

The St Kilda boat cough under the microscope

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ABSTRACT The inhabitants of St Kilda, a remote archipelago in the Outer Hebrides, suffered from outbreaks of a respiratory tract infection known as the boat cough every time strangers visited their isolated community between the seventeenth and nineteenth centuries. This condition has always been labelled influenza, but a review of contemporary records and modern microbiological evidence strongly suggests the illness was due to rhinovirus.

KEYWORDS Boat cough, Hebrides, Hirta, influenza, rhinovirus, St Kilda

DECLARATION OF INTERESTS No conflict of interests declared.

Published online August 2008

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INTRODUCTION

'There are few questions connected with the science of medicine involved in greater obscurity than the origin of contagious diseases.' – John Morgan¹

'Yet the Scots purchased all these (the Hebrides) with their ready money of the Norwegians as if they had been the very buttresses or pillars of the Kingdom.' – William Camden²

St Kilda is a remote, inaccessible archipelago in the Hebrides, and was occupied by a small community for perhaps 2,000 years until it was evacuated as a non-sustainable society in 1930. The community did not have electricity, sewerage or running water by the time of the depopulation. For centuries the islanders' diet was predominantly seabirds and seabird eggs, some fish and limited supplies of fruit and vegetables. There were intermittent episodes of malnutrition.

Prior to the advent of steamships, Hirta, the main island, had only a few visitors each year. The small rocky harbour usually offered limited protection to sailing vessels, except on the infrequent days of light winds and good weather. The St Kildans' contact with the wider world and its contagious diseases was very limited. They remained a society with low herd immunity, and therefore very susceptible to common infections, such as an outbreak of smallpox in 1727 that killed most of the community.³

The islanders did not have the healthcare professionals that were available even in small communities throughout Scotland. The best-known medical problem of St Kilda was the tragedy of neonatal tetanus, which caused the death of two out of three babies for some 150 years,^{4–6} but there were also other health issues specific to St Kilda.

ORIGINAL REPORTS OF THE BOAT COUGH

The St Kildans complained of the inevitable onset of an acute respiratory illness with a severe predominating cough, which developed shortly after the first arrival of the year and often recurred with subsequent visits of travellers. The native Gaelic speakers of St Kilda called it *cnatan-na-gall*, or the strangers' cough; visitors to the archipelago called it the boat cough. Martin Martin MD visited the island in 1697 and was the first to record details of this boat cough. He wrote: 'They [the islanders] contract a cough as often as any strangers land and stay among them, and it continues for some eight or ten days; they say the very infants on the breast are affected by it.'⁷

In 1705 the Church of Scotland sent the Reverend Alexander Buchan as minister to St Kilda, where he lived until his death in 1730. His book, *A Description of St Kilda*, was based on notes taken during his time as minister. The notes were in part his own observations and in part a repeat of Martin's book, and were collected and published by his second daughter.⁸ Buchan, clearly quoting from Martin, wrote: 'The inhabitants here contract a cough sometimes, when Strangers come among them and stay for any Time, which continues some 8 or 10 days; with this the infants upon the Breast are infected, as has been observed.'

The Reverend Kenneth Macaulay, the great uncle of Lord Macaulay, the eminent poet, historian and member of parliament, went to St Kilda as its minister in 1758. One of his assignments was to evaluate the claims of a boat cough, and he approached this story initially with scepticism. The islanders told him that they developed a cough upon the steward's landing, that they produced large amounts of phlegm and that the cough was more troublesome at night. Their condition lasted 10–14 days, and they claimed to be cured by their gibben or fowl fat. Macaulay was unimpressed with their complaint:

I told them plainly that I thought all this notion of infection was but a mere fancy, and that at least it could not always hold; at which they seemed offended, saying that never any, before the minister and myself, was heard doubt of the truth of it, which is plainly demonstrated upon the landing of every boat.⁹

For confirmation the islanders told Macaulay that even breastfeeding infants developed the cough, which could not be an affectation. Macaulay's testament clearly distinguishes between the boat cough and neonatal tetanus, hence Martin's and Buchan's story of a cough in infants cannot be seen as possible early evidence of tetanus. Macaulay related his experience as follows:

When I landed, all the inhabitants, except two women in child-bed enjoyed perfect health and continued to do so for two days. I began to conclude, with pleasure, that my visit would do them no injury. On the third day after I landed, some of the inhabitants discovered evident symptoms of a violent cold, such as hoarseness, coughing, discharging of phlegm, etc. and in eight days, they were all infected with this un-common disease, attended in some with severe head-achs and feverish disorders.⁹

Macaulay noted that once this epidemic had resolved it did not recur without further visitors, 'though we had frequently assembled upon the occasion of divine service, yet neither young nor old amongst us did so much as once cough more'.

