BRIEFING NOTE

Has Brexit changed how Wales participates in global infectious disease prevention, preparedness and response?

September 2022

Purpose of this briefing note:

At 11pm on the 31st of January 2020, the United Kingdom (UK) officially left the European Union (EU). Only a few days earlier, the UK confirmed its first case of infection by the SARS-CoV-2 (COVID-19) virus – which subsequently swept across the globe to create a pandemic that remains ongoing at the time of publication.

The COVID-19 pandemic has brought fresh awareness of the considerable threat that infectious diseases can pose to people's health and well-being, as well as to livelihoods and national economies. Understanding what can be done to better prevent, prepare for and respond to infectious disease threats is at the top of government agendas across the world.

For Wales, navigating the current pandemic and planning for future infectious disease threats has, and will continue to be, significantly influenced by the UK's departure from the EU, particularly in relation to how the UK and its devolved nations, including Wales, work collaboratively with other nations around the world.

This briefing from Public Health Wales aims to explore this by looking at what relationships and processes were in place to support international collaboration on infectious disease threats before Brexit, and how this has now changed. We hope it will be a valuable resource for those involved in infectious disease planning and response, and of wider interest to public health professionals and officials working on public health policy as a demonstration of the many ways that Brexit can influence health and well-being in Wales.

Box 1: Definitions of key terms

Outbreak: an observed number of cases greater than that expected for a defined place and time period, or two or more cases with common exposure (1). Over a greater geographical area an outbreak can be called an epidemic (2).

Pandemic: the worldwide spread of a new disease (3).

Zoonotic disease: infections that can pass between animals and humans (4).

Public health protection: protecting individuals, groups and populations from infectious disease and non-infectious threats including radiation, chemical and environmental hazards (5).

Health security: the activities required, both proactive and reactive, to minimise vulnerability to acute public health events that endanger the collective health of populations living across geographical regions and international boundaries (5).

Surveillance: the ongoing systematic collection, analysis, and interpretation of outcome specific data for use in planning, implementing and evaluating public health policies and practices. An infectious disease surveillance system serves two key functions: an early warning of potential threats to public health and programme monitoring functions which may be disease specific or multi-disease in nature (6).

Key points:

- Brexit has shifted the landscape in which Wales and the UK operates to tackle infectious diseases through international collaboration. It has also seen the UK develop new international partnerships. The COVID-19 pandemic has given a glimpse of how some of these new and changed arrangements work in practice.

- International collaboration is important to three main areas of infectious disease preparedness, prevention and response:

  - Data and information sharing ensures threats are identified quickly and that an effective, coordinated response can be developed and reviewed to reflect the changing scenario;

  - Trading of medicines and medical goods means that resources get from the nations that produce them to where they are needed, when they are needed;

  - Collaborating on prevention and preparedness, including through trade agreements, supports research to better understand and treat infectious diseases, and shapes healthcare workforce expertise and regulatory standards.

- Although the timelines for Brexit and the COVID-19 pandemic have overlapped, many post-Brexit arrangements were still in development. It will be the next international infectious diseases threat that fully tests the new systems in Wales and the UK.

- A healthy population is more resilient to infectious diseases. Brexit has been shown to have the potential to impact on the health and well-being of the Welsh population. Consideration should be given to these impacts of Brexit in the context of infectious disease prevention, preparedness and response.

1.0 What risks do infectious diseases pose for health?

Infectious diseases are usually caused by bacteria, viruses, fungi or parasites and can be transmitted through contact with an infected person, an infected animal, or by encountering the causative agent in the environment (7,8).

As the ongoing COVID-19 pandemic demonstrates, infectious diseases, and our responses to them, can have substantial negative implications for public health, and has the potential to threaten international health security (7,9). Welsh Government have grouped the harm related to COVID-19 into five key areas (10,11) (see Figure 1).

Figure 1. Five harms related to COVID-19, adapted from Welsh Government's original four related harms infographic (10,11).
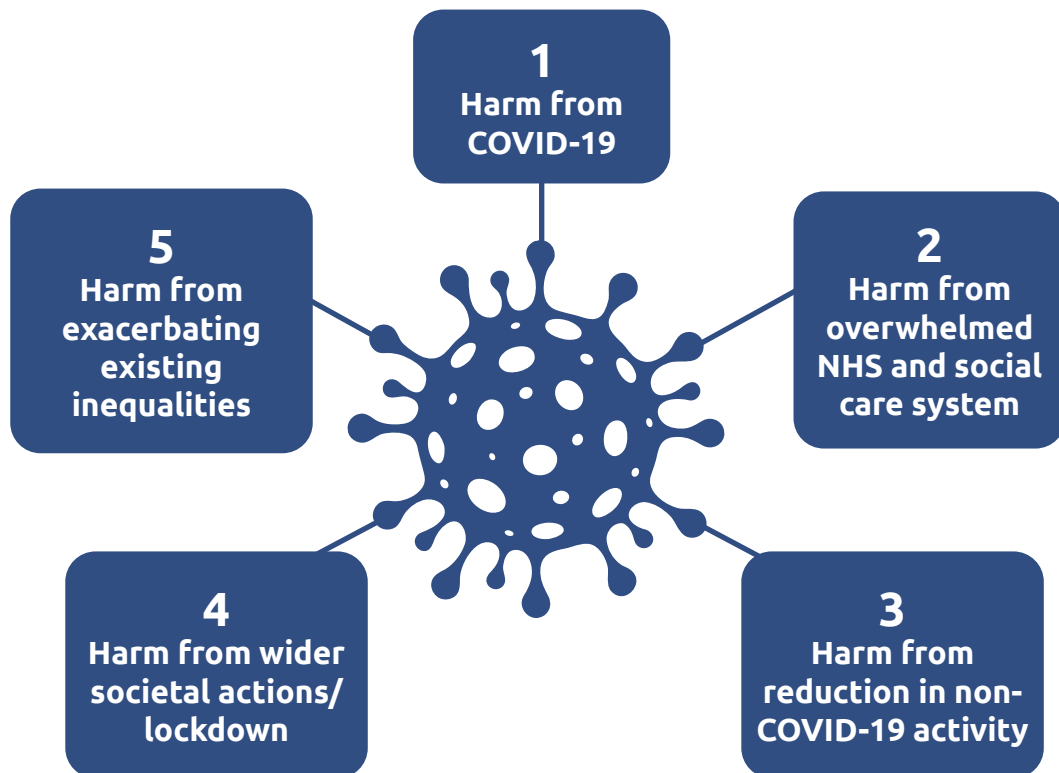
To support the Welsh Government response, Public Health Wales (PHW) have engaged in a number of activities to advise on public health, and to understand and reduce the harms caused directly and indirectly by COVID-19. See Box 2 for more detail on PHW's role in responding to the COVID-19 pandemic (11).

Box 2. Summary of Public Health Wales' role in responding to the COVID-19 pandemic.

- Providing **specialist advice and support** to a wide variety of public sector partners and response services, including Welsh Government and the Chief Medical Office for Wales (12).

- Producing a **Public Health Protection Response Plan** describing the public health actions that were necessary during the COVID-19 pandemic. Including population surveillance, sampling and testing, and preventing the spread of disease through contact tracing. This plan underpinned **Welsh Government's Test Trace Protect** (TTP) Strategy (11,12).

- Establishing the **National Contact** Centre and **National Health Protection** Centre to provide expert and fast specialist health-protection advice for issues arising from regional TTP teams, and a telephone advice line for professional enquiries in Wales (12).

- Communicable Disease Surveillance Centre staff have developed and launched **new surveillance systems** and played a main role in developing procedures and systems to support a range of responses to COVID-19. For instance, monitoring hospital deaths, developing a communicable disease case-management system, monitoring variants and mutations of concern, and supporting a COVID-19 vaccine trial (12).

- Collaborating with Cardiff University to **develop surveillance techniques** that identify clusters and outbreaks, describe patterns of infection and spread of COVID-19, and allow real-time monitoring of transmission in different areas (11,12).

- Developing **an international horizon scanning system** to research, evaluate and analyse international evidence to help guide policy and support Wales' ongoing response to the COVID-19 pandemic (12).

- Coordinating the **'How are we doing in Wales?' survey**, which asks members of the public how the pandemic and the related restrictions are affecting them (12,13).

