

# Hunting for Previous Coronavirus Pandemics Using Corpus Linguistic Analysis of 19<sup>th</sup> Century British Newspapers

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**Abstract:** COVID-19 is the first known coronavirus pandemic. Nevertheless, the seasonal circulation of the four milder coronaviruses of humans – OC43, NL63, 229E and HKU1 – raises the possibility that these viruses are the descendants of more ancient coronavirus pandemics. This proposal arises by analogy to the observed descent of seasonal influenza subtypes H2N2 (now extinct), H3N2 and H1H1 from the pandemic strains of 1957, 1968 and 2009, respectively. Recent historical revisionist speculation has focussed on the influenza pandemic of 1889-1892, based on molecular phylogenetic reconstructions that show the emergence of human coronavirus OC43 around that time, probably by zoonosis from cattle. If the “Russian influenza”, as *The Times* named it in early 1890, was not influenza but caused by a coronavirus, the origins of the other three milder human coronaviruses may also have left a residue of clinical evidence in the 19<sup>th</sup> century medical literature and popular press. In this paper, we search digitised 19<sup>th</sup> century British newspapers for evidence of previously unsuspected coronavirus pandemics. We conclude that there is little or no corpus linguistic signal in the UK national press for large-scale outbreaks of unidentified respiratory disease for the period 1785 to 1890.

Keywords: COVID-19; OC43; coronavirus; pandemic; influenza; historical revisionism; corpus linguistics

## Introduction

The article “Did a coronavirus cause the pandemic that killed Queen Victoria's heir?” by journalist Robin McKie (2020), which appeared in *The Observer* on 31<sup>st</sup> May 2020, presents an intriguing piece of historical revisionism. Ever since the late 19<sup>th</sup> century, it has been generally accepted that the pandemic of respiratory illness that occurred between 1889 and 1892, was caused by influenza. *The Times* first referred to it as “the Russian influenza” on 6<sup>th</sup> January 1890 and the official death toll by the end of 1892 in the United Kingdom was 110,000 (Honigsbaum, 2011), slightly under half the number of deaths that occurred in the UK during the so-called “Spanish flu” pandemic of 1918-1920 (Arnold, 2018). Samples derived from the graves of pandemic victims in 1918 prove beyond doubt that they died from influenza subtype H1N1 (Taubenberger et al., 1997). However, similar samples from the early 1890s have so far been unobtainable, leaving open the possibility that the causative agent of that previous pandemic was something other than influenza. McKie’s article draws attention to one of the most famous victims of the “Russian flu” - the Duke of Clarence, second in line to the throne whose illness was first reported by *The Times* on 11<sup>th</sup> January 1892:

*We regret to announce that the Duke of Clarence and Avondale, who is with the Prince and Princess of Wales at Sandringham, is suffering from a severe attack of influenza, accompanied by pneumonia. A telegram last evening from Sandringham states that his Royal Highness's strength is well maintained. Dr. Laking [see footnote<sup>1</sup>] has been at Sandringham since Saturday. All the Duke's engagements have, of course, for the present been cancelled. His Royal Highness's 28th birthday was celebrated at Sandringham by a dinner party on Friday.*

The following morning *The Times* observed that “a large number of the Prince of Wales's household are down with influenza”. Reports on the health of the Duke were initially optimistic: his temperature had returned to normal, he had slept. However, by the following day – the 13<sup>th</sup> - the descriptions of the Duke's condition had become a little more ambiguous. A drop in the stock market was blamed on nervousness concerning the effect the Duke's illness might have on the line of succession. The next day's early editions described the Duke as “almost in the jaws of death”. By the time these papers were being read, he was already dead.

Retrospective diagnosis is always difficult, especially at historical distances of time, and there are many pathogens that could have produced the pneumonia that killed the Duke. However, McKie's suggestion of coronavirus rather than influenza is not based purely on symptomology. Vijgen et al. (2005) produced the first complete genome of human coronavirus OC43 and dated its common ancestor with bovine coronavirus at 1873 (95% CI 1815-1899), using a maximum likelihood method. Bayesian phylogenetic estimation produced dates of 1890 (95% CI 1859-1912; coalescent model) and 1893 (95% CI 1866-1918; exponential growth model), respectively. Additionally, the period 1870-1890 saw mass culling of cattle due to an outbreak of infectious respiratory disease. If that disease was caused by bovine coronavirus, Vijgen et al speculate, then such culling provides an obvious candidate process for effective zoonosis of the common ancestor of bovine coronavirus and human OC43, from cattle to humans. A final piece of circumstantial evidence is provided by the observation that the “Russian flu” involved frequent neurological complications. This is not typical of influenza infection but is found in some OC43 patients (Jacomy et al., 2006; Riski and Hovi, 1980).

Defenders of the accepted theory that the “Russian flu” was influenza will, at this juncture, point to the evidence of seroarchaeology – the detection of antibodies against influenza in historically donated sera. Worobey et al. (2014) produced a comprehensive attempt to synthesize the findings of seroarchaeology with more recent advances in influenza genome sequencing, concluding that the evidence points towards influenza H3N8 as the cause of the “Russian flu”. This also explains the higher excess mortality from “Spanish flu” among those born in the late 1880s, since their principal exposure to influenza, especially during the crucial early childhood period, would have been to H3N8, giving them poor protection on the arrival of H1N1 in 1918. Older adults, by contrast, may have been exposed to previously circulating influenzas containing H1, N1 or both, and thus have been better prepared for “Spanish flu”. Furthermore, those survivors of “Russian flu” who lived long enough to see the “Hong Kong flu” pandemic of 1968, caused by influenza H3N2, had a lower mortality rate than younger individuals, providing a further piece of evidence for exposure to influenza H3 antigens in the 1890s.

