Fan and Hsuan were placed in charge, assisted by the railway doctor Gilleson. All trains arriving and leaving were inspected medically. The first plague case occurred in a Russian who died on March 14th. He had arrived a few days previously from Nikolsk in the Primorsk region (East Siberia). We ascertained that cases had already occurred at Nikolsk since March 8-10. A Russian Medical Officer from Nikolsk visited our station on Feb. 21st, and later on wrote that he had seen cases among Chinese in his town on March 8th. The second Suifenho case was reported on March 16th. Between this date and April 17th twelve cases were reported, ten among Chinese and two among Russians. Nine of the former

were found in local inns, the tenth being caught at the station while trying to escape inspection. The first Russian patient has been described; the second was a nurse employed at the railway hospital.

#### 8. OTHER INFECTED FOCI IN HEILUNGKIANG.

Heilungkiang Province is separated from Kirin Province by the Sungari River. The Chinese Eastern Railway traverses this province from Manchouli until just north of Harbin, when it crosses the fine iron bridge and then enters Harbin, and thus Kirin Province. Practically all the important stations lying on this route were more or less infected by the plague. These included (counting from west to east) Abagatui (8), Dalainor (27), Hailar (175), Mentuho (282), Khingan (347), Buketu (371), Chalantun (487), Tsitsihar (623), Lamayantzu (707), Anda (757), Mankou (817), Tuichingsan (847), Station 62 (867), the figures after each city denoting the distance in miles from Manchouli. The scenery for 200 miles between Mentuho and Chalantun was most beautiful, the railway making many picturesque windings. But plague spared no spot, however beautiful, and during the epidemic *Mentuho* reported 4 cases, *Khingian* 3, *Buketu* 25, and *Chalantun* 1. Buketu had large railway workshops employing 1500 persons, and among the dead were six Chinese in one family.

The Russian railway surgeon at *Anda* was 70 years of age, lame and half blind, and did not believe in the infectiousness of plague. At the time of our visit on Feb. 12th he had made no preparations and did not consider these necessary. He handed us a long memorandum on the treatment of plague, which could rival any essay prepared by Chinese quacks. However, the engineer in charge undertook to carry out our instructions, and arranged 29 wagons on special sidings in the form of letter V. Sixteen of these were on one side and comprised cars for plague suspects, kitchen, disinfection, bath and *personnel*, while the other siding was reserved for isolation cars. The first case at *Anda* was found on March 19th, and altogether 25 died. At the next station, *Tuichingsan*, the soldiers interfered with the work, and 8 out of the 28 deaths happened among them. An important city *Hulan* lies opposite Harbin. In summer, there is river communication between these two grain marts, but in winter the frozen river is crossed by carriage, and hence the sick could escape from one to the other. The magistrate in charge was quite go-ahead and followed the instructions of the missionary doctor there, Dr McKillop Young, as well as his Chinese physician. Proper measures were adopted, and the total mortality from Feb. 7th, when the first case was reported, to the termination in April was 322. In the 1910-11 outbreak, the deaths numbered over 4000.

#### 9. OTHER INFECTED LOCALITIES IN KIRIN.

From the second week of February, the plague began to extend its activities eastwards along the Railway. The first city to be attacked was *Asheho*, 40 miles from Harbin. A small merchant Sun, whose people had died in Harbin, reached

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Asheho on Feb. 13th, and stayed in the house of Liu. Sun spat blood on the 16th, and died soon after. On the 19th Mrs Liu (aged 45) died of plague. No report was made to the authorities. Then came the police, who removed Liu, his son and daughter to isolation. All kept well and were released. Unfortunately, Liu was again exposed to infection, coughed up blood on Feb. 27th, and died the following day. The local soldiers encouraged a mob of 60 to invade the isolation hospital, set free two contacts, and actually forced the latter into the quarters provided for our dressers. This was too much for our Medical Officer, Liu, who left the town before instructions reached him from Harbin. The local magistrate was slow and did little to help the sanitary staff. The gentry undertook most of the responsibility and employed a pharmacist to look after affairs. In the workhouse, 40 inmates took the infection and died. In many cases whole families were wiped out. Deaths totalled 123.