Macaulay observed that the disease was not seasonal or limited to specific months but occurred shortly after the steward's arrival, whenever that might be. He remarked that the present steward's brother, a fellow clergyman 'and a man of veracity and learning' saw islanders 'seized with this cold three different times, upon the landing of his father's boat, in the space of eight weeks'. Macaulay noted the islanders' claim that the disease could also occur following the arrival of packages of foreign goods, although a ship with sailors must have arrived to deliver the goods. Macaulay related the following anecdote:

Mrs. McLeod, a native of Skye, and widow of the late minister of St Kilda, confirmed to me by herself and others: For three years after she went to the island she escaped the general infection; but afterwards being as it were, in some measure, becoming a native of the place, she was seized with it annually during her stay in the island.⁹

Samuel Johnson, the renowned English literary figure, met Macaulay during his celebrated *Journey to the Western Islands of Scotland* with James Boswell in 1773.¹⁰ Macaulay was then the minister in Nairn. Johnson initially complimented Macaulay on his book *The History of St Kilda* and described it as a 'very pretty piece of



FIGURE 1 Village Bay on Hirta, where the arrival of a boat required eight to ten men to walk out into the cold water to assist with the landing. (© istockphoto.com/Gannet77)

topography'. However, Johnson was unimpressed by Macaulay's intellect, suspected that he was not the author of the book and ultimately regarded him with contempt. Johnson is reported to have said that Macaulay was 'as obstinate as a mule and as ignorant as a bull, an example of the ignorance of the Scottish clergy'. While Johnson thought Dr John Macpherson, the minister of Sleat, had written the book, he accepted that Macaulay had collected the information. Johnson thought Macaulay approached the boat cough story with prejudice against the possibility, but was obliged to admit its truth.

In 1773, the year of Johnson's visit to Scotland, the concept now recognised as droplet infection from respiratory secretions was expressed by Benjamin Franklin, the eighteenth-century American printer, author, diplomat, scientist and president. In a letter to the physician and statesman Benjamin Rush, Franklin wrote:

I have not seen Dr. Cullen's Book [William Cullen, President of the RCPE] But am glad to hear that he speaks of Catarrhs or Colds by Contagion. I have long been satisfy'd from Observation, that besides the general Colds now termed Influenza's, which may possibly spread by Contagion as well as by a particular Quality of the Air, People often catch Cold from one another when shut up together in small close Rooms, Coaches, &c. and when sitting near and conversing so as to breathe in each others Transpiration, the Disorder being in a certain State. I think too that it is the frowzy corrupt Air from animal Substances, and the perspired Matter from our Bodies, which, being long confin'd in Beds not lately used, and Clothes not lately worne, and Books long shut up in close Rooms, obtains that kind of Putridity which infects us, and occasions the Colds observed upon sleeping in, wearing, or turning over, such Beds, Clothes or Books, and not their Coldness or Dampness.¹¹

The Reverend Neil Mackenzie kept records while he was the minister on St Kilda between 1829 and 1843, and noted that four islanders died of the boat cough

between 1830 and 1839.³ He stated the islanders' belief that they acquired the cough when the boat came from Harris. Mackenzie attributed this to the fact that 'the natives stand round exposed to the weather in a way to which they are not accustomed. During that time also they partake of a good deal of spirits, of which they seldom partake at any other time... the wonder would be if they escaped a cold.' Mackenzie also observed their susceptibility to other infections: 'When hooping cough, measles, or scarlet fever visit the island, there are more than the average number of deaths.'³

John Morgan, a member of the Royal College of Physicians of London, visited St Kilda during a cruise among the Western Islands in June 1860. He also was initially doubtful about the story of the boat cough, but rapidly changed his mind on finding the whole population was already suffering from this condition at the time of his arrival. 'The illness had commenced two days after a visit by *HMS Porcupine*, commanded by Captain Otter RN in 1860, and affected nearly the entire population. Morgan recorded that the illness began with a cold sensation, pain and stiffness in the muscles of the jaw, aching in the head and bones and great lassitude and depression, like the ordinary symptoms of catarrh, but in an aggravated form, followed by a discharge from the nose, a rapid pulse and a severe cough, which was particularly harassing during the night.