Nevertheless, the evidence on both sides of the question remains circumstantial. In the absence of any clinical samples from “Russian flu”, a decision between one theory or the other depends largely on how one weights the importance of the various circumstances. Even if one rejects the candidacy of OC43 as a potential aetiological agent of the “Russian flu” pandemic, the possibility remains that

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<sup>1</sup> Sir Francis Henry Laking (1847-1914) has achieved considerable posthumous notoriety: <http://news.bbc.co.uk/1/hi/world/europe/3746596.stm>

the four seasonal coronaviruses of humans are indeed the descendants of more historically distant unidentified pandemics. Although it is important not to draw too many analogies between coronaviruses and influenza (an orthomyxovirus) – their common properties are virtually limited to the observations that they are respiratory, potentially fatal, highly infectious and have incubation periods of a few days – the inevitable annual return of seasonal influenzas H3N2 and H1N1, descended from the pandemics of 1968 and 2009 respectively, provides a persuasive model for the origins of the more irregular seasonal return of the four milder human coronaviruses.

If pandemics of respiratory disease occurred prior to 1890, they may have been remarked upon in the newspapers of the time. In this study, we perform a search of a digitized corpus of national and local British newspapers from the 19<sup>th</sup> century, using keywords indicative of coronavirus symptoms. We plot the occurrence of these keywords over time and identify years when they were significantly elevated ( $p < 0.05$ ). For candidate dates identified using the corpus linguistic method, we review the newspaper texts in question for further contextual information. For those instances where outbreaks of respiratory disease are described, we search the medical literature around those dates for the contemporary attribution of their cause.

## Methods

### Keywords

Based on clinical descriptions of COVID-19 (reviewed by Cevik et al., 2020), we identified the following keywords: 1) cough, 2) fever, 3) pneumonia. To avoid confusion with years when influenza pandemics may have occurred, we added 4) influenza and 5) epidemic.

### Newspapers

Newspapers and years searched were as follows: *Belfast Newsletter* (1828-1900), *The Era* (1838-1900), *Glasgow Herald* (1820-1900), *Hampshire & Portsmouth Telegraph* (1799-1900), *Ipswich Journal* (1800-1900), *Liverpool Mercury* (1811-1900), *Northern Echo* (1870-1900) *Pall Mall Gazette* (1865-1900), *Reynold's Daily* (1850-1900), *Western Mail* (1869-1900) and *The Times* (1785-2009).

Searches were performed using Corpus Query Processor (CQP; <https://cqpweb.lancs.ac.uk/>; Hardie, 2012). CQP's database is populated from the newspapers using optical character recognition (OCR), so for older publications in particular, some errors may be present (McEnery et al., 2019).

### Statistics

The occurrence of each of the five keywords was calculated per million words within the annual output of each publication, in CQP. The annual words per million for each keyword was determined over the total year range for each newspaper given above. Within those distributions, the top 1% of years for each keyword was determined, following Gabrielatos et al. (2012). These are deemed to be years when that keyword was in statistically significant usage at  $p < 0.05$  (Bonferroni correction applied: top 5% / 5 = top 1%). Collocates at range  $n$ , i.e. other words found at statistically significant usage, over random distribution, from  $n$  positions to the left to  $n$  positions to the right of the keyword – using default  $n=10$  throughout, unless specified - were calculated using the log ratio method in CQP.

## Results

Table 1 summarizes the years when each of the keywords achieved statistically significant usage at  $p < 0.05$ . When each year was examined in more detail it was found that keyword “cough” was prone to artefactual hits due to marketing campaigns for patent medicines, namely “Du Barry's Excellent Revalenta Arabica Food” in 1854, “Dr Locock's Pulmonic Wafers” in 1855, “Tamarind Cough Emulsion” in 1857, “Taylor's Cough Elixir” in 1876, “Powell's Balsam of Aniseed” in 1881 and 1886 and “Keating's Cough Lozenges” in 1860, 1879, 1880, 1886, 1887 and 1896. 1860 was a particularly intense year for

patent medicine advertising with “Gostling's Cough Balls”, “Smith's Sedative Cough Candy” and “Pectoral Cough Lozenges” also contributing to the statistical signal. These instances are deleted from Table 1. A “cough” signal from the year 1888 derived from accounts of the death of Emperor Frederick of Germany from throat cancer along with some marketing for throat lozenges, and has also been deleted.

Year	Influenza	Pneumonia	Cough	Fever	Epidemic	Comments
1790			1			whooping cough
1791			1			whooping cough
1792			1			whooping cough
1793			1			whooping cough
1804				1		yellow fever & typhus abroad
1817				1		typhus
1819				1		yellow fever, scarlet fever, measles & typhus
1832					1	cholera
1847				3		typhus
1848				1	1	typhus, scarlet fever
1849				1	3	cholera, typhus
1852				1		typhus, cholera, yellow fever
1853				1	2	typhus, cholera, yellow fever
1854					1	cholera
1865					2	typhus, cholera & a “Russian epidemic”
1866					2	cholera
1870				1		scarlet fever, typhoid, typhus, smallpox, diphtheria, yellow fever
1873			1			whooping cough
1876			1	1		scarlet fever, typhoid, diphtheria, yellow fever, whooping cough
1877				1	1	scarlet fever, typhoid, diphtheria, yellow fever, whooping cough
1878			1	1		scarlet fever, typhoid, diphtheria, yellow fever, whooping cough
1881				1		scarlet fever, typhoid, typhus
1884					1	cholera abroad, measles, sore throats, whooping cough, smallpox in India
1887				1		malaria, scarlet fever, typhoid, typhus, smallpox, diphtheria, measles