- Utilising a **Health Impact Assessment approach** to look specifically at the health and well-being implications of the **'Staying at Home and Social Distancing Policy'** (12,14,15). In addition to reducing the transmission of the virus and slowing down the spread of infection, it identified evidence that the measures increased the sense of community for some people in Wales but had a detrimental impact on the mental health and well-being of others, increasing feelings of depression, anxiety and loneliness; and worsening existing mental health conditions (15).

The impact of the COVID-19 pandemic on people's lives in Wales and around the world has been significant. Some of the work PHW has undertaken during the COVID-19 response has helped reveal the negative impacts the pandemic has had on the mental and physical health and well-being of the Welsh population. For example, 42% of adults say their mental health is worse now than it was before the pandemic, and many report that they are now drinking more alcohol and exercising less (16).

Despite efforts to reduce the spread of COVID-19 and ongoing improvement in treatment, as of March 2022, COVID-19 has resulted in 6,011,482 deaths worldwide (17). In the United Kingdom (UK), there have been 184,458 deaths from COVID-19, of which 9,674 were in Wales (18). In March 2021, 56,000 people in Wales were also reporting symptoms of 'long COVID'[1](19).

Unfortunately, the COVID-19 pandemic does not represent an unprecedented or isolated risk. Even within the last century there have been serious infectious disease outbreaks and other pandemics; and it is anticipated that there will be more in the future (11,20–26).

One increasing threat is antimicrobial resistance. This occurs when bacteria, viruses, fungi and parasites no longer respond to treatment or preventative measures. This makes it harder to manage infectious diseases and means they are more likely to spread and/or cause more severe illness, and death (27). Current data suggests that antimicrobial resistance is responsible for approximately 700,000 deaths a year globally (28,29). This number is estimated to grow to 10 million deaths by 2050 if no action is taken (28,30).

Welsh Government has stated its commitment to reducing antimicrobial resistance in Wales. This includes a goal to reduce antimicrobial use by 15% by 2025 (31). PHW also have a dedicated antimicrobial team working on the 'Healthcare Associated Infection, Antimicrobial Resistance & Prescribing Programme', which aims to reduce antimicrobial resistance across Wales (32).

Another growing threat is the increased risk of zoonotic infectious diseases. These are diseases that have crossed over from animals into humans (4). Today, nearly two thirds (60%) of emerging infectious diseases in humans are zoonotic, and they are estimated to be responsible for two million deaths globally each year (33). This has been connected to changes to our food systems and land use, effecting habitats for wildlife and bringing them into closer contact with humans (34,35).
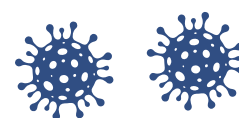
Given the ongoing threat to health from infectious diseases, it is important to understand how new arrangements between the UK and the European Union (EU) following Brexit, and the new trade agreements that are being negotiated with other countries may impact on our ability in Wales to tackle them.
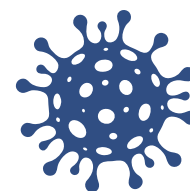
The Brexit landscape is continuously evolving and this briefing reflects only a snapshot of the arrangements in place as of September 2022. Over the coming months and years, the UK Government may choose to make decisions that further shape and change this, for example, through new trade agreements or as a result of reviewing EU laws that have so far been retained (36).

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[1] The NICE guidelines define 'long COVID' as signs and symptoms that develop during or following an infection consistent with COVID-19 which continue for more than 12 weeks and are not explained by an alternative diagnosis (245).

2.0 What is the role of international collaboration in tackling infectious disease spread?

Infectious diseases do not respect borders or boundaries: a serious infectious disease in any part of the world creates a potential threat for the whole world. For example, the first recorded case of COVID-19 originated in Wuhan, China in December 2019, and by January had spread as far as the UK, Europe and the United States (US) (37,38). By the 28th of February, the first case was confirmed in Wales (11). In this context, it is important to recognise the role that international collaboration can play in preventing, preparing for and responding to infectious disease threats, and consequently in protecting human health here in Wales (11,39).

There are three main ways that international collaboration can add value:

1. Sharing data and information

Sharing data and information can alert other countries to emerging infectious diseases so outbreaks can be identified and tackled early (25). During an ongoing threat, timely sharing of information about patterns of disease spread, or the availability and effectiveness of treatments, can play a critical role in helping governments identify effective response strategies (25). For example, during the COVID-19 pandemic, data has been used to inform international travel rules across the world (25) (see Box 3). Epidemiological data from previous threats of infectious disease can also help countries to prepare and plan for future scenarios.
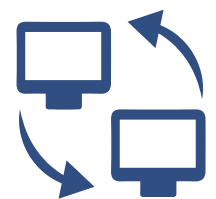
Globally, there are numerous infectious disease surveillance systems in place (40). However, these systems often function very differently, making it difficult to compare and share data effectively between countries. Experts agree that being able to share up-to-date, accurate data across the world is an essential part of tackling the current COVID-19 pandemic and similar future threats (40).

Box 3: Using data to help contain the international cross-border spread of COVID-19

Global trade and travel is known to lead to, and exacerbate, the spread of infectious diseases (11,41,42). During the COVID-19 pandemic, real-time information on case numbers and the identification of new variants has been used by the UK Government to set and revise rules on international travel. In 2020, the UK Government established a 'traffic light system' to help limit the number of individuals travelling into the UK from countries that had high infection rates (43–45). Data sharing has also informed UK Government decisions around additional measures, such as vaccine passports or testing and quarantine procedures (45–47).

Announcing changes to international travel rules in Wales, Welsh Government's First Minister stated that the approach would align with England and Scotland (43,44). However, on occasion, Welsh Government has diverged from the UK rules (48). For example, in September 2020, NHS Wales Test and Trace Protect service identified multiple clusters linked to Zakynthos, Greece, that, at the time, the UK Government had not placed any restrictions on people quarantining on return to the UK. Following concerns that this could lead to significant health and economic impacts for Wales, and advice from public health teams, Welsh Government introduced new measures. This included, ensuring all passengers arriving from Zakynthos to Cardiff received a letter requesting they isolate for 14 days and offering a COVID-19 antigen test 48 hours after arriving into Wales, and a repeat test on day eight (49).

The EU also adopted a similar mechanism to the traffic light system for international travel (50).

2. Trading medicines and medical goods

International trading relationships play an important role in accessing the vaccines, medicines and other essential goods, such as protective equipment for healthcare workers, required to tackle infectious disease spread (25,51). Reducing the barriers to trade (see Box 4) between the UK and other countries, and/or taking steps to work collaboratively to source these goods, can increase their availability and affordability.

During the COVID-19 pandemic, we have seen examples of where countries worked together to share vaccines and oxygen gas when they were lacking (52), as well as examples of where poor international relationships led to disruption in the supply of these goods (53–57). You can read about these examples in more detail in section 3.2.2.

Box 4: Tariff and non-tariff barriers

An *import tariff* is an extra charge or tax that is added onto the price of a foreign good entering a country. It is set by the country and paid by the importer. High tariffs make imported goods more expensive. This can be used to help domestic producers compete with foreign producers (58).

An *export tariff* is less commonly used. It puts an extra charge on domestic goods leaving a country. This makes it more expensive for companies to export their goods. These can be used to help make sure a country keeps enough of an important good (59).

A *non-tariff barrier* refers to any other measure that acts as barrier to international trade, such as regulations and rules on selling arrangements (59).

3. Collaborating on prevention and preparedness

1) Life science skills, research and development:

Working with international partners can benefit research. It can create
access to a greater pool of potential research funding; enable knowledge sharing and the
creation of expert networks; and, in some instances, lead to more rapid and innovative
findings (57,60–62). For example, the first Messenger RNA (mRNA) vaccine to be approved
for use against COVID-19 was developed by a German company (BioNTech) with funding,
manufacturing and testing support from companies in the US (Pfizer) and China (Fosun)
(26,63).

2) Contributing to the healthcare workforce's expertise and capacity:

Drawing on international expertise can also support infectious disease preparedness by
bolstering the healthcare workforce (64). During COVID-19, the UK and Welsh governments
called on the public to "stay at home, protect the NHS, save lives" (65), reflecting the
importance of not overwhelming the healthcare service so it can respond as effectively as
possible (66,67). Having a well-staffed and highly skilled healthcare workforce helps ensure
countries are better prepared to respond to future infectious disease threats (68).