Morgan wrote: 'One of the most remarkable peculiarities... was the extent to which the whole population appeared to be affected... the short hacking cough heard on every side resembled the monotonous and gloomy sounds which issue from the wards of a consumption hospital.'¹ He reviewed the records of the Rev. Mackenzie and noted the comment that 'the natives are almost always attacked by influenza after the arrival of a boat from the long island [Harris].'

Morgan noted that the arrival of a boat required eight to ten men to walk out into the cold water of Village Bay (Figure 1) to assist in the landing, and that some attributed the cough to this exposure. He thought the condition, which he described as attacks of influenza, to be more prostrating than the normal catarrh and that haemoptysis was an occasional occurrence. Morgan wondered about the nature of contagious disease and observed astutely: 'That susceptibility to certain contagious diseases has a natural tendency to increase, and the diseases themselves, when they do appear, to prove more malignant in proportion as their outbreak is the longer delayed.'¹

George Seton, a traveller and author, visited the archipelago in 1876. He added some more specific clinical details: 'Another remarkable malady which occasionally prevails among the inhabitants of St Kilda is a species of influenza, locally termed "boat cough".¹² The islanders told Seton that the problem was more severe

when visitors came from Harris rather than Glasgow or more distant ports, although Seton noted the cough also occurred after a visit by an Austrian crew. Seton wrote that young babies could suffer from the boat cough and noted the theory that the cold water of Village Bay could cause the condition, but thought this unlikely as the inhabitants were often exposed to cold water when there were no visitors. He noted the suggestion that it was a more common affliction when the winds were easterly – the wind direction most favourable for a landing in St Kilda. Seton thought tuberculosis was rare, with only two of 132 recorded deaths being due to the condition, so he described the boat cough as 'influenza'.

C. MacDonald, from Beith in Ayrshire, provided the most significant clinical contribution to the story of the boat cough. He was the medical officer of health for the County of Ayr, and visited St Kilda in June 1885. MacDonald was the only doctor recorded as auscultating the chest of an islander suffering from an episode of the boat cough and the only contemporary witness to describe a prolonged cough:

When any stranger lands there, the natives immediately contract an affection of the nature of influenza... in severe cases there is marked fever... In a few days these unpleasant symptoms usually disappear, except the cough which in some cases lasts for weeks. In mild cases the patient merely suffers from a cough for a few days.¹³

MacDonald wrote that in the past, with infrequent visits, that is, during the era of sailing vessels only, the boat cough would invariably follow the arrival of the first annual visitor at the start of summer, and also follow any subsequent visit in the same year when there was a long interval between visits. However, with the development of steamships and more frequent visits over more months of the year, the situation changed, perhaps due to the development of acquired immunity. MacDonald wrote: 'They [the St Kildans] do not now all suffer when strangers go there within short periods.'¹³ When he arrived, 'almost every person on the island was suffering from a cough', following the visit of a party on board a steamer. MacDonald stated: 'I examined the chest of a few of them, and I could hear the moist rales of bronchial catarrh in one or two of the worst cases.'

The Reverend Mackay, who arrived in St Kilda in 1866, believed the island air was very pure and attributed the illness to the introduced impurities in the atmosphere. MacDonald noted that, although the minister was unaware of germ theories and microorganisms, his concept was not far from correct. MacDonald wrote: 'The atmosphere in St Kilda is free from a number of disease-causing organisms, which are rife in other parts, where the inhabitants are more or less inured to them... consequently they [the St Kildans] suffer as a rule when

exposed to them.¹³ These insights into immunity were ahead of their time, as was MacDonald's objective statement that 'as no medical man has stayed longer on the island than during the short periods boats usually anchor in its somewhat unsafe bay, all our information regarding the *trismus neonatorum*⁴ and the "strangers' cold" must still be considered unsatisfactory'. In summary, MacDonald described an infection that caused lower respiratory tract signs and a cough that was not usually prolonged, and apparently generated a degree of immunity with frequent exposure.

MODERN MICROBIOLOGY OF ACUTE RESPIRATORY TRACT INFECTIONS

The aetiological agent of acute bronchitis can be difficult to establish, even in a modern pathological laboratory, and identification is achieved in only a minority of cases. Only 29% of 42 episodes in one study¹⁴ and 16% of 113 patients in another study¹⁵ had identified organisms.