1890	7	1			6	Russian flu, typhoid, scarlet fever, typhus, diphtheria, cholera
1891	5			2	2	Russian flu, typhoid, scarlet fever, malaria, swine fever, typhus, smallpox, measles, yellow fever, diphtheria,
1892	9	2	1	1	9	Russian flu, typhoid, scarlet fever, malaria, swine fever, typhus, smallpox, measles, yellow fever, diphtheria, cholera, whooping cough
1893	2	1	2			Russian flu, whooping cough
1894			1	1		scarlet fever, typhoid, swine fever, whooping cough
1895	3		1	1		scarlet fever, typhoid, swine fever, influenza, whooping cough
1896			1	1	1	scarlet fever, typhoid, swine fever, whooping cough, measles, diphtheria
1899		2				pneumonia (S. Africa)
1900		8	1	3		swine fever (UK), typhoid, malaria, pneumonia (all S. Africa)
1901		1		1		typhoid, malaria, pneumonia (all S. Africa)
1902		1		1		typhoid, malaria, pneumonia (all S. Africa)
1918	1	1			1	Spanish flu, typhus, cholera
1919	1	1				Spanish flu
1957	1					H2N2 pandemic
2001					1	foot-and-mouth, measles, AIDS, influenza
2005	1					bird flu H5N1
2006	1					bird flu H5N1
2009	1					swine flu H1N1

**Table 1: Statistically significant occurrences of keywords.** The numbers refer to the number of newspapers in which that keyword was statistically significant at  $p < 0.05$  (after Bonferroni correction) for that year. Prior to 1799 and from 1901 onwards, all numbers are 1, since only *The Times* was available to be searched for those years. Years of acknowledged influenza pandemics are shaded in red, years of cholera pandemics in green and years when these two categories overlap in blue. Some acknowledged influenza pandemic years are absent from the table (1830-31, 1833, 1968) because there are no statistically significant hits to the five keywords.

We deal with each keyword in turn, listing the years when it achieved statistical significance at  $p < 0.05$  after Bonferroni (1936) correction and reporting their score in words/million. If that score is non-

significant, it is indicated in the text as “non-sig”. All scores without this indication can be assumed to be statistically significant. For some years, collocates – significantly associated words occurring within a window of 10 words, unless otherwise specified, on either side of the keyword - are also calculated and scored using their log ratio of actual to random incidence. For those who do not wish to read the detail for each keyword on a year-by-year basis, a summary is provided at the bottom of each keyword subsection.

## Influenza

It should be noted that statistical significance at  $p < 0.05$  for keyword “influenza” is not achieved for any years prior to 1890. However, since McKie (2020) and Vijgen et al. (2005) postulate that at least one ostensible influenza pandemic may have been in reality a coronavirus pandemic, all years when the distribution of keyword “influenza” showed a peak are considered, as well as the “official” influenza pandemic years specified by Worobey et al. (2014), namely 1830-1833 (see also Brown, 1835) and 1847-1850. The pandemic of 1830-1833 appears to have struck the UK in its later stages, in 1833, as judged by occurrences of keyword “influenza” (1.94 words/million, non-sig.). All but two of the occurrences are from the 16<sup>th</sup> April to the 24<sup>th</sup> June, for instance the following upbeat message on the 1<sup>st</sup> May 1833:

*The grippe, or influenza, coming from the east, is approaching us .... it is now said that there have been some cases here since yesterday morning. We do not fear it, however, as it is attended with little inconvenience, and no danger.*

Evidently not all were reassured, as on the 7<sup>th</sup> May, *The Times* felt the need to complain that “*The alarmists have begun to raise the most absurd and boundless apprehensions in the public mind on the subject of the present epidemic*”. On the 16<sup>th</sup> May, it was pointed out that things were much worse in France: “*It is calculated that there are at this moment about 100 000 individuals in Paris who are under the influence of this strong disorder.*” Annoyingly, the weather refused to make any difference as the epidemic had “*lately become very troublesome here, in spite of the truly beautiful weather and steady temperatures that we have been enjoying since the close of the last month*”. Such virulence during summer months is typical of a pandemic flu, and was seen in the H1N1 pandemic of 2009 (Uscher-Pines et al., 2013).

Although 1833 is a recognised pandemic year, mentions of keyword “influenza” peaked even higher in *The Times* in 1837 (4.85 words/million, non-sig.). However, in 1837, the distribution of occurrences differs. All but 12 mentions occur before the 30<sup>th</sup> May. Although the pattern in 1833 certainly suggests a pandemic, that in 1837 might represent simply a prolonged and severe seasonal outbreak or a “second wave” phase of the pandemic of 1833.

In 1847, influenza is mentioned at 1.14 words/million (non-sig.). Reports begin in the foreign news section on the 2<sup>nd</sup> December 1847: “*The influenza continued to spread in an alarming manner in Paris*” and by 13<sup>th</sup> December it was referred to as “*the prevailing epidemic*” in London, especially in “*the most unhealthy spots*” such as “*East London, Poplar and Camberwell*”. As Christmas approached *The Times* was also bemoaning “*the number of those who are at present incapacitated by influenza*”. The brunt of the epidemic in the UK appears to have occurred in 1848 when *The Times* has keyword “influenza” at 2.72 words/million (non-sig.), principally in January and February.

Nevertheless, in neither 1833, 1837 nor 1848 does the keyword “influenza” creep above the significance threshold. This is perhaps due to the elevation of that threshold by the extremely high number of mentions from 1890-1893 and 1895 (peaking at 21.0 words/million in 1892, although quite a lot of that coverage revolved around the unfortunate Duke of Clarence). After the “Russian flu”

pandemic, keyword “influenza” peaks again in 1900 in *The Times* (6.87 words/million, non-sig.). 193 deaths from influenza were recorded in London in the week ending 3<sup>rd</sup> January 1900, rising to 340 in the week to 17<sup>th</sup> January, declining a month later to 63.