Other important towns lying on the railway east of Harbin are: *Imiampo* (153), *Shitao Hotzu* (210), *Hantao Hotzu* (255), *Hailin* (313), *Mutanchiang* (332), *Mulin* (402), *Machiaoho* (433), and *Suifenho* (512), the figures denoting distance in miles from Harbin. All these places were more or less affected, but in no case seriously because of the scarcity of population.

The tract going southwards from Harbin passes the following towns: *Shwangcheng* (47), *Taolaichao* (114), *Yaomen* (151), *Misatzu* (196), the figures denoting mileage from Harbin. The magistrate at Shwangcheng was old-fashioned and allowed the plague to run its course. Fortunately, owing to the strict measures adopted at Harbin, only a few contacts reached this city, and the total deaths numbered 134. The mortality in the other cities was not great.

From Changchun, the Kirin-Changchun Railway runs for 77 miles to the capital city Kirin, a residential centre. No cases were reported in Kirin, but a few were encountered along the line, having travelled by road from Misatzu where they escaped inspection quarantine.

A large city *Yu Shu*, lying 100 miles south of Harbin but not on the railway line, received its first infection on March 8th. The magistrate Mo had served as Chief of Police in Fuchiatien in 1910-11, and was therefore *au fait* with the elementary principles of plague prevention. He adopted the strictest precautions, sent his police to surround the city, telegraphed for some assistants from us, made house to house inspection, isolated contacts from the sick and cremated the dead. In this way he did good work. The plague claimed in his district 253 victims out of a scattered population of 50,000. Over one-third of these were females.

### 10. INFECTED LOCALITIES IN FENGTIEN PROVINCE.

With our preventive measures adopted in the north and the watchfulness along the South Manchurian Railway, the only cases which escaped detection were those incubating the disease. At *Kungchuling* station (40 miles from Changchun) one sick second class passenger was caught on Jan. 31st in the train. He had travelled overnight from Harbin in the second class and had not

therefore been quarantined. Three more cases were similarly discovered, and removed.

*a. Mukden.* Mukden, being the capital city of Manchuria, the Governor-General was early communicated with. From the beginning he appointed me supreme chief of anti-plague operations, and wired to all subordinates including the military, to obey instructions. He had an efficient staff in Mukden, and was assisted by Dr Christie's staff and the Japanese. The first case occurred on March 29th at Siao Si Men (small west gate), in an inn with 36 other inmates. The servant at the inn caught the infection and died. A third case (corpse) was found on April 1st near the Chinese Railway station dressed in uniform. The fourth and last one occurred in the city, and strict measures prevented further spread. Hence the record of Mukden in 1921 was excellent. In 1911 about 5000 persons died in this city.

*b. Koupangtzu.* An interesting localised outbreak occurred at Koupangtzu district, where the Peking-Mukden line branches off to Yinkow (Newchwang) 90 miles away. A man Li arrived from Changchun on March 17th and lodged with a family named Wang at the village of Lo Chia Tun (9 miles north of Koupangtzu). A wedding was in progress and guests (male and female) were busy playing *machiang* (dominoes). Li died on the 19th, followed by four of the Wangs and two others including the bride-to-be. Altogether seven died of plague. Kao Chia Tun (a village half a mile away) was infected by one of the guests, and lost 11 persons. The outbreak lasted from March 17th to April 4th. All the sick had fever, cough and blood-spitting. The local epidemic cost 18 lives and was due to one sick man arriving among a happy party.

#### 11. VLADIVOSTOCK AND USSURI DISTRICTS.

For some time reports had been received from Vladivostock as to the progress of the plague in that district. The first case was detected on April 9th. From the first the Russian authorities appeared to have taken very strict measures. On May 24th Drs Chapplick, Loshiloff and myself proceeded in a special car to Suifenho and Vladivostock. After staying the day at Suifenho, we arrived at *Grodoveko*, the Russian station on the other side. Here we met the Japanese military surgeon Iyeda, who a few weeks previously had come to Suifenho with twenty wagons for carrying out anti-plague work in Chinese territory. He informed me that the Russians closed up a whole house with the inmates as soon as a case of plague occurred. *Nikolsk*, where the Ussuri Railway proceeded northwards to Harbarovsk (410 miles), was reached three hours afterwards. We found over 40 cars reserved for anti-plague work by the Russians. As soon as any suspected cases was detected, all the other passengers in the same car went into isolation. The isolation cars were surrounded by barbed wire. The first true case of plague, a passenger probably from Harbin, occurred on March 17th. A total of 16 deaths was reached in this city. Vladivostock (70 miles from Nikolsk and 488 miles from Harbin) is a beautiful seaport, the eastern terminus of the Transiberian railroad. The Russian doctor in charge was Popoff, a keen man, formerly assistant of Zabo-