3) Regulations in trade agreements:

International trade in goods and services, and the cross-border movement of people that
involves, can increase the risk of infectious diseases reaching new shores and spreading
between countries. Trade agreements themselves can also include commitments around
investment in medical research and clinical trials, for example, which can be specifically
relevant to infectious disease control (69). In addition, the terms of agreements can also
impact on environmental and food standards, which have been linked to the likelihood of
new infectious agents coming into contact with humans (34,70–72).

3.0 How has Brexit changed international collaboration to tackle infectious disease threats?
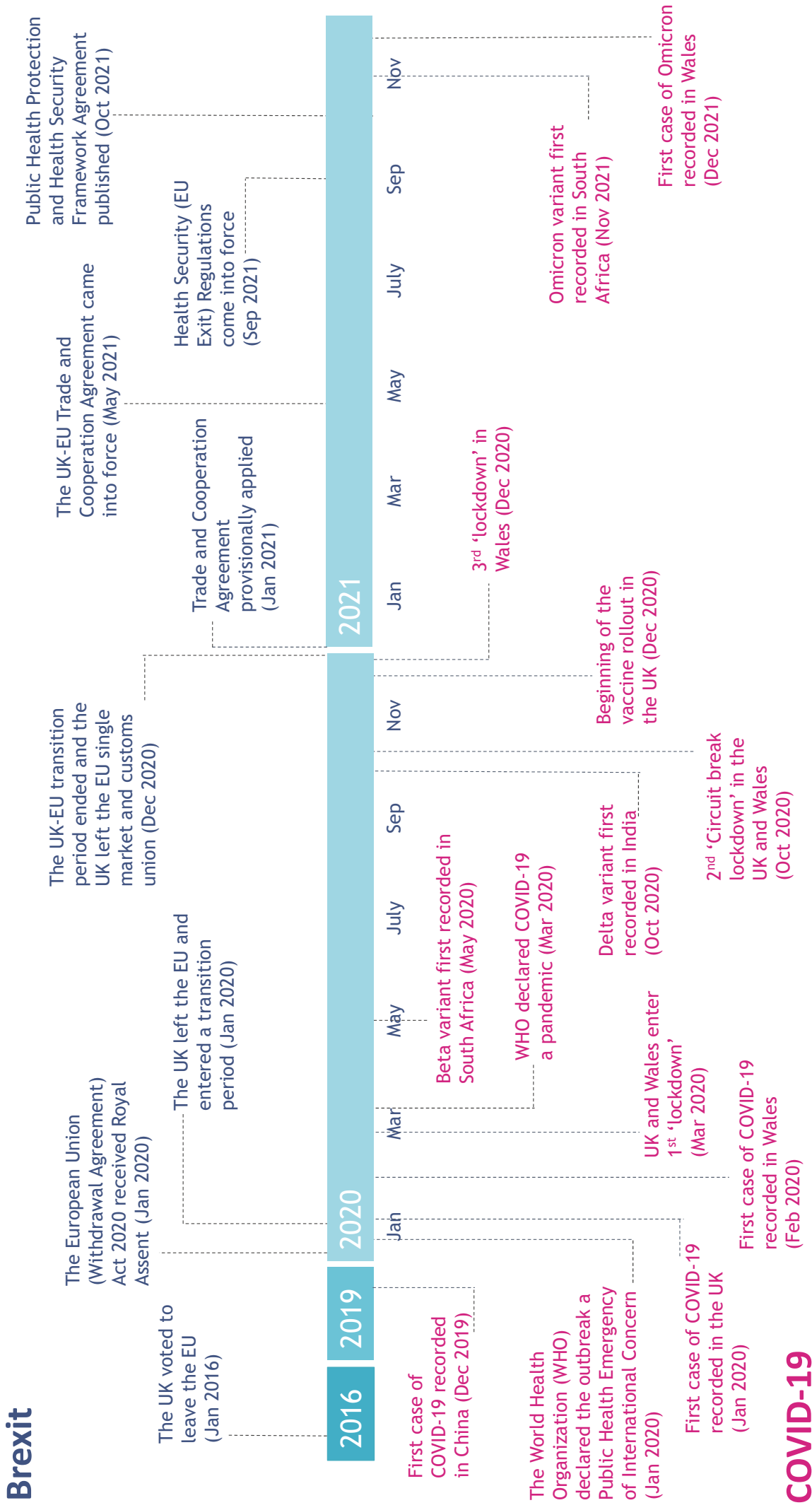
The UK's departure from the EU has rewritten the ways in which the UK collaborates with EU member states. This has been set out in the UK-EU Trade and Collaboration Agreement (TCA), which came into force on the 1st May 2021 (73). However, it has also catalysed change to the ways in which the UK operates across the devolved nations through the UK Internal Market Act and how the UK interacts with other countries, including through new international trade agreements (74).

"Infectious diseases can spread rapidly across borders, and so it is imperative we build a global pandemic response system... protecting us against future health threats and ensuring our expertise is being shared across the globe"
-- UKHSA Chief Executive (75)

This briefing will summarise the international systems the UK and Wales participated in to tackle infectious disease threats before Brexit. It will then explore how these have changed post-Brexit and what potential impact that may have on the role of the UK and Wales in global efforts to prevent, prepare for and respond to infectious disease threats.

It is important to note in this analysis the overlapping timelines of the Brexit process and the unfolding COVID-19 pandemic (see Figure 2). Undoubtedly the recent experience of the COVID-19 pandemic will have influenced government priorities in Wales, the UK and globally, making it difficult to isolate the impact of Brexit. Therefore, although new policies or collaborative mechanisms associated to infectious disease prevention, preparedness and response may have been established or changed after the UK left the EU, Brexit will not have been the only, or even the most important, factor.

Figure 2. Timeline illustrating the key milestones during Brexit and COVID-19

Figure 2. Timeline illustrating the key milestones during Brexit and COVID-19

Brexit

- The UK voted to leave the EU (Jan 2016)
- The European Union (Withdrawal Agreement) Act 2020 received Royal Assent (Jan 2020)
- The UK left the EU and entered a transition period (Jan 2020)
- The UK-EU transition period ended and the UK left the EU single market and customs union (Dec 2020)
- Trade and Cooperation Agreement provisionally applied (Jan 2021)
- The UK-EU Trade and Cooperation Agreement came into force (May 2021)
- Health Security (EU Exit) Regulations come into force (Sep 2021)
- Public Health Protection and Health Security Framework Agreement published (Oct 2021)

Timeline axis: 2016 | 2019 | 2020 (Jan, Mar, May, July, Sep, Nov) | 2021 (Jan, Mar, May, July, Sep, Nov)

COVID-19

- First case of COVID-19 recorded in China (Dec 2019)
- The World Health Organization (WHO) declared the outbreak a Public Health Emergency of International Concern (Jan 2020)
- First case of COVID-19 recorded in the UK (Jan 2020)
- First case of COVID-19 recorded in Wales (Feb 2020)
- UK and Wales enter 1st 'lockdown' (Mar 2020)
- WHO declared COVID-19 a pandemic (Mar 2020)
- Beta variant first recorded in South Africa (May 2020)
- Delta variant first recorded in India (Oct 2020)
- 2nd 'Circuit break lockdown' in the UK and Wales (Oct 2020)
- Beginning of the vaccine rollout in the UK (Dec 2020)
- 3rd 'lockdown' in Wales (Dec 2020)
- Omicron variant first recorded in South Africa (Nov 2021)
- First case of Omicron recorded in Wales (Dec 2021)

3.1 Sharing data and information

3.1.1 Before Brexit
As a member of the EU, the UK was required to comply with EU law on health security and public health protection (5,76). This included:

- surveillance of infectious diseases;

- an early warning system, to alert other member states to new threats e.g. the Early Warning Response System (EWRS);

- ongoing monitoring of serious cross-border health threats; and

- EU preparedness and response planning.

The law aimed to take a preventative approach to public health through the cooperation and coordination of EU member states. This specifically included plans to improve the prevention and control of infectious diseases across borders (as well as to combat other serious health threats) (5).