**Summary:** the statistically significant signal for keyword “influenza” from 1785 to 1900 is dominated by the “Russian flu” pandemic and spans the years 1890-93 inclusive plus 1895. Nevertheless, smaller, non-significant peaks are observed for the other known pandemic years of 1833 and 1848. Among accepted non-pandemic years, 1837 and 1900 have peaks and indeed 1837 is higher than 1833. After 1900, statistically significant signals are observed for the “Spanish flu” in 1918 and 1919, for the “Asian flu” in 1957, for the “bird flu” scare in 2005 and 2006 and for the H1N1 pandemic in 2009. A non-significant peak is observable for “Hong Kong flu” in 1969. We did not examine the 20<sup>th</sup> and 21<sup>st</sup> century peaks in detail as they are all explicable by influenza pandemics for which clinical samples are available and there is no doubt that the causative agent was influenza and not a coronavirus.

### Pneumonia

The statistically significant peaks for keyword “pneumonia” overlap those of the “Russian flu” and “Spanish flu” years. A third significant peak in years 1899-1902 refers to the Boer war when many deaths from pneumonia were recorded among British troops. Keyword “pneumonia” presents a generally flatter distribution than influenza and, unlike influenza, there are no non-significant yet notable peaks. In particular, we note that there is no signal for a pneumonia epidemic independent of influenza, which might be potentially characteristic of a coronavirus.

**Summary:** With the exception of the Boer War years, keyword “pneumonia” only occurs at statistically significant levels during influenza pandemic years. There is therefore no evidence of a non-influenza pneumonia outbreak in the period from 1785 to 1890.

### Cough

The first statistically significant years for mention of keyword “cough” are from 1790-1793 in *The Times*, peaking at 10.9 words/million in 1792. These predominantly refer to whooping cough (spelled “hooping cough” in the 1790s), now known to be caused by *Bordetella pertussis*. In *The Times*, for the decade of the 1790s, the highest collocates at length 1 – meaning the words most commonly found to the immediate left and right of “cough” – are “hooping”, “violent”, “dreadful”, “continued”, “dry” and “bad”. Of these “hooping” is the most statistically significant with a log ratio of 18.5 over random co-occurrence.

The same disease, now spelled in the modern manner, resurfaces as a statistically significant signal for keyword “cough” in the *Hampshire & Portsmouth Telegraph* in 1873 with 6.64 words/million. The highest collocation at length 10 is “whooping” at log ratio 17.9. Three years later in 1876, the same newspaper also displays keyword “cough” at 5.79 words/million, reporting on the 15<sup>th</sup> April 1876 that the death rate in Portsmouth from “seven principal zymotic [i.e. infectious] diseases” is 8.3 per thousand over the previous 12 months – a total of 407 deaths, of which 143 are recorded as due to whooping cough. This would give whooping cough a mortality rate of 2.9 deaths per thousand per annum in the city of Portsmouth in 1876 (c.f. the UK death rate from COVID-19 to December 2020 of around 1.0 per thousand). Another two years later, in 1878, keyword “cough” surfaces again in the *Hampshire & Portsmouth Telegraph* at 12.8 words/million and once more “whooping” is the highest collocate at log ratio 16.9.

*The Times* shows statistically significant signals for keyword “cough” from 1892 to 1896 inclusive, partly overlapping the period of the “Russian flu”. The vast majority of these are advertising for cough

remedies. The remainder overwhelmingly refer to whooping cough at collocation log ratio 17.6. The same pattern is found in the *Ipswich Journal*, but restricted to 1893, and in the *Western Mail* in 1900.

**Summary:** once influenza pandemic years are removed, the statistically significant usage of keyword cough refers overwhelmingly to whooping cough. There is therefore no evidence of a cough-associated non-whooping cough outbreak in the period from 1785 to 1890.

### Fever

The *Hampshire & Portsmouth Telegraph* has a hit for keyword “fever” in 1804 at 75.4 words/million. However, this mostly refers to military situations abroad, including Savannah, Gibraltar, the Cape of Good Hope, Antigua, Santo Domingo and Dalmatia among others. The fever described is most often yellow fever – “yellow” has a collocation at log ratio 10.2. Other references to keyword “fever” describe “putrid fever” – a lice-borne disease now known as typhus, caused by *Rickettsia prowazekii* – and, again overseas, “jungle fever”, of less certain aetiology (some later authors used it as a synonym for dengue virus e.g. Anon., 1872). Among the fewer references to domestic fever outbreaks, on 29<sup>th</sup> October 1804, it was reported “*that in consequence of the prevalence of the scarlet fever at Westminster school, an extraordinary vacation, for the term of a fortnight, has taken place*”.

The next significant appearance of keyword “fever” is in the *Liverpool Mercury* in 1817 at 44.0 words/million. In this instance the top collocate is “typhus” at log ratio 16.1. Most of these are cases within the UK (see also Kidd, 1818), for instance on 12<sup>th</sup> September 1817 there is a report on the:

*alarming progress of the typhus fever in Ireland. Not one part of the country is free from it. This wide and rapid extension of the disease has been effected by the wandering hordes of beggars who traverse the island in every direction in search of food, to prolong their miserable existence.*

In *The Times* in 1819, keyword “fever” is found at 39.5 words/million. These are a mixture of descriptions of yellow fever, scarlet fever, measles and typhus, with the latter described on 23<sup>rd</sup> July 1819 as “*the present prevailing epidemic*”, then on the 17<sup>th</sup> September:

*We regret to state that the typhus fever is rapidly spreading in the town of Montrose; so much so, that the Chief Magistrate has judged it necessary to call a general meeting of the citizens on the subject.*

Keyword “fever” reaches statistical significance again in 1847 in the *Liverpool Mercury*, *Glasgow Herald* and *Belfast Newsletter*. This was the year that typhus also made a literary appearance in Charlotte Brontë’s novel *Jane Eyre*. 1847 was also a flu pandemic year although, as mentioned above, influenza peaked the following year in the UK. The *Belfast Newsletter* has keyword “fever” at 112 words/million with “typhus” again featuring as a collocate at log ratio 12.7. On 12<sup>th</sup> February 1847, it was reported that:

*Pestilence, was now beginning to complete the work of famine -the typhus fever was raging in Ireland - and if the national generosity were not extended to that country, even the people of England would not be safe from its ravages.*

This proved to be the case, as the *Liverpool Mercury* for 1847 has keyword “fever” at 119 words/million with “typhus” as top collocate at log ratio 11.8. On the 18<sup>th</sup> of June 1847, the *Liverpool Mercury*, while reporting on the sixth death of a Catholic priest from typhus in Liverpool within two months, opined that the cause was “*the burden thrown by the national calamity on Liverpool ..... the deluge of pauperism and disease which has been pored [sic] upon our shores from Ireland*”.