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lotny, with whom I had worked in 1911. A revolution was in progress, and Popoff was on the point of being taken prisoner by the new masters (Kappelists). We found him at home however after three hours' search. His anti-plague organisation was somewhat complex. He employed nearly 1000 persons with a monthly budget of 200,000 yen. He had sub-offices at Olga, Ugolskya, Suchan, and Habarovsk. At Vladivostock, there were four separate pest-houses, each with eight beds (32), 14 isolation rooms each with four beds (56), and accommodation for 500 contacts in a military barrack. At the railway station were four wagons for isolation and one for the sanitary staff. The staff consisted of 27 doctors at Y320 each, 40 dressers at Y230 each, 420 sanitars at Y140 each. Up to May 26th, there had died at *Nikolsk* 16 persons, at *Vladivostock* 240, at *Olga* 6, at *Ugolskaya* 9, and at *Suchan* 6. Among the staff there had died two dressers, three sanitars and one sister at plague hospital (out of eight employed). Compensation in case of death was two-thirds of monthly salary to the widow or the nearest relative for life. One dresser and one sanitar were infected while working in the city; one dresser, one sister and two sanitars while in the isolation hospital. Estimated population of Vladivostock was 190,000 (Russians 100,000, Chinese 60,000, Japanese 30,000), *Nikolsk* 40,000 and *Habarovsk* 30,000.

The following were the mortality figures at Vladivostock:

April 9 to May 20 . . . . .	286
May 21 to May 25 . . . . .	81
May 26 to June 14 . . . . .	102
June 15 to Oct. 15 . . . . .	<u>48</u>
Total . . . . .	517

Two cases of bubonic plague were seen—one on July 10th, the other on Aug. 10th. Five infected rats were found on July 23rd and two on Aug. 10th. It would be interesting to know how widely the rats were infected. Dr Popoff was poisoned the following October by his political enemies, and died.

### 12. INFECTED LOCALITIES IN SHANTUNG AND CHIHLI.

(a) *Sangyuan District*. About the middle of February, after the plague had made some progress in Harbin, the startling news came from south Chihli and the adjoining Sangyuan district of Shantung that many deaths from pneumonic plague had been detected in the villages. Medical assistance was rushed to the spot from Peking and Tientsin, including Chinese, American and French doctors. From Dr C. W. Young's investigations, it appeared that a man Chang living at Chang Chia Wa village visited Tientsin about Feb. 1st to buy a trousseau for his daughter, and died on the 4th soon after his return. His whole family of eight caught the infection and died; altogether 40 persons fell victims in this village, every one traceable to Chang. Another man Wang visited the locality, returned to his home at Sangyuan on the Tientsin-Pukow Railway and infected his whole family, all of whom died except a small boy. Other families were also infected leading to about 120 deaths. The railway was practically stopped for some time, and only the express-trains to Shanghai

ran. With later improvement, the service was extended, but the trains avoided the infected districts. The plague continued throughout April, and the last case was reported early in May. The usual train service was resumed on May 6th. Altogether 200 persons died of plague in these parts.