Most cases are due to the following viruses:

- Influenza A and B
- Parainfluenza
- Coronavirus (types 1–3)
- Rhinovirus
- Adenovirus
- Respiratory syncytial virus
- Human metapneumovirus

The following bacterial pathogens that cause pneumonia can also cause acute bronchitis:

- *Streptococcus pneumoniae*
- *Haemophilus influenzae*
- *Staphylococcus aureus*
- *Moraxella catarrhalis*
- *Mycoplasma pneumoniae*
- *Chlamydophila* (formerly *Chlamydia*) *pneumoniae*
- *Bordetella pertussis*
- Gram-negative bacilli

Heikkinen¹⁶ reviewed the common cold, and the estimated annual proportion of colds caused by the most common viruses is as listed below:

- Rhinovirus: 30–50%
- Coronavirus: 10–15%
- Influenza viruses: 5–15%
- Respiratory syncytial virus: 5%
- Parainfluenza: 5%
- Adenovirus: <5%
- Enteroviruses: <5%
- Metapneumovirus: unknown
- Unknown: 20–30%

Previous reviews of the boat cough condition have not attempted the challenging concept of identifying the infecting organism. The infection was colloquially labelled influenza by several primary sources and doctors, but that



FIGURE 2 Men during their 'Parliament' on Main Street, Hirta, in 1886. Note the bare feet. (© Bob Charnley Collection; reproduced with permission of the Sunnyfield Collection, www.sunnyfield.co.uk)

does not necessarily mean the virus influenza A or B. Pathology testing and radiology were not available. A medical examination of the chest for pulmonary signs was only once performed.¹² It is not known for certain if those affected had a fever or not, nor what proportion had pneumonia. Fever is a relatively unusual sign in acute bronchitis and, when accompanying cough, suggests either influenza or pneumonia. Presumably the deaths on St Kilda ascribed to the boat cough were due to the development of pneumonia.

The pathogen (or pathogens) causing the boat cough was a microorganism with a short incubation period, perhaps three days, causing an acute illness lasting some 10–14 days, but not longer, with occasional deaths. It spread rapidly among both adults and children in a small community and did not give immunity to a subsequent exposure only a few weeks later. The immunonaive population of St Kilda may have developed symptoms to circulating viruses that could have been asymptomatic in the mainland population. The viral load is generally higher in symptomatic individuals, increasing the risk of transmission to the non-infected inhabitants of St Kilda.

A nineteenth-century photograph of the adult males during their 'Parliament' in Main Street on Hirta (Figure 2) shows them to be warmly dressed. However, many of them had bare feet, which seems surprising in the cold climate but may be explained by the suggestion that they had prehensile toes, more helpful for climbing without shoes. A 2005 study by Johnson et al.¹⁷ to test the hypothesis that acute cooling of the feet causes the onset of common cold symptoms may be relevant in this context. The study involved 180 students: 90 had their feet chilled in cold water for 20 minutes; 90 students, whose feet were not chilled, were a control group. The study measured the subjects' self-reported cold symptoms and their belief that they had a cold, but not whether an actual respiratory infection developed.

The chilled group had twice as many colds over the next five days.

Johnson et al. proposed that when colds are circulating in the community some people carry the virus without symptoms and that chilling the feet causes a constriction of blood vessels in the nose that inhibits the immune response and defences in the nose, allowing the virus to replicate and cause cold symptoms. Those people with chilled feet believe they have caught a cold, but in fact the virus was already present in the nose, though not causing symptoms.

It is also possible that the individual visitors to St Kilda may have been carrying different microorganisms, so that the boat cough was due to more than one microorganism with a short incubation period, for example rhinovirus plus coronavirus. Perhaps 25% of individuals with upper respiratory infections presenting to medical practitioners have co-infections with more than one virus. In 1965, Portnoy¹⁸ found 38% of children with lower respiratory disease showed serological evidence of concomitant viral infection.

Beckham,¹⁹ using the more modern techniques of reverse transcription-PCR (polymerase chain reaction), tested patients with exacerbations of chronic obstructive pulmonary disease. A virus was identified in 81 illnesses in 96 patients suffering from 196 acute respiratory infections. In seven cases (8.6%), there was dual viral infection (DRVI), involving four picornaviruses, four parainfluenza viruses, four coronaviruses and one each of respiratory syncytial virus, adenovirus and influenza B.