The same was true in Scotland where the *Glasgow Herald* has keyword “fever” at 52.2 words/million in 1847, with “typhus” as top collocate at log ratio 12.9 (see also Orr, 1848). However, on the 2<sup>nd</sup> of

July 1847 the *Glasgow Herald* was able to report that “*typhus fever is not at the present time alarmingly prevalent in London*”, presumably accounting for the statistically significant signal for keyword “fever” in 1847 for the newspapers of Belfast, Liverpool and Glasgow but not in *The Times*. The following year the *Glasgow Herald* also scored another hit for keyword “fever” at 39 words/million. “Typhus” was the top collocate at log ratio 13.2 but followed closely by “scarlet” at log ratio 10.8. The succession of typhus by scarlet fever - now known to be caused by *Streptococcus* - is illustrated by a report from 17<sup>th</sup> July 1848:

*Typhus fever, lately so prevalent, also steadily declines in frequency and fatality.... Scarlet fever is unusually prevalent among children, having almost entirely taken the place of measles and hooping-cough [sic], which are comparatively rare at present. Smallpox still continues prevalent among the unvaccinated. Diseases of the brain and of the respiratory organs have been less fatal during June than during any previous month of the year.*

The latter comment on respiratory disease probably refers to the decline of the 1847-1848 influenza pandemic mentioned above. In 1849, keyword “fever” at significant levels is confined to the *Belfast Newsletter* at 66.8 words/million. Among the collocates, we find “typhus” at log ratio 14.1 but also “cholera” at log ratio 8.0. Cholera is now known to be caused by *Vibrio cholerae*.

The next significant appearance of keyword “fever” is in *The Era* for the years 1852 and 1853 at 23.1 and 21.4 words/million respectively. “Typhus” is again collocated at log ratio 13.1, along with “yellow” at log ratio 11.1 and “cholera” at log ratio 9.0. Yellow fever outbreaks in New Orleans (Anon., 1856) and the Caribbean are reported from November 1852 onwards, not decreasing until September 1853.

In 1870, keyword “fever” appears at 68.1 words/million in the *Hampshire & Portsmouth Telegraph*. The collocates are various: “enteric” log ratio 13.1, “scarlet” log ratio 12.5, “typhus” log ratio 12.1, “smallpox” log ratio 11.4, typhoid log ratio 10.5, “diphtheria” log ratio 9.7, “measles” log ratio 8.6 and “yellow” log ratio 8.0. Enteric fever can be considered to be synonymous with typhoid – now known to be caused by *Salmonella typhi*. On 15<sup>th</sup> January 1870, while noting that scarlet fever was the leading infectious disease cause of death in a national survey of the previous week, closely followed by whooping cough and far ahead of measles, diphtheria and smallpox, the *Hampshire & Portsmouth Telegraph* reported that “*in the metropolis scarlet fever has been epidemic since 5th October last, but is now gradually subsiding*”, but by 15<sup>th</sup> October things were worse again: “*The scarlet fever epidemic goes on increasing in fatality, the disease showing the most marked increase in London and in Bristol*”. The yellow fever reports for 1870 were from Haiti, Brazil and Jamaica.

In 1876, also in the *Hampshire & Portsmouth Telegraph*, keyword “fever” reaches 59.3 words/million, with a very similar pattern of collocates but among which there are two additions, “scarlatina” and “gastric”. However, these are merely alternative names for scarlet fever and typhoid respectively. More importantly, in 1876 “typhus” is absent, unlike in 1870. The yellow fever reports for 1876 were from Barbados, Brazil and Santo Domingo. A very similar pattern is observed for the following two years in the *Hampshire & Portsmouth Telegraph*.

In 1881, *Reynold’s Daily* significantly displays keyword “fever” at 56.3 words/million with “typhoid”, “typhus” and “scarlet” as collocates at log ratios 15.3, 11.8 and 10.2 respectively. An entry for 27<sup>th</sup> November 1881 for the London neighbourhood of “*the parish of Marylebone, notorious for its fever dens*” states that “*typhus fever of the most severe type was raging there, entirely attributable to the overcrowding of the people and bad sanitary state of the locality*” showing that in places, little had changed for much of the 19<sup>th</sup> century (Monjaras, 1895).

In *The Times* for 1887, keyword “fever” appears at 52.9 words/million, again with similar collocates to those found in the significant hits of the 1870s and earlier 1880s with the addition of “malarial” at log ratio 13.2. “Scarlet” is also collocated at log ratio 13.2, but in contrast to previous years, the discussion about scarlet fever is positive, for instance on the 21<sup>st</sup> January 1887 writing: “*There has certainly been a steady and persistent decline of the London death-rate for this disease for some years*”. There was more good news: “*smallpox is for the moment almost stamped out in London, only five deaths having occurred during 1886*”.