(b) *Chefoo and District*. On May 4th, Chefoo was startled on hearing that the Russian Volunteer Fleet steamer *Kishinev*, just arrived from Vladivostock, had two cases of plague on board. The Port Health Officer, Dr Malcolm, who examined the passengers found that one patient died soon after the steamer left Vladivostock, and the second a short time before arrival at Chefoo. Nearly 200 deck passengers were on board. There being no quarantine station ready, the vessel was isolated with all on board. Five more deaths occurred during the next two days, and by the 10th 16 had died, all from pneumonic plague. A deserted spot, Kentucky Island near Chefoo was found, where the survivors were landed, mat-sheds were hastily erected and food was brought ashore. One hundred and eight of the contacts escaped on the 5th leaving only four, and this produced a panic in the city. Fortunately, no further cases were reported. On June 8th the British steamer *Ralph Moller* reached Chefoo from Vladivostock, and reported three deaths from plague on the voyage. The passengers, numbering about 700, were removed to Kentucky Island, this time better fitted for the purpose. H.M.S. *Marazion* and two submarines stood on guard, searchlights were thrown on the island at night, thus preventing any one from escaping. The quarantine period having expired without mishap, the passengers were liberated. Strict measures were enforced in Chefoo city, but no local cases developed. In the meantime, five deaths had happened up to May 24th in a neighbouring village, *Ninghai*, ten miles east of Chefoo. These were traced to one man who escaped from the island on May 5th. There was no further incident, and the Chefoo outbreak closed with a mortality of 24.

(c) *Tsingtao*. The British steamer *Kiangsi* from Vladivostock and Shanghai arrived at Tsingtao on June 4th with a case of pneumonic plague on board. This was followed on the 7th by the death of the mother from the same disease. No more cases were reported at Tsingtao.

#### D. APPROXIMATE EXPENDITURE ON ANTI-PLAGUE WORK.

During this last epidemic, the expenditure was much less than in 1910-11, when it amounted to eight million dollars. So far as I can ascertain the following sums were expended at different places in 1920-21:

Sum expended	Source	Authority	Locality spent
\$300,000	Canton Customs surplus	Ministry Interior	Sangyuan district
¥170,000	S. Manch. Railway	Japanese	Along S.M.R.
\$20,000	Mukden Governor	Governor	Fengtien
\$80,000	Customs	Ministry Interior	Changchun district
\$200,000	C. Eastern Railway	Management	Along C.E.R.
\$100,000	Harbin Munic.	Municipality	Harbin district
\$50,000	Manchouli	"	Manchouli
\$40,000	Dalainor mines	Management	Dalainor
Total about \$960,000.			



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The Director of the North Manchurian Plague Prevention Service received £150,000 from the Customs for operations in N. Manchuria. The Service itself only spent \$38,000 out of this sum.

Accounts are as follows:

Received from Customs . . .	\$150,000.00	Paid out to Harbin Taoyin . .	\$60,000.00
"    "    Heilung. Governor	1,000.00	"    "    Heilung. Governor	20,000.00
"    "    Miscellaneous		"    "    Kirin Governor . .	20,000.00
sources . . . . .	518.50	"    "    Plague Prevention	
		Service . . . . .	37,717.85
		Balance left with Customs	
		accountant . . . . .	13,800.65
Total . . . . .	<u>\$151,518.50</u>	Total . . . . .	<u>\$151,518.50</u>

Grand total for whole epidemic \$1,111,518.50.

### E. CHINESE REFUGEES FROM URGA.

Early in February 1921, we received urgent requests from the civil and military authorities to aid ten thousand destitute Chinese refugees who were returning to China after the sack of Urga by the mad Baron Ungern and his hordes. As the plague was then at its height at the principal stations through which these people would pass, it was most essential not only to provide suitable cars but also to make all sanitary arrangements so as to prevent any possible infection. There would be no quarantine, provided the refugees were confined in the cars under proper escort, when the trains stopped at the various stations. Our Medical Officers at Manchouli, Buketu, Hailar, Tsitsihar and Harbin were instructed to take every precaution and to affix a seal upon the right sleeve of each person for identification. About fifteen trains were used altogether, food being provided them by the Chinese government at different places. The Russian and Japanese railway authorities co-operated heartily in this rescue work, and although the evacuation took over one month to complete, no mishap occurred, and the refugees reached their several homes without introducing one case of plague.

The following numbers were passed at Manchouli:

March 22 . . . . .	1278
"    29 . . . . .	1174
"    30 . . . . .	1548
April 3 . . . . .	1728
"    8 . . . . .	1328
May 8 . . . . .	79
"    15 . . . . .	1517
"    19 . . . . .	1267
Total . . . . .	<u>9919</u>