The UK, both when it was a member of the EU and now, is also a member of the World Health Organization (WHO). As such, the UK is bound by a treaty, called the International Health Regulations 2005, which commits all 196 member countries of the WHO to collaborate on global health security (5).

The treaty aims to develop each country's ability to detect, assess and report public health events through data collection and sharing (5,11). It also includes measures at borders to limit the spread of infectious diseases (5,77). For example, developing key sanitary and health services and facilities at airports, ports and ground crossings (77,78). As part of the UK, Wales works closely with colleagues in other UK nations to support the UK wide response, and prevent the spread of diseases (11). EU Member States are also members of the WHO, and the EU works to support and coordinate compliance with this treaty through its systems (79,80).

As an EU member state, the four UK nations coordinated and shared information on public health protection with the EU through Public Health England (PHE) – the UK's national competent authority and focal point for communications with the EU (which has now been replaced by the UK Health Security Agency (UKHSA)) (81). PHE responsibilities involved sharing information on serious cross-border health threats, new and emerging threats, and surveillance; response coordination; and covering ongoing responsibilities under the International Health Regulations (81).

3.1.2 After Brexit
Public health protection and health security are devolved policy areas, making it Welsh Government's responsibility in Wales (5). When the UK was part of the EU, the systems across the UK were aligned as Wales, like the other UK nations, fell under EU law and made use of EU systems and processes. After Brexit, new legislation and other changes were needed in order for Wales and the other nations of the UK to continue to work collaboratively.

In creating a new system for UK-wide collaboration, it was necessary that the changes also took account of the need for the UK to continue to (5,81,82):

1. fulfil its international obligations under the WHO International Health Regulations 2005; and

2. collaborate with the EU in line with terms negotiated during Brexit.

The governments of all four UK nations have worked together to develop and own a new Public Health Protection and Health Security Framework in order to achieve this new way of working (5). The framework includes an agreement to establish a new UKHSA in April 2021 to plan for, prevent and respond to external health threats, such as infectious diseases (5,83). The UKHSA is the new focal point for the UK, and as such has inherited the responsibilities previously designated to PHE (81). It is worth noting that discussions are ongoing as to exactly how devolved administrations interact with the UKHSA in order for it to fulfil its UK-wide functions, and that the overarching Public Health Protection and Health Security Framework is undergoing committee scrutiny in the Senedd (84).

The framework was also intended to align with, and complement, the Health Security (EU Exit) Regulations 2021 (76,81,82,85). This came into force in September 2021 with the consent of the Welsh Government, Scottish Government and the Northern Ireland Executive (5,81,82).

The legislation transfers new powers to the UKHSA so that it can take over the coordination functions at a UK level that were previously carried out at an EU level (5). It also addresses the legislative gap left by Brexit by requiring Wales, and the rest of the UK, to undertake activities similar to those previously required under EU law (see above). Specifically, all four UK nations are required to (86):

- undertake surveillance on infectious disease and related health matters e.g. antimicrobial resistance;
- coordinate efforts to develop and strengthen their capacities for monitoring, early warning and assessment of, and response to, serious cross-border health threats; and
- communicate any cross-border health threats to the UKHSA.

The UK's obligations and role under the International Health Regulation 2005 will also remain the same. This will ensure that serious cross border threats to health are reported to the WHO, and that intelligence will continue to be shared with other countries to aid international contact tracing (87).

What these changes mean for how the UK and Wales can share data and information with the EU and with non-EU countries to prevent, plan for, and respond to infectious disease is set out below.

Data and information sharing with the EU

Although the UK is no longer a member of the EU, cross-border travel between the UK and the EU is still common. For example, in 2019, 72% of UK visits abroad were to EU countries (88). With this comes the risk of regularly importing infectious diseases (39). Therefore, both parties have seen value in continuing to cooperate on health security (73). These commitments are set out in the UK-EU TCA.

Under the terms of the TCA, the UK and the EU have both committed to informing each other of an infectious disease threat if it has spread, or has the potential to spread, across the border of the UK and an EU member state – a so-called "serious cross border threat to health".

The TCA also allows the UK to request access to the EU's EWRS if a threat is identified in order to facilitate the exchange of information and coordination of response measures (5,86). For example, once the risk of COVID-19 was recognised, the UK requested temporary access to the EWRS and was granted it on the same day (89). Prior to Brexit, this access was instantaneous. Information regarding other infectious diseases is required to be communicated with the EU via the EU focal point. The TCA also states that the EU may invite the UK to participate in its health security committee of Member States to further support response coordination activities (90,91).

On the 1st December 2021, a Memorandum of Understanding was signed between the UKHSA and the EU's ECDC (92). This relationship is intended to support the UKHSA and ECDC to prepare, detect and respond to health protection incidents and outbreaks (92).

In addition to some aspects of the EWRS, the UK will also maintain access to the five platforms under the Epidemic Intelligence Information System (EPIS) – a web-based communication platform that facilitates the exchange of intelligence on public health threats in EU countries, and other non-EU countries who participate (93). This includes information on food and waterborne diseases and zoonosis, legionnaires' diseases surveillance network, antimicrobial resistance and healthcare-associated infections, sexually transmitted infections, and vaccine preventable diseases (93,94). However, the UK will no longer have access to the Threat Tracking Tool (TTP), a database for tracking events with a known or possible impact on public health (93,95). The UK will also no longer have access to the European Surveillance System (TESSy) for reporting data, with the exception of COVID-19 and influenza (as requested by the WHO) (93). Other infections will need to be reported directly to the WHO (93,96,97).

Finally, the TCA allows the UK to continue to cooperate with the ECDC on scientific and technical matters. The ECDC is particularly active in providing training, facilitating professional networks and boosting collaboration (39). However, the UK will not maintain the same level of access to all of these functions as before Brexit; for example, UK staff are no longer eligible for the ECDC's 2-year Fellowship Programmes that enable fellows to carry out activities related to surveillance, outbreak investigation and control of communicable disease threats (98).

Despite these provisions, the UK now lacks the same level of instantaneous data sharing on infectious disease threats it was able to access before Brexit. Therefore, **rather than having a source of information to help identify incoming threats, the collaboration with the EU is limited to supporting decision-making once a threat has been recognised**. This may impact on the UK and Wales's ability to take action at an early stage, before the disease has become widespread across the population or crossed further international borders (89).

Data and information sharing with other countries

As health protection is a devolved responsibility but international relations sits with the UK Government (99), the new Health Security (EU Exit) Regulations 2021 developed by the UK Government needed to set out how the UK would continue to take a coordinated approach to international collaboration on health protection post-Brexit (5).

The regulations state that all four nations of the UK will work together to meet their obligations under the WHO International Health Regulations Treaty as well as strengthen their coordination and engagement internationally. This includes a commitment to identify 'further opportunities for engagement with international partners'.

International collaboration on health protection also remains active through other channels, such as the International Association of National Public Health Institutes (IANPHI) (100). IANPHI aims to strengthen the capacity and capabilities of public health by connecting institutes across the world (100). The UK was a member prior to Brexit and remains so.

In May 2021, the **UK Government announced plans for a new 'Global Pandemic Radar'**, in partnership with the WHO and the Wellcome Trust. The aim of the Radar is to identify and track new COVID-19 variants and other emerging diseases globally, and share that information internationally, so new infectious diseases can be addressed quickly before they escalate (101).

The UK has also established a new collaboration with the United States (US). Announced in June 2021, **the UKHSA has partnered with the US Centre for Disease Control and Prevention to launch a 'Centre for Pandemic Preparedness' (CPP)** (75). However, this is a new development and it is unclear what role Wales will play in the centre. With regard to data sharing, the most relevant element of the partnership is the agreement to **establish an early warning system** that will help to monitor and detect infectious diseases (75). The intention is for the CPP to become a 'world-leading hub for all aspects of pandemic preparedness', with the capability to share early warning information with other countries. More information about this partnership can be found in section 3.3.2.1.

These developments have no-doubt been spurred on by the COVID-19 pandemic. However, whether the new relationship between the UK and the US on data sharing for an early warning system would have been possible before Brexit is unclear. The EU's ECDC does partner with other countries on disease prevention and control, including the US through a Memoranda of Understanding signed in 2007 (102). The details of this understanding are not publicly available. **However, it is uncertain whether this goes so far as to include the level of data sharing required for a joint early warning system** as the EU is recognised to have tight data protection laws while US regulation is at state-level with no overarching federal law.