For the period of the “Russian flu” pandemic, keyword “fever” makes significant appearances in 1891 and 1892 in *The Times* at 51.8 words/million averaged over both years, and in the *Northern Echo* for 1891 at 122 words/million. The usual suspects are once again found as collocates, indicating that many other infectious diseases continued to make their way through the population in parallel to the ongoing “Russian flu” pandemic. Interestingly, given the known ability of influenza to jump hosts from humans to pigs and vice versa, the *Northern Echo* reports on 16<sup>th</sup> April 1891 that “*swine fever is bad likewise, there having been 424 fresh outbreaks in Great Britain during the same period, with 2,119 pigs attacked ... 917 diseased pigs were killed and 811 died in these five weeks only, 180 having recovered while 371 remained alive ailing*”. The *Ipswich Journal* continues to show a significant signal for keyword “fever” for the years 1894 to 1896, with “swine” a collocate at log ratio 9.8. It was not until 26<sup>th</sup> December 1896 that the *Ipswich Journal* could report that “*swine fever is undoubtedly a diminishing quantity*”. However in 1900 the same newspaper again scored keyword “fever” at 59.6 words/million with “swine” a collocate at log ratio 9.8 and declaring on 26<sup>th</sup> May 1900 that “*the administrative county of West of Suffolk, is now an area infected with swine fever*”.

From 1900 to 1902, keyword “fever” appears significantly in *The Times* averaging 96.7 words/million over the three years. Many of these entries are related to outbreaks of typhoid and blackwater fever – a complication of malaria (Thin, 1899) - among British troops in the Boer War.

**Summary:** keyword “fever” is mostly used in the context of well-known diseases, including typhoid, typhus, scarlet fever and yellow fever or, in a veterinary context, “swine fever”. When a simple reference is made to “the fever”, without qualification, examination of the context often indicates typhus as the cause, and for much of the early 19<sup>th</sup> century, “the fever” appears to be virtually synonymous with typhus. There is no evidence, using the present method, of any outbreak of fever in the period from 1785 to 1890, which a contemporary journalist felt it necessary to remark upon as unexplained.

### Epidemic

The first year in which keyword “epidemic” scores at statistically significant level is 1832 at 9.0 words/million in the *Liverpool Mercury*, referring overwhelmingly to cholera. This is followed by 1848 in which keyword “epidemic” scores at 13.4 words/million in the *Glasgow Herald*. Although 1848 was a flu pandemic year, there is no statistically significant collocation of “epidemic” with “influenza”, although there is one reference to “epidemic influenza” on the 10<sup>th</sup> January 1848. “Cholera”, by contrast, is collocated with “epidemic” at log ratio 9.25. On 4<sup>th</sup> December 1848 we find the *Glasgow Herald* indulging in some predictive epidemiology concerning the cholera outbreak, some optimism that things might improve when the weather got better, some observations on the greater burden borne by the poor and, finally, a look forward to what we would now call herd immunity:

*Judging from the analogy of 1831 and 1832, the chief force of the epidemic will fall on the summer months of 1849. In the interim, judicious measures may destroy the pabulum of the disease; arrangements may be made usual for placing within the reach of the poor the resources of medical*

science; the seasons may interfere; and the half or two-thirds, of the population, who were before exposed to the disease, will not be likely to suffer a second time in the same proportion as before.

1849, as the *Glasgow Herald* had predicted the previous year, indeed proved (Adams, 1849) to be another year when keyword “epidemic” would reach significant proportions, at 14.0 words/million. On 30<sup>th</sup> March 1849, it reported the alarming statistic that:

*from the first outbreaking [sic] of the epidemic In Glasgow on the 14th day of Nov., till the 22nd of March, when it may be said to have almost ceased, there have been buried from cholera 3,777, or about 1.06 per cent of the whole estimated population.*

Further afield, the victims of the global cholera pandemic included the recently outgoing US President James K. Polk.

Similar statistical significance for keyword “epidemic” is found in 1849 in *The Times* and *Liverpool Mercury*, at 16.0 and 9.27 words/million respectively. On 5<sup>th</sup> Sept 1849, *The Times* reported that:

*The deaths registered in London in the week ending Sept. 1 were 2,796, of which 1,663 were by cholera, 234 by diarrhoea. The mortality exceeds that of any previous week. The greatest number ever registered before in any week since 1840 was 2,454 deaths, in the week ending Dec. 4, 1847, when the last epidemic of influenza prevailed. .... The mortality is nearly three times the average of the season, and is sensibly felt all over the metropolis.*

1853 is the next year when keyword “epidemic” reaches significant levels at 8.47 words/million. “Cholera” is a collocate at log ratio 9.65 in *The Times*, which reported on the 2<sup>nd</sup> December 1853 on the previous appointment of: “Tuesday, the 29th of November, as a day of humiliation and prayer on account of the present visitation of epidemic cholera”. The *Hampshire & Portsmouth Telegraph* also scored 9.98 words/million for that year with “cholera” collocated at log ratio 10.7. The following year, *Reynold’s Daily* scored keyword “epidemic” at 17.3 words/million. This was 1854, when the Broad Street pump episode took place (Snow, 1856).

In the next decade, 1865 appears with significant hits for keyword “epidemic” in the *Glasgow Herald* and *Belfast Newsletter* at 10.4 and 13.5 words/million respectively. Unlike the previous decades, “cholera” is not a significant collocate, and the *Belfast Newsletter* reported on 28<sup>th</sup> January 1865 that:

*For some time past a fever epidemic has been raging in Liverpool, and Government recently sent down Dr. Buchanan [see footnote<sup>2</sup>] to report upon its cause and spread .... Dr. Buchanan concludes that the disease is mainly attributable to drink and to overcrowding, rather than to other sanitary defects.*

On 10<sup>th</sup> April 1865, the *Belfast Newsletter* was also reporting on an outbreak of an unidentified disease in Russia and Germany:

*There was then, neither plague nor cholera in those countries. At St. Petersburg an epidemic of recurrent fever has prevailed since Sept. last, and has rather increased than diminished of late. Not much is known as regards its origin, although there can be no doubt that the severe cold, the dram-drinking which is now carried to an unheard-of extent, the vile quality of the spirituous compound which is sold to the people, the bad black bread, the putrid water which is used for drinking, and the overcrowding in the miserable lodgings of the poor have done much towards rendering the epidemic severe.*