Drews²⁰ reviewed eight prospective epidemiological studies using PCR, cell culture and serology, conducted between 1991 and 1995 for DRVI. Two viruses were identified as the cause of 67 (5.0%) of 1,341 acute respiratory virus infections. Picornavirus combinations with one other virus were 33 of the 67 DRVIs, and the most common second virus was one of adenovirus, influenza and coronavirus.

Another possibility is that the infection on St Kilda may have been due to a pathogen as yet unknown to medical science. Potential microorganisms causing the boat cough are reviewed below and classified as excluded, possible and probable.

Excluded microorganisms

Even today in cases of respiratory infection, no sign or symptom can reliably identify patients with definite bacterial infection, or those who would benefit from antibiotics. However, some microbiological agents, particularly most bacterial infections, would appear to be excluded by the short incubation period of the boat cough. Long incubation periods occur with:

- Legionnaire's disease: 2–10 days
- Pertussis: 7–10 days
- Mycoplasma: 1–4 weeks
- Chlamydia pneumonia: 3–4 weeks
- Tuberculosis: 4–8 weeks, or up to many years

Legionella pneumophila was not known to exist during the seventeenth to nineteenth centuries. It was identified in 1977 following an outbreak of a mystery disease among delegates attending the 1976 American Legion convention in Philadelphia in which 221 persons sickened, with 34 deaths. The disease is usually transmitted as an aerosol generated by shower-roses or from the water cooling towers of air-conditioning units. The other common microorganism causing current outbreaks of legionnaire's disease, *Legionella longbeachae*, can contaminate soil or potting mix, but would not be associated with the arrival of strangers.

Bordetella pertussis and *B. parapertussis* can cause acute upper respiratory symptoms with substantial morbidity and mortality, as occurred for example in the inhabitants of the Pacific Islands following the arrival of European explorers, but the incubation period is longer than that seen with the boat cough and both bacteria can cause a chronic cough persisting for several weeks. *B. pertussis* may account for about 1% of cases of acute bronchitis, but has been found by Nennig to be the cause in 12% of adults with an illness marked by a prolonged cough.²¹

Mycoplasma pneumoniae is a relatively common infection in young adults and causes constitutional symptoms with pharyngitis, as well as a severe cough that may persist for up to four to six weeks. An upper respiratory tract infection is the most common clinical picture, but severe pneumonia can occur.

Chlamydia pneumoniae can cause pharyngitis, laryngitis and bronchitis, with symptoms such as hoarseness and a low grade fever, but is an uncommon cause of acute upper respiratory illnesses. In a study of 63 college students with acute bronchitis, *C. pneumoniae* was responsible in 5%.

Tuberculosis was well recognised in the boat cough era as a very different chronic and often fatal illness. The incubation period can be very difficult to ascertain and may be months to years. The boat cough, however, was a rapid onset, short duration illness totally unlike pulmonary tuberculosis.²²

Possible microorganisms

Short incubation periods of between one and three days are seen with:

- Influenza A and B viruses
- Pneumococcus
- Respiratory syncytial virus

- Parainfluenza viruses
- Human metapneumoviruses
- Enteroviruses

Respiratory syncytial virus (RSV), human metapneumoviruses and parainfluenza viruses are very much diseases of childhood, with increasing immunity among adults. Metapneumovirus may not have existed before 1958. Parainfluenza viruses and RSV predominantly affect the immunosuppressed rather than the immunonaive adult.

Influenza merits special consideration as a cause of the boat cough among the microorganisms that cause acute bronchitis, because it has always previously been considered the probable cause and because of its clinical similarity and morbidity. Characteristic features include cough, purulent sputum fever and constitutional complaints during the influenza season. Immunocompetent individuals, however, should develop acquired immunity to the prevailing strain, and the influenza virus should not undergo the rapid mutation or antigenic drift that caused the three outbreaks in eight weeks documented by Macaulay.⁹

The incubation period of pneumococcal infection is compatible with the boat cough, and different serotypes can cause recurrent infections in a short time frame. However, the introduction of pneumococcus to an immunonaive community would surely result in a more severe disease, especially among children, causing pneumonia and meningitis with a much higher mortality. Pneumococcal meningitis usually arises in the context of sustained bacteraemia and has a mortality rate of 20–30%.