3.2 Trading medicines and medical goods

3.2.1 Before Brexit
Access to medicines and medical devices requires cross-border collaboration as many of the products or components required are developed and manufactured outside Wales or the UK.

The World Trade Organisation's (WTO) 1994 Agreement on Trade in Pharmaceutical Products removes taxes and other charges on a number of medicines and vaccines, as well as their components, when they are traded by the countries who signed the agreement (103). Fewer restrictions are intended to make vaccines and medical supplies cheaper and more accessible, and therefore help to prevent medicine shortages (40). When initially signed, the UK was included through its membership of the EU. Other signatories included Canada, Japan and the US (103).

Additionally, as a member of the EU, the transportation between the UK and other Member States of medicines, medical goods and devices was not subject to trade restrictions (104–108). In 2019, while the UK was still functioning as a member of the EU, four in five medicines imported into the UK came from the EU, making up two-thirds of the total NHS medicine supply (104,109). Before Brexit, the EU was also an important source of other key medical supplies, such as personal protective equipment (PPE) (51,110,111).

3.2.2 After Brexit
Since leaving the EU, the UK has become a signatory of the WTO 1994 Pharmaceutical Agreement in its own right, and so, like the EU, continues not to place additional charges on the trade of medical goods covered by the agreement (103).

Since Brexit, according to key NHS stakeholders, there has not been widespread medicine or vaccine supply shortages in the UK, despite the ongoing COVID-19 pandemic (104). This may be due, in part, to the strategies that were developed while Brexit negotiations were ongoing to check and change UK supply chains to address vulnerabilities and stockpile important goods (104,112). While this Brexit preparation may have provided valuable 'non-Brexit' resilience, stockpiles were reported to be drying up after the first wave of the pandemic (113).

Welsh Government also had its own contingency plans in place to deal with the potential impacts of Brexit on medical supplies (114–117). This included working with the NHS and UK Government to maintain a medicine supply chain for Wales; stockpiling £5 million worth of consumable equipment, including syringes, needles and blood tubes; and working with suppliers to increase stock levels above normal (114–117).

Notably, not all products that have been essential in tackling COVID-19, and that will likely be important during future infectious diseases threats, are protected under the WTO 1994 Pharmaceutical Agreement. Examples include PPE, hand sanitiser and medical devices (118). An analysis by the WTO in April 2020 found that, during the COVID-19 pandemic, many of its Member States applied high charges onto these types of products. On average, the extra charges (tariffs) on protective products was more than five times higher than those for medicines (118). In contrast, the UK Government announced that, from January 2020, the import duty and VAT usually added to the cost of these goods coming into the UK from non-EU countries could be claimed back by certain importers (119).

In the post-Brexit period, laboratories across the world, including the UK, have faced a shortage in reagents – chemical ingredients that are an essential element in COVID-19 testing kits (120). The UK has also faced a shortage of haulage drivers (121–123). Despite the UK Government's efforts to address the shortage (40), the UK has on one occasion experienced disruption in the supply of flu vaccines and essential healthcare workers being unable to access the fuel needed to get to work (104,121,123–125). There is debate over the extent to which this is linked to Brexit rather than other factors, including the COVID-19 pandemic (126); but it demonstrates the importance of a functioning supply chain, including the required workforce, for pandemic response and prevention.

Trading medicines and medical goods with the EU

The TCA continues to commit the UK and EU to "facilitate the availability of medicines" in each region (127). However, the number of medical supplies imported from the EU has dropped to its lowest level in years, and remained lower than pre-2016 (Brexit vote) levels for the whole of 2021 (104). Overall, trade in goods between the UK and EU has reduced by nearly a quarter (23%) between 2018 and 2021 (128).

This is due in part to the fact that, although both the UK and the EU are committed to removing tariff barriers to trade in medicines under the terms of the TCA and the WTO 1994 Pharmaceutical Agreement, neither of these documents commit them to removing non-tariff barriers (89,103,109,129).

Examples of non-tariff barriers include checks at borders, extra paperwork and regulatory alignment issues (89,103,109,129). This can affect the availability of vaccines and medical supplies, and may prevent them from getting to where they are needed most (40), or mean that perishable medicines cannot be transported quickly enough to still be usable on arrival (104,130).

1. Medicines

Responding to learning from previous infectious disease threats, the EU set up a Joint Procurement Agreement (JPA) in 2014 (51,131). The aim of the JPA was to pool resources so that they could be shared among Member States during future threats of infectious disease (51,132). By doing so, the EU limited competition between Member States and reduced its dependence on non-EU countries for sourcing key supplies (51).

Initially, in the response to COVID-19, the UK decided not to participate in the JPA tenders for procuring ventilators, PPE and COVID-19 testing kits, and instead took its own route for procuring supplies (51,56,131). This was met with limited success and the UK joined the JPA tender for COVID-19 antiviral treatment in October 2020, and also used the EU's Emergency Support Instrument: a fund established to help Member State's source PPE (51,56). This was possible as the UK was still in the 'transition period' of its EU exit, and was therefore still a functioning member of the EU. As of May 2021, this is no longer the case (56,131,133,134).

The JPA is likely to continue beyond the COVID-19 pandemic. In the longer-term, as the EU gains more market power with these type of measures, the UK may find it increasingly difficult, or costly, to source supplies such as PPE (51,56).

In addition, following the transition period, the UK will be subject to any exportation bans that the EU imposes on essential products during public health emergencies (129). This again **may hinder the UK's ability to access medical equipment and vaccines** that are necessary to respond to new waves of COVID-19 and other future threats of infectious disease (129).

Whilst a member of the EU, and during the COVID-19 pandemic, the UK followed the European Medicine Agency's (EMA) approval for medicines, medical devices and vaccines (130). The UK will continue to adopt decisions made by the EMA on market authorisation of vaccines for two years following the end of the transition period (135). The UK Medicines and Healthcare Products Regulatory Agency (MHRA) will be required to set up its own drug and review approval process during this time to ensure vaccines and medicines are safe and effective to roll out (136).

2. Vaccines

When COVID-19 vaccines first became available, the UK quickly began to vaccinate its population and received praise for the efficiency of its procurement programme (137). In contrast, the EU's vaccination rate was initially only a quarter of the UK's (138–140). In a press statement on the 24th March 2021, the president of the EU commission noted that a reason for this was that "not every company is delivering on its contract", affecting the supply of vaccines to EU Member States. To address this, the EU altered its export rules to include principles of 'reciprocity' and 'proportionality', allowing the EU authority to deny exports to certain countries if they were identified as restricting vaccine exports, or if the conditions (e.g. vaccine rate, access to vaccines and epidemiological situation) in the destination countries were better than the EU (141).

Although the EU vaccination programme started slowly, it did catch up to UK vaccination rates (138,139). The EU process has also included sharing vaccine doses with neighbouring countries that needed them (139,142), and it has exported over 1 billion vaccine doses worldwide as of October 2021 (142). The extent to which the UK has shared vaccine doses is less clear, with some reporting that not a single dose was exported prior to March 2021 (139,143). However, by the end of 2021, the UK had delivered 30 million doses to other countries and was aiming to deliver a further 70 million by June 2022 (144).

Trading medicines and medical goods with other countries

The global nature of pandemics means that decisions taken by all countries regarding whether and how they trade medicines and medical goods may affect the UK and Wales.

During the COVID-19 pandemic, insufficient stockpiles and sudden demand for essential medical supplies globally meant that some countries opted to restrict their exports of these goods in order to use them at home (55–57). For instance, India banned the export of respiratory masks and pharmaceutical ingredients used in vaccines (55); and the US were accused of redirecting masks that were bound for Germany from other countries to the US (145–147). By the end of 2020, 215 measures had been taken across the world to restrict exports on medicines and medical supplies (55).

There are also examples of where countries have stepped in to support other nations in need of goods and medicines. For example, in May 2021, when COVID-19 cases peaked in India and the health care system was under unsustainable pressure. In response, countries across the WHO European Region, including the UK, sent urgent, life-saving respiratory equipment (148).