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<sup>2</sup> Sir George Buchanan (1831-1895), later Chief Medical Officer during the “Russian flu” pandemic

By contrast the significant collocates of keyword “epidemic” in the *Glasgow Herald* in 1865 include “typhus” and “cholera” at log ratios 11.9 and 9.58 respectively. However, “Russian” is also a collocate at log ratio 6.78, referring to the same outbreak as the *Belfast Newsletter*. On the 7<sup>th</sup> April 1865, the *Glasgow Herald* reassured its reader that “Dr. Murchison, of the London Fever Hospital, in a letter to the *Times*, says, - *The public need be under little apprehension as to the importation of the Russian epidemic into England*”. The following day it reported that question on the “Russian epidemic” had been asked in the House of Lords. More intriguingly, given the known neurological complication of some coronaviruses, such as OC43, on the 22<sup>nd</sup> April 1865 the *Glasgow Herald* quoted from another parliamentary debate:

*your Lordship will have gathered that, neither as regards the fevers which are present in St. Petersburg, nor as regards the nervous disease which is occurring in North Germany, are the circumstances such as have on former occasions led to the adoption of quarantine by this country; that, as regards the importability of the nervous disease, our danger in communicating with the Baltic ports (unless there were movements of masses of infected population) is apparently nothing, or next to nothing.*

The “Russian epidemic” may never have arrived in the UK, notwithstanding the reports from January in the *Belfast Newsletter*, mentioned above. By the following year of 1866, the *Pall Mall Gazette* has keyword “epidemic” at 22.9 words/million, but “Russian” is now not collocated, whereas “cholera” is, at log ratio 9.80. *The Times* also scored keyword “epidemic” at 22.9 words/million and on the 19<sup>th</sup> August 1866 wrote that “*The Lancet has commenced an investigation into the epidemic of cholera in the East-end of London*” and the collocation of “epidemic” with “cholera” in *The Times* for 1866 is log ratio 13.1.

In 1884 the *Ipswich Journal* record keyword “epidemic” at a statistically significant 13.5 words/million, reporting on 29<sup>th</sup> March 1884 that “*There is an epidemic of sore throats in London, which is spoiling the talk in both Houses of Parliament*”, listing four affected senior politicians. However, the main collocation is with “cholera” at log ratio 11.0 with most references to cases abroad. There is also mention during the year of smallpox in India as well as local measles and whooping cough outbreaks.

From 1890-1892, keyword “epidemic” scores significantly in several newspapers, mostly associated with the “Russian flu” pandemic. For instance, *The Times* has it at 29.2 words/million over those three years with “influenza” collocated at log ratio 11.4. Other epidemics ran contemporaneously, as shown by collocates with “cholera” at log ratio 10.1, “typhoid” at 8.9, “typhus” at 8.6, “smallpox” at 8.3, “diphtheria” at 7.2 and “scarlet” at 6.0.

In 1896, the *Ipswich Journal* again recorded keyword “epidemic” at a statistically significant 12.3 words/million. The top collocate is “measles” at log ratio 10.9, which resulted in the closure of schools in Suffolk for several weeks from February to April 1896. Diphtheria is also mentioned on several occasions, but the virtual absence of references to influenza and cholera is noticeable.

The two remaining instance when keyword “epidemic” rises above statistical significance are in *The Times* in 1918 and 2001, at 9.64 and 10.7 words per million respectively. 1918 is not just concerned with “Spanish flu” since typhus and cholera are also collocates of “epidemic” with log ratios 12.5, 11.3 and 10.5 respectively. 2001 has collocates of “foot-and-mouth”, “measles”, “AIDS” and “flu” [appearing instead of “influenza”] at log ratios 12.9, 9.4, 7.5 and 6.6 respectively.

**Summary:** just as keyword “fever” seems mostly to refer to typhus in the 19<sup>th</sup> century, keyword “epidemic” is mostly associated with cholera. The only hint of any epidemic of unknown aetiology for the period from 1785 to 1890, is the “Russian epidemic” of 1865 and the unspecified fever which hit Belfast early in that year, investigated by the government’s Dr Buchanan. 1884’s “epidemic of sore

throats” seems scarcely with of consideration, as its most likely cause is a bacterial infection similar to, but milder than, that which causes scarlet fever.

## Discussion

McKie (2020) and Vijgen et al. (2005) propose that the four mild coronaviruses infecting humans may be descended from animal coronaviruses whose zoonotic movement into humans would trigger pandemics similar to that caused by COVID-19. They also propose that, on the basis of a Bayesian phylogenetic reconstruction of the date of the most recent common ancestor of OC43 coronavirus and its nearest animal coronavirus relative, that OC43 is a candidate for the aetiological agent of the pandemic known to history as the “Russian flu”, conventionally regarded, largely on the evidence of seroarchaeology, as having been caused by influenza H3N8 (Worobey et al., 2014).

The theory of McKie and Vijgen et al. also permits us to hypothesize that the previous “official” flu pandemics of 1830-1833 and 1847-1848 might have been caused not by influenza but by another coronavirus. There is some tentative seroarchaeological and molecular phylogenetic evidence that suggests that these pandemics may have been caused by influenzas H1N1 and H1N8 respectively, although the argument is not as compelling as that for influenza H3N8 as the causative agent of “Russian flu” (Worobey et al., 2014). Certainly, at the time, although there was no recourse to any method of diagnosis other than symptomology, these two early 19<sup>th</sup> century pandemics were seen as a disease – influenza – different to all the other respiratory diseases affecting the population, among which tuberculosis and bacterial bronchitis would have been prominent.