The enteroviruses are second only to the ‘common cold’ viruses, the rhinoviruses, as the most common infectious viral agents in humans. They can be spread by respiratory secretion droplets, but, unlike the St Kildans, most clinically infected individuals do not develop clinical illness and many of those who do develop a skin rash. Infection is most frequent in summer and autumn. Myocarditis is a rare complication.

Probable microorganisms

Short incubation periods of between one and three days are seen with:

- Rhinoviruses
- Coronaviruses
- Adenoviruses

Adenovirus infections cause illness of the respiratory system, but are usually associated in some of the victims with a rash, gastroenteritis or conjunctivitis, symptoms not mentioned in the original reports.

Coronavirus infection can cause upper respiratory tract disease. Apart from the SARS strain it does not usually

cause lower respiratory tract infections. Coronavirus can cause gastrointestinal symptoms and can be transmitted to other mammals and even birds. Again, these features are not noted in original reports on St Kilda, even though the islanders kept cattle in their homes during the winter. Coronaviruses do not cause colds as often as rhinoviruses, and tend to cause colds in humans primarily in the winter and early spring seasons. Winter exposure to strangers and external pathogens, however, was very uncommon on St Kilda. The true frequency of human coronaviruses is hard to assess as they are difficult to grow in the laboratory.

Rhinovirus

The rhinovirus and the enterovirus are members of the picornavirus family, which has nine distinct genera of non-enveloped, positive-stranded RNA viruses with an icosohedral capsid. The rhinovirus genus is one of the most important and frequent. Although rhinovirus in the past has been seen as only causing mild head colds with nasal congestion as a common symptom and cough as an infrequent one, occurring in perhaps 30%, modern medical research indicates cough as a more frequent symptom and supports the concept of rhinovirus as the most likely cause of the boat cough:

- Rhinovirus is the most common cause of upper respiratory infections by a large margin, and can cause recurrent infections in a short space of time.^{23,24}
- Contrary to past concepts, rhinovirus does cause lower respiratory tract infections. No other virus with a short incubation period causes more frequent coughs.^{23,24}
- Rhinovirus generates large quantities of sputum.²⁶
- Rhinovirus can cause pneumonia and fatal infections.^{24,26,27}

Human rhinoviruses (HRV) are the most common worldwide infective viral agents in humans, and the most frequent cause of the common cold. Adults usually experience one proven rhinovirus infection per year, whereas in children it is a more frequent condition. Traditionally, rhinoviruses were believed to be responsible for approximately 30–50% of all cases based on viral cultures, but improved detection techniques including reverse transcription-PCR suggest the true rate is higher. Rhinovirus has been perceived as causing only upper respiratory tract infection. However, pneumonia and death have been reported. Immunocompetent subjects can clear HRV within ten days, the usual duration of an episode of boat cough on St Kilda, but clearance is delayed in the immunosuppressed. Asthma patients have relative immunosuppression with impaired T-helper cell type I and interferon responses, leading to HRV infection and exacerbations of asthma.

Arruda²³ tested 346 individuals with self-diagnosed cold in autumn and found an overall rate of picornavirus

detection of 82%. The mean duration of symptoms in the HRV culture-positive patients was 11 days, compatible with the duration of the boat cough, although culture-negative patients had a similar duration of illness. Viral culture detected 224 cases of HRV and seven of enterovirus; PCR detected another 52 cases of picornavirus. Polymerase chain reaction could not distinguish rhinovirus from enterovirus. Coronavirus RNA was detected by PCR in five of the remaining 62 negative samples. Thus a cause for symptoms was found in 83% of cases, with 82% having picornavirus infection.

Nicholson²⁴ followed 533 elderly subjects over two winters, a total of 24,700 person weeks of observation, taking throat and nasal swabs during symptoms of respiratory infection for HRV reverse transcription-PCR, and paired blood samples for antibodies to adenovirus, influenza A and B, respiratory syncytial virus, coronavirus, *Mycoplasma pneumoniae* and *Chlamydia psittaci*. A total of 497 episodes occurred, with detection of pathogens in 43% of illnesses. Human rhinovirus was the most common, causing 107 infections in 96 adults or 52% of respiratory infections, followed by 28% with coronavirus, 9.5% with influenza A and B and 7% with RSV. Sixty subjects with HRV had lower respiratory tract (LRT) symptoms, symptoms lasted a mean of 16 days – twice the average duration for young working adults, 18 were confined to bed, 25 were unable to undertake normal household activities and one died. These disabling illnesses occurred in spite of 47% of subjects having had an influenza vaccination, and antibiotics being prescribed for 28 patients. Clearly, HRV was the most common cause of severe recurrent and persistent lower respiratory disease in these elderly subjects, even causing death despite modern antibiotics.