Vaccinating the population is arguably one of the main ways of combatting an infectious disease threat. The COVID-19 pandemic has shown, however, that this is only possible if vaccines are accessible and affordable for the whole world (149,150). A COVAX fund was established in April 2020 to increase the vaccination levels in low and middle income countries (148,151,152). In February 2021, the rollout of the vaccine initiative began, but only delivered 76 million of its 170 million doses target (151), and the target for January 2022 was also reduced from 2.2 billion to 1.2 billion doses (25,151).

Failures to reach the vaccination level target has been attributed to difficulties in procurement but also in the administration of vaccinations in areas where health infrastructure is poor (151). However, also in February 2021, it was claimed that between all G7 countries there was enough COVID-19 vaccination doses to vaccinate each of their citizens three times over, while many of those in lower-income nations were yet to receive a single dose (150).

Some countries have been pushing for Intellectual Property rights on COVID-19 vaccines to be waived to reduce barriers to countries producing their own vaccine, and to increase the accessibility of vaccines in less developed countries (25,55,153). However, it has been argued that by doing so, the incentive to develop vaccines for future infectious disease threats will be reduced (25,149).

Learning from the current COVID-19 pandemic highlights that global health threats do not respect national borders and so, in our global efforts to tackle them, "we are only as strong as the weakest member" (United Nations Secretary-General) (144). Post-Brexit, the UK can make its own decisions about how and whether it will work collaboratively with other countries to access or share medicines and medical goods in any future pandemic situation.

3.3 Collaborating on prevention and preparedness

There are three main ways that international collaborations support infectious disease preparedness and prevention:

1) Life science skills, research and development:

Research during the COVID-19 pandemic has been vital for the production of medicines, medical devices and policies to stop the spread of disease (154–157). It has also helped experts to understand the health and well-being impacts of COVID-19 on the population and vulnerable groups (14,158).

2) Contributing to the healthcare workforce's expertise and capacity:

A skilled and robust workforce can shape our knowledge and understanding of infectious disease, and can help to deal with the consequences they bring. NHS and social care staff, among other key workers, have been integral to the COVID-19 pandemic response (159,160), and will be crucial in responding to future infectious diseases threats.

3) Regulations in trade agreements:

Now that the UK sits outside of the EU, the UK Government will be negotiating its own international trade agreements for the first time in almost 50 years (161). Trade agreements allow countries the opportunity to further liberalise trade between them (make it cheaper and easier), by setting new regulatory standards, and reducing tariff and non-tariff barriers (162). Changes in regulatory standards in this way has the potential to influence the likelihood of future infectious disease threats. For instance, lowered environmental and food standards could increase the risk of new zoonotic diseases (see section 1), while changes to where food is sourced from may introduce new foodborne diseases (34).

3.3.1 Before Brexit

3.3.1.1 Life science skills, research and development

The UK is a world leader in research and development (130,163). In 2021, after the post-Brexit transition had ended, the UK was among the top four for global innovation nations with three universities ranked in the top 10 globally (164–166). Wales is also highly regarded around the world for its research (167–169), producing quality research with an international reach (166,168,170). Welsh universities had the highest percentage of world leading research in terms of its impact than anywhere else in the UK (measured by the number of cited publications); sitting 80% above the global average and 13% above the UK average (168,170).

Global collaboration plays a key role in research. Notably, 50% of Wales' research output was produced through international collaborations (167,169,170). However, domestic policy and funding streams are also necessary to support research and innovation. In Wales, spending on research and development per head, and as a percentage of Gross Domestic Product[2] (GDP), is among the lowest in the UK (166) and before Brexit, often relied on a combination of UK and EU funding for large research projects (166,171,172).

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[2] Gross Domestic Product (GDP) is the total value of goods produced and services provided in a country during one year).

Being a member of the EU also gave the UK (and Wales) access to other important sources of funding. The Erasmus+ 2014-2020 programme was an EU-led scheme that aimed to support employment, education, training and sport across Europe, with a total funding pot of €14.7 billion (173–175). The next Erasmus+ programme is set to make available almost double this amount (€26.2 billion) (175). The scheme facilitated Welsh and UK nationals to study in EU countries and vice versa.

Another EU-funding stream, the Horizon programme, is one of the largest funding sources for research and development across the world (176). During the Horizon 2020 programme, which took place between 2014-2020, €80 billion was made available to support multi-national collaborative projects and research (177). The UK secured the second largest percentage of the funding (12%) (178–180), of which Wales received €138.8 million (180).

3.3.1.2 Healthcare workforce expertise and capacity
An assessment by Welsh Government working with the NHS revealed that, before Brexit, approximately 8% of health and social care staff in Wales identified as non-British nationals in 2020; with EU nationals making up 1.6% of the overall NHS workforce in 2019 (181–183). In the UK, 12% of the healthcare workforce identified as non-British, and nurses and doctors were more likely to be EU nationals than any other staff groups (2018) (184). At this time, both the UK and Wales were experiencing staff shortages, staff burn out and high staff turn-over rates (184–190).

3.3.1.3 Regulations in trade agreements
Before joining the EU, the UK was viewed as the 'dirty man of Europe' with respect to its climate and environmental policies (191). However, during its time in the EU, the UK has become an international leader in these areas; often pushing the EU to adopt more stringent targets and shorter implementation periods (192). The EU is considered to have some of the world's highest environmental and food standards, and its approach to trade agreement negotiations aim to ensure these are maintained (193–196). As a member of the EU, the terms under which the UK traded with non-EU countries was determined by the agreements negotiated on its behalf by the EU.

3.3.2 After Brexit

3.3.2.1 Life science skills, research and development
Preserving links with the EU whilst also being able to establish new collaborative relationships with other countries may have potential benefits for the life science sector in the UK and Wales (197–199). However, new barriers affecting collaboration between the UK/Wales and the EU, including restricted access to funding compared to pre-Brexit, may have a negative impact (166). The details of how things have changed post-Brexit for research collaborations with the EU and other countries are explored further below.

The UK Government has also outlined its ambitions for the next decade of the life science sector in its 'Life Science Vision' report. It sets out how the UK Government plans to work with the life science sector to address key healthcare challenges, including, among other things, improving testing for, and the capacity to respond to, infectious diseases (200).

Collaborating on life science research and skills with the EU

The UK Government has stated that it intends to maintain research links with the EU post-Brexit (201). For example, the UK-EU TCA specifically commits both parties to cooperate on tackling antimicrobial resistance (drugs that can prevent and treat infections in humans, animals and plants) (27,202,203). Resistant strains of bacteria have long been identified as a cause of concern for future disease threats (e.g. drug-resistant tuberculosis) (27,188,204,205).

The most relevant EU funding stream for infectious-disease related research is likely to be the Horizon Europe research programme (successor of the Horizon 2020 programme), which will invest €95.5 billion into research and collaboration (206).

Under the TCA, there are provisions for the UK to continue participating in some EU programmes, including Horizon Europe (207). However, access for UK/Wales to these programmes is yet to be ratified and remains only an agreement in principle (207,208). The UK Government is reportedly considering triggering a mechanism in the TCA to look into what they see as an unfair delay in access (209). This follows reports that exclusion from the Horizon Europe programme is an option being considered if the UK fails to comply with the terms of the TCA with respect to the Northern Ireland border (207).

With the UK no longer a member of the EU, students in the UK/ Wales can also no longer access the Erasmus Scheme (173). To fill this gap, the UK Government introduced the Turing Scheme, which aims to continue to offer students the opportunity to study abroad (173). Welsh Government have also introduced an International Learning Exchange Programme (called 'Taith'), which has similar objectives to the Turing Scheme and Erasmus (210).

The UK Government has also modified the UK's visa system to help aid international collaboration with all countries, including the EU (211–213). For instance, British citizens are covered by a Schengen visa waiver, allowing visa-free travel to the Schengen area for tourism and certain business activities (e.g. attending meetings) for up to 90 days (212,214,215). They hope this will give sufficient time to enable meaningful research collaboration (e.g. Horizon research projects), or for visiting experts to provide lectures or training (215).