It is notable that, in Parsons’ (1894) review of influenza in England and Wales from 1847 to 1892, it is observed that annual mortality from influenza decreased from 460 deaths per million per annum (dpm) in the pandemic year of 1848 to less than 10 dpm for the period 1874 to 1889 (excepting 1875 and 1879 when it was nearer 20 dpm). For the third quarter of the 19<sup>th</sup> century, influenza appears to have ceased to be a major cause of mortality. Among modern seasonal flu outbreaks in the UK, the particularly bad winter of 2017-2018 produced 15,969 deaths attributed to influenza, or 253 dpm (Moss et al., 2020). Such a level was not seen for influenza in the 19<sup>th</sup> century in the entire inter-pandemic period of 1849-1889, according to Parsons. There is a possibility that Parsons’ figures for the 1890-1892 pandemic are underestimated – his total influenza mortality of 1270 dpm for the “Russian flu” gives a total death toll of just under 45,000 individuals based on a late 19<sup>th</sup> century UK population of 35 million, well under half of the final total of excess deaths estimated by the Registrar-General (Honigsbaum, 2011). If pandemic influenza deaths were underscored at the time, there may have been a systematic under-registration of influenza on UK death certificates in the latter part of the inter-pandemic period in the 19<sup>th</sup> century. Whether or not this is true, it is nevertheless discernible from Parsons’ collation of the data available to him, that evidence of any widespread outbreaks of respiratory, potentially coronavirus, infection that might have been confused with influenza, as McKie (2020) and Vijgen et al. (2005) suggest for the “Russian flu”, appears to be absent.

Coronaviruses, as we see in COVID-19, may present with symptoms which, although respiratory, are not necessarily very flu-like (Cevik et al., 2020). However, references to fever in the 19<sup>th</sup> century are overwhelmingly associated with diseases that were already well characterised then and easily recognisable today: scarlet fever (Freeman, 1803), typhus (Mossman, 1797), typhoid (Anon., 1839), diphtheria (Radcliffe, 1859), smallpox (Hebb, 1801) and yellow fever (Clark, 1797) all present with distinctive signs that make recasting of their occurrence as instances of coronavirus infection, highly implausible. Yellow fever in the UK was confined to arriving seamen and was not onwardly transmissible (Milroy, 1869).

A constant cough is one of the hallmarks of COVID-19 infection. The commonness of this symptom makes it especially challenging to identify significant usage, especially when patent medicine advertising pollutes the signal. Nevertheless, references to whooping cough are clustered in the early 1790s, the 1870s and 1890. Once again, whooping cough is a very characteristic form of cough and this is unlikely to be a misidentification of a hidden coronavirus outbreak (Alderson, 1831).

On the 25<sup>th</sup> June 1854, *The Era* remarked that “we have driven off the ... worst foes by quarantine and other regulations; vaccination has defeated the small-pox [sic]; ... Typhus, however, still contends with us, and cholera”, an illustration of the way that references to epidemics in the 19<sup>th</sup> century are overwhelmingly associated with typhus, cholera and, from mid-century onwards, also with typhoid fever. Table 1 highlights the period from the early 1830s to the early 1870s when cholera had its largest impact on the UK. Cholera pandemics occurred in 1826-1837, 1846-1860 and 1863-1875, first arriving in the UK in December 1831 (Anon., 1832). During the second pandemic, 1853-1854 (Traill and Alison, 1854) was the worst year in the UK and 1866 (Radcliffe, 1869) during the third pandemic.

The nearest that our present technique achieves in the identification of an epidemic that does not fall into any well recognised class of disease is the mysterious “Russian epidemic” of 1865, which was the subject of some interest in the newspapers, although it may not have arrived in the UK at all. Its description in the *New York Times* on 5<sup>th</sup> May 1865 is confusing, suggesting it was a mixture of ongoing typhoid and typhus outbreaks with perhaps even bubonic plague overlapping. It certainly was not respiratory in nature (Anon., 1865). Therefore, if the “Russian epidemic” of 1865 was a single disease, and even if it was genuinely a medical novelty, it cannot provide us with a candidate coronavirus pandemic.

## Conclusion

We set out, in the spirit of McKie (2020) and Vijgen et al. (2005), to find candidate disease outbreak events in the 19<sup>th</sup> century that may represent coronavirus pandemics from which our four milder seasonal coronaviruses are descended, just as our seasonal flu strains are descended from pandemic influenzas. Although conclusive clinical evidence of the causative agents of the 19<sup>th</sup> century outbreaks, conventionally accepted as influenza pandemics, is unlikely to be found within the limitations of modern molecular technology, it should be remembered that retrieving influenza genomes from the victims of the “Spanish flu” would once also have seemed mere science fiction. In the meantime, we admit to our scepticism concerning the reassignment of influenza pandemics to coronavirus, partly because influenza was recognised, from early in the 19<sup>th</sup> century, as a specific constellation of symptoms that were not to be confused with the myriad other respiratory infections common in the cold, damp and polluted environments of Victorian Britain. In any case, Parsons’ (1894) review strongly suggests that the inter-pandemic period of 1849 to 1889 was increasingly devoid of serious clinical impact from influenza. If real, rather than a mere artefact of medical culture in recording the disease, there are very few, if any, suggestions of an outbreak of sufficient magnitude to serve as a plausible candidate for a previously unrecognised coronavirus pandemic of the 19<sup>th</sup> century.

Our analysis suggests that, for the Victorians, the main epidemic threats – or perhaps their main media disease obsessions - were the dramatic intrusions of cholera and typhus. In the earlier period, we see smallpox also circulating, dropping out to a certain extent – defeated, as *The Era* optimistically proclaimed in 1854, by vaccination - and being replaced with typhoid in the second half of the century. Measles, scarlet fever, diphtheria and whooping cough were almost omnipresent, attacking mainly children. We see little evidence of Victorian doctors hesitating over a diagnosis, with most of their diagnoses being things we would recognise today. This leaves little scope for detection of mysterious respiratory outbreaks that would fit the bill as candidate coronavirus pandemics. The “Russian

epidemic” of 1865 cannot be considered a contender, as it is a diagnostic mess and, in any case, lacks the necessary respiratory component.

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