The boat cough is reported to be associated with profuse quantities of sputum. A paper by He et al.²⁵ examined the effect of HRV infection on mucin secretion from bronchial tissue and epithelial cells in vitro. Human rhinovirus infection was found to increase mucus production by 258% over the baseline secretion, making it one of the most potent known stimuli of mucus release from small airways.

Corne²⁶ studied 76 cohabiting couples where one partner was asthmatic and the other was not. Diaries of airway symptoms were recorded over three months, scored from one to three according to severity, and nasal secretions were tested fortnightly for HRV by reverse transcription-PCR. Upper respiratory symptoms were defined as coryza, blocked nose, sore throat, hoarse voice, headache, malaise, fever or myalgia, and LRT symptoms were defined as wheeze, cough, dyspnoea and chest tightness. Fifty-one subjects had one or more episodes of HRV infection. Human rhinovirus was found only marginally more frequently in nasal secretions of asthmatics (odds ratio 1.15, CL 0.71–1.87). However,

there was a significant difference in the association of LRT symptoms with the initial HRV infection. Of 28 asthmatics experiencing the initial HRV infection, 12 had LRT symptoms, compared with only four of 23 healthy partners ($p = 0.051$). The severity and duration of LRT symptoms were also worse in asthmatics.

Kaiser²⁷ screened 69 lung transplant patients with bronchoalveolar lavage and identified rhinovirus by PCR in ten patients either acutely or persistently infected for a total of 23 episodes. Three patients suffered relapsing pneumonia with graft dysfunction and in two of them the infection was due to the persistence of a single HRV strain. Two of these three died of graft dysfunction, and HRV was found to be the only infecting microorganism. Clearly, HRV can cause lower respiratory tract infection and death in the immunosuppressed patient.

Pappas²⁸ recorded signs and symptoms of young school children aged 5–12 with a common cold. Rhinovirus was the most common microorganism detected, being the cause of 46% of episodes. Cough was reported in 69%, and nasal congestion in 88%.

Calvo²⁹ assessed 85 hospital admissions of infants under the age of two with respiratory infections. Respiratory syncytial virus was the most commonly identified causal agent at 41.5%, closely followed by rhinovirus in 34.8%. In this hospitalised group, obviously with more severe disease, wheezing was found in 48.2% and bronchiolitis in 36.5%, but nasal symptoms and rhinorrhoea in only 8.2%. Even in the young, rhinovirus is common and cough may be a more common symptom than rhinorrhoea. Infectious episodes in St Kilda may well have been more severe than in a developed community today because of substandard housing, exposure to the elements, low herd immunity and a substandard diet with limited vitamin intake.

Development of immunity is limited and recurrent infection common as there are more than 110 serologic virus types that cause cold symptoms. Symptoms include sore throat, runny nose, nasal congestion, sneezing and cough; sometimes with the systemic effects of malaise, anorexia, myalgia and headache. Rhinoviral infection is most common in autumn in dense populations, but infection in an isolated community will relate more to exposure than season.

CONCLUSIONS

- The cause of the boat cough cannot be diagnosed with certainty, but even if more than one microorganism may have been responsible, rhinovirus would be the most frequent.
- Many infecting microorganisms can be excluded as the boat cough had an incubation period of two to three days.

- Other organisms can be excluded by the recurrence of episodes of the boat cough within eight weeks, the absence of very prolonged cough or the lack of associated gastroenteritis or rashes.
- Rhinovirus as the most common cause of recurrent upper and lower respiratory tract infections, with infrequent pneumonia and death, is the 'best fit' as the cause of the St Kilda boat cough.