The Medicines and Healthcare Products Regulatory Agency (MHRA) is responsible for managing clinical trials in the UK under the requirements and procedures of the Medicine and Human Use (Clinical Trials) regulations 2004 (246). This was also the case before Brexit but some of the processes were changed by the European Union (Withdrawal) Act 2018 that was passed as part of the Brexit process (247,216). This act provides the UK with the ability to update and amend legislation relating to clinical trials in the UK– in February 2022 the Medicines and Healthcare products Regulatory Agency launched a public consultation on the proposed legislative changes for clinical trials (248). The UK Government has subsequently, through a Medicines and Medical Devices Act 2021 (249), sought to update and amend legislation relating to clinical trials in the UK. Consequently, the MHRA has proposed changes to clinical trials legislation; the stated aims of which are to streamline regulation, improve transparency and promote public involvement in clinical trials as part of the UK Government's ambition to make the UK an attractive place to conduct clinical research (248).

An MHRA representative also stated that the proposals aim to ensure "international interoperability" so that the UK remains a "preferred site to conduct multi-national trials" (248). However, Brexit does mean the UK faces changed requirements if it seeks to collaborate with the EU or engage with the EU medicines market than it did as a member of the EU itself (109,202). This includes changes to clinical trial conduct, supply chains for production and the process of getting new treatments to market and monitoring their effects (217). For example, UK led trials that span multiple EU countries will be required to hire a legal representative in the EU.

See section 'collaborating on life science research and skills with other countries' for more information on the Turing Scheme and the UK's visa system.

Collaborating on life science research and skills with other countries

The Turing Scheme was launched by the UK Government in March 2021 to replace the EU-focused Erasmus scheme. The new scheme will allow UK students the opportunity to study or work in potentially any country in the world (173,218). The UK Government expects the scheme to bring investment into the UK, facilitate the transfer of skills and knowledge, and reinforce global ties with international partners (173).

New rules introduced by the UK Government also mean that, as of July 2021, all international students studying in the UK will be allowed to continue to work and live in the UK for a period following their course: three years for PhD students, and two years for those completing an Undergraduate or Master's degree (171,219).

With regard to visas, the UK Government has introduced a new Global Talent visa, which allows leaders in their field a five year stay in the UK (171,213,215,220).

Through its new trade agreement negotiations, the UK Government has also started to develop more specific international research collaborations relevant to infectious diseases. For example, the new UK-India Enhanced Trade Partnership, which was announced in May 2021, includes plans to see India invest in UK health and technology jobs, support clinical trials and research, and potential investment into vaccines manufacture (69,221). The Prime Minister hopes this deal will help to prevent the spread of future infectious diseases (69). The Serum Institute, a vaccination manufacturing company in India, has already begun trialling a one-dose nasal vaccine for COVID-19 in the UK (69).

As previously mentioned (see section 3.1.2), the UK Government has also established a new 'Centre for Pandemic Preparedness' (CPP) with the US (75). In addition to an early warning system, the CPP also aims to increase the capacity of genomic sequencing to identify new variants of infectious diseases, as well as advance clinical trials for vaccines, diagnostics and therapeutics (75,222). The ambition is for the CPP to be able to deliver safe, affordable and effective treatment within 100 days of a new threat being identified (75,222).

Since Brexit, it is notable that the UK Government has published a new 'UK International Research and Innovation Strategy', setting out their intention to build international partnerships to tackle global health challenges. It also commits to the largest investment in research by a UK Government to date: 2.5% of GDP by 2027 and 3% GDP in the long-term (198), some of which is expected to be invested in Wales. This demonstrates that in addition to forging new relationships with research partners around the world, the UK Government is also seeking to align domestic policy and funding to make the UK a world-leader in life science research post-Brexit.

3.3.2.2 Healthcare workforce expertise and capacity

After the Brexit referendum in 2016, the number of EU nationals joining the UK healthcare workforce decreased, whilst an increase was reported in the number of new international, non-EU staff (129,223). In Wales, the available data suggests that there has not been a significant change in the number of EU staff working in the NHS since the referendum, but individual organisations are still committed to encouraging EU nationals to seek work with the NHS in Wales (224).

Impact on healthcare workforce expertise and capacity through the EU

As a result of the end to free movement between the UK and EU, EU nationals no longer have the right to freely work in the UK (223)(225).

The UK Government has introduced a new Health and Social care visa, which it hopes will support more medical professionals to come to work in the UK (89,211). However it is argued that some frontline health workers, and most care workers, will not qualify for the visa as they do not meet the qualifications and salary threshold criteria (89,129). This has the potential to exacerbate existing staff shortages in the health and care sector (64,179,184,226).

Impact on healthcare workforce and expertise through other countries

The new trade agreement signed between the UK and Australia, and other trade agreements currently being negotiated, for example with India, include consideration of how to make working between countries simpler. Historically, the UK has recruited a large number of healthcare staff from India as they use similar English medical training schemes (163). By simplifying the working arrangements, the UK hopes to attract more talented international workers to help address its shortages (163). The UK Government have also committed to recruiting 12,000 international nurses by 2025 (223,227).

The UK Government's new Health and Social Care visa also applies to citizens of non-EU countries, but the same challenges outlined above also apply.

Upskilling the Welsh population has also been identified as a long-term opportunity post-Brexit to address understaffing issues, and to move away from reliance on foreign workers to maintain sufficient staff within the Welsh NHS (179).

Whatever the post-Brexit healthcare workforce challenges may have been, it will now be greater due to the impact of the COVID-19 pandemic. Staff burnout, stress and poor mental well-being has increased during the pandemic due to the pressures placed on the health service, raising further concerns around staff recruitment and retention (189,190).

More generally, a weakening of the UK economy following its departure from the EU has the potential to reduce the funding available to Wales, and therefore to the health budget (179). Experts have flagged the potential knock-on consequences for NHS funding and investment in disease prevention (129). This could include how the UK and Wales are able to respond, directly and indirectly, to future infectious disease threats (see section 4.0). Brexit has already been linked to a drop in GDP in the UK of around 5% and this is expected to exceed the 2% drop in GDP predicted as the long-term economic impact of COVID-19 (129,228–232).

3.3.2.3 Regulations in trade agreement

Historically, environmental and food policy has been strongly influenced by the EU. Since Brexit, many of EU laws and standards have been incorporated into UK law through the Withdrawal Act, maintaining these standards (191). However, there is scope in the future for the UK Government to reconsider its stance on these issues.

Regulations in the UK-EU Trade and Cooperation Agreement

For the first time in a trade agreement, environmental targets have been embedded into the TCA text - setting a precedent for future trade agreements (233). A 'non-regression' mechanism within the text prevents either the UK or the EU from weakening their existing environmental standards through future trade agreements (89,234). In addition, the TCA requires both the UK and the EU to take sufficient action to reach the desired targets, or the agreement could be suspended or terminated (89,233,234).

Regulations in trade agreements with non-EU countries

Now that the UK sits outside of the EU, there is an opportunity for the UK to go further than the agreements negotiated on its behalf by the EU to protect public health. For example, the UK and US have agreed to work together on a 'One Health' approach to address the animal and environmental risks that contribute to infectious disease spread (222). By continuing to advocate for more sustainable farming and high environmental standards in the UK's future trade agreements, the risk of new infectious diseases transmitted from animals (zoonotic infections) could also be reduced. Conversely, the UK may enter into trading agreements that enable a weakening of these standards at home or by their trading partners.

4.0 Wider impacts of Brexit on population health and its implications for future infectious disease spread

The overall health and well-being of the population will influence Wales' vulnerability to future infectious diseases threats; the healthier the population is, the better it is likely to cope with infectious diseases. We can see this playing out through the ongoing COVID-19 pandemic.

Multiple vulnerable and disadvantaged population groups have been identified as having worse outcomes from COVID-19 infection. For instance, the elderly and black and minority ethnic groups are particularly susceptible to experiencing severe symptoms of COVID-19, hospitalisation and death (11,235–237). People already living with a health condition are also more at risk of worse outcomes from COVID-19 as well as other infectious diseases (11,238–241).

We also know that people who smoke or are overweight are more at risk developing long-term illnesses, such as stroke and cancer. But these same risk factors also increase their vulnerability to catching, or having more severe symptoms, of infectious diseases (242). In communities with high deprivation and disadvantage, the prevalence of smoking, drinking and consuming poor diets is higher (243). Therefore, these communities are at increased risk of contracting and experiencing infectious and non-communicable diseases.

During the UK Government's trade negotiations with Australia, they agreed a 'side letter', committing them to greater cooperation on public health issues. This included addressing health inequalities, tackling obesity, reducing tobacco use and preventing/minimising alcohol-related harms (48). All these areas have been linked to unfavourable outcomes of COVID-19.
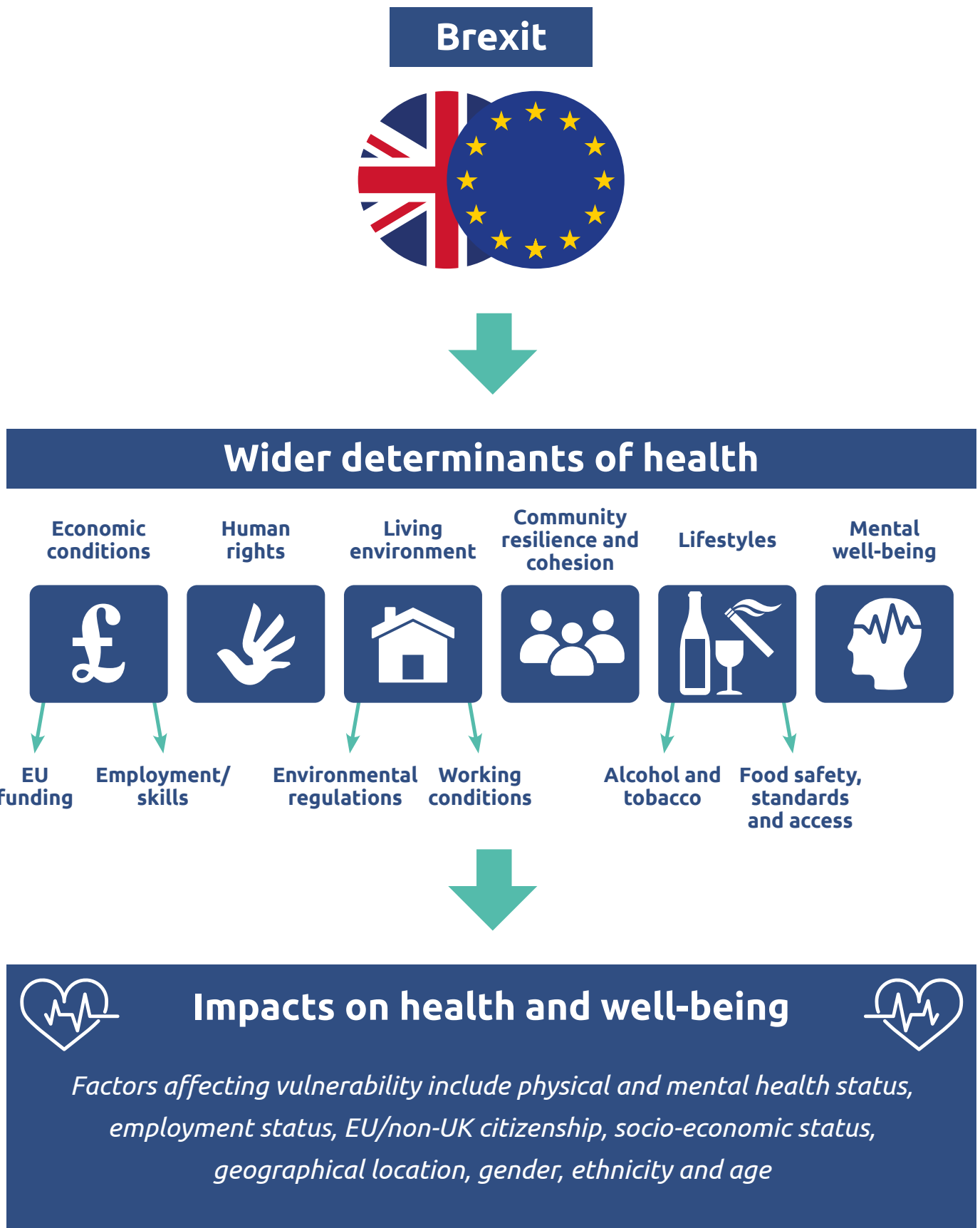
When considering the impact of Brexit on Wales' ability to prevent, prepare and respond to infectious diseases, it is important to recognise the complex ways in which Brexit may influence the underlying health and well-being of the population, particularly those who are already vulnerable.

PHW used a Health Impact Assessment approach to explore the potential threats and opportunities Brexit poses to health and well-being in Wales (see Figure 3). It found potential opportunities for Brexit to improve health and well-being by offering new job opportunities in employment that previously relied on EU workers (179,244). Having good, fair work is linked to better health outcomes (16). However, Brexit was also found to bring potential risks, including the potential to affect the food supply by disrupting supply chains or making fresh food, like vegetables, more expensive. A healthy diet is critical to good health (179,244).

Although the assessment identified both potential positives and negatives from Brexit, it found that the adverse impacts were more likely to affect already vulnerable and disadvantaged populations, worsening their health further and widening existing inequalities (179).

As outlined in the previous sections, infectious diseases are a global health threat, making **international collaboration a critical part of preventing, preparing for and responding** to them. Brexit has shifted how this landscape operates for both the UK and Wales. But when considering what impact Brexit has had that could be relevant to future infectious diseases, **it is important not to overlook how it is playing out at home, and the many ways it has the potential to influence population health and resilience.**

Figure 3. The impact of Brexit on the wider determinants of health.

Brexit

Wider determinants of health

Economic conditions

Human rights

Living environment

Community resilience and cohesion

Lifestyles

Mental well-being

EU funding

Employment/ skills

Environmental regulations

Working conditions

Alcohol and tobacco

Food safety, standards and access

Impacts on health and well-being

Factors affecting vulnerability include physical and mental health status, employment status, EU/non-UK citizenship, socio-economic status, geographical location, gender, ethnicity and age

Conclusion:

Infectious diseases are a global health threat, making international collaboration a critical part of prevention, preparedness and response. Although Brexit has necessarily meant a loosening of the collaborative ties between the UK and the EU, it has also opened doors to new collaborations with countries outside of the EU.

The areas where international collaboration is vital – data and information sharing, access to medicines and medical goods, and accelerating efforts to improve infectious disease preparedness and prevention – have remained the same, before and after Brexit. What has changed for Wales and the UK is the processes and, in some cases, the international partners used to achieve those things.

The overlap between the COVID-19 pandemic and the Brexit process has allowed us to observe these new collaborative relationships, and the complex legislation, policies and agreements that underpin them, being put immediately to the test. It has also been a reminder of the importance of getting this right, and an opportunity to reflect and learn from the experience for future infectious disease threats (25,40).

As well as shifting the landscape for how the UK and Wales operate internationally, it is important not to overlook how Brexit is playing out at home. It has the potential to impact on whether people can access nutritious, affordable food or be employed in secure work, as well as many of the other building blocks needed for good health and well-being. Many of these issues have also been made worse by the impacts of COVID-19, especially for those already most vulnerable.

A population where everyone has the opportunity to enjoy the best possible health and well-being will be more resilient to future threats of infectious disease, in whatever form they may take. This should be at the forefront of considerations as Wales looks to adapt post-Brexit and, like the rest of the world, create a fair and sustainable recovery from the COVID-19 pandemic.

Limitations

Due to the complex and real-time nature of the subject matter, the evidence used within the briefing uses a mixture of grey and academic literature. Grey literature included non-governmental organisation reports, government reports, Think Tank pieces, policy papers, experts' blogs and news articles. Academic literature included expert opinion pieces based on theory, primary research and literature reviews.

Authers and acknowledgment

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Further reading

Abbreviation list

COVID-19	SARS-CoV-2 pandemic	**TCA**	Trade and Cooperation Agreement
Brexit	The UK's exit from the EU	**ECDC**	European Centre for Disease Control
UK	United Kingdom	**EWRS**	Early Warning Response System
EU	European Union	**CPP**	Centre for Pandemic Preparedness
US	United States	**WHO**	World Health Organization
UKHSA	United Kingdom Health Security Agency	**WTO**	World Trade Organization
PHW	Public Health Wales	**EMA**	European Medicine Agency
EEA	European Economic Area	**JPA**	Joint Procurement Agreement
PHE	Public Health England	**mRNA**	Messenger RNA

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