REFERENCES

- 1 Morgan J. The diseases of St Kilda. *British and Foreign Medico-Chirurgical Review* 1862; XXIX:176–91.
- 2 Camden W. *Britannia*. London; 1586. Reprinted Bristol: Thoemmes Press; 2003. Available from: <http://www.philological.bham.ac.uk/cambrit>
- 3 Mackenzie JB. Antiquities and old customs in St Kilda, compiled from notes made by Rev Neil Mackenzie, Minister of St Kilda 1829–43. *Proc Soc Antiq Scot* 1905; 39:397–402. Available from: http://ads.ahds.ac.uk/catalogue/adsdata/PSAS_2002/pdf/vol_039/39_397_402.pdf
- 4 Stride P. St Kilda, the neonatal tetanus tragedy of the nineteenth century and some twenty-first century answers. *J R Coll Physicians Edinb*; 38:70–77.
- 5 Maclean C. *Island on the edge of the world*. Edinburgh: Canongate; 2006.
- 6 Randall J, Walters E et al. *The decline and fall of St Kilda*. Lewis: The Islands Book Trust; 2006.
- 7 Martin M. *Description of the Western Islands of Scotland*. London: 1703. Available from: <http://www.undiscoveredscotland.co.uk/usebooks/martin-westernislands/index.html>
- 8 Buchan A. *A description of Saint Kilda*. Edinburgh: Lumisden and Robertson; 1732.
- 9 Macaulay K. *The history of St. Kilda*. London: Beckett and de Hondt; 1764.
- 10 Johnson S. *A journey to the Western Isles of Scotland*. Dublin: Leathley; 1775. Available from: <http://ebooks.adelaide.edu.au/j/johnson/samuel/western>
- 11 Franklin B. *The writings of Benjamin Franklin*. Vol. 3. London; 1757–75.
- 12 Seton G. *St Kilda, past and present*. Edinburgh; 1878. Reprinted Edinburgh: Birlinn; 2000.
- 13 MacDonald CR. St Kilda: its inhabitants and the diseases peculiar to them. *BMJ* 1886; 2:160–3.
- 14 Jonsson JS, Sigurdsson JA, Kristinsson KG et al. Acute bronchitis in adults: how close do we come to its aetiology in general practice? *Scand J Prim Health Care* 1997; 15:156–60.
- 15 MacKay DN. Treatment of acute bronchitis in adults without underlying lung disease. *J Gen Intern Med* 1996; 11:557–62.
- 16 Heikkinen T, Järvinen A. The common cold. *Lancet* 2003; 361:51–9.
- 17 Johnson C, Eccles R. Acute cooling of the feet and the onset of common cold symptoms. *Fam Pract* 2005; 22:608–13.
- 18 Portnoy B, Eckert HL, Hanes B et al. Multiple respiratory virus infections in hospitalized children. *Am J Epidemiol* 1965; 82:262–72.
- 19 Beckham JD, Cadena A, Lin J et al. Respiratory viral infections in patients with chronic, obstructive pulmonary disease. *J Infect* 2005; 50:322–30.
- 20 Drews AL, Atmar RL, Glezen WP et al. Dual respiratory virus infections. *Clin Infect Dis* 1997; 25:1421–9.
- 21 Nennig M, Shinefield H, Edwards K. Prevalence and incidence of adult pertussis in an urban population. *JAMA* 1996; 275:1672–74.
- 22 Vynnycky E, Fine PEM. Lifetime risks, incubation period, and serial interval of tuberculosis. *Am J Epidemiol* 2000; 152:247–63.
- 23 Arruda E, Pitkaranta A, Witek T. Frequency and natural history of rhinovirus infections in adults during autumn. *J Clin Microbiol* 1997; 35:2864–8.
- 24 Nicholson K, Kent J, Hammersley V. Risk factors for lower respiratory complications of rhinovirus infection in elderly people living in the community: prospective cohort study. *BMJ* 1996; 313:1119–23.
- 25 He S, Zheng J, Duan M. Induction of mucin secretion from human bronchial tissue and epithelial cells by rhinovirus and lipopolysaccharide. *Acta Pharmacol Sin* 2004; 25(9):1176–81.
- 26 Corne J, Marshall C, Smith S. Frequency, severity and duration of rhinovirus infections in asthmatic and non-asthmatic individuals: a longitudinal cohort study. *Lancet* 2002; 359:831–4.
- 27 Kaiser L, Aubert J, Pache J. Chronic rhinoviral infection in lung transplant recipients. *Am J Respir Crit Care Med* 2006; 174:1392–9.
- 28 Pappas D, Hendley J, Hayden F. Symptom profile of common colds in school-aged children. *Pediatr Infect Dis J* 2008; 27:8–11.
- 29 Calvo C, Garcia-Garcia M, Blanco C. Role of rhinovirus in hospitalized infants with respiratory tract infections in Spain. *Pediatr Infect Dis J* 2007; 26:904–8.