

## University of Dundee

### Optimising maternity services and maternal and newborn outcomes in a pandemic

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# **Optimising maternity services and maternal and newborn outcomes in a pandemic**

## **A rapid analytic scoping review**

Conducted for the Royal College of Midwives

by the RCM Professorial Advisory Group

Mary J Renfrew, Helen Cheyne, Billie Hunter, Soo Downe

with

Jane Sandall, Helen Spiby, Fiona Dykes, Tina Lavender, Lesley Page

Version 4  
8 April 2020

NB: This review was conducted very rapidly and new information is being published frequently. It will be updated regularly.

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## Summary

Childbearing women and newborn infants continue to require care during the current COVID-19 pandemic. When staff and services are under extreme stress there is a real risk of increasing avoidable harm, including an increased risk of infection and reductions in the overall quality of care. Safety, quality, and avoiding harm must be key priorities in decision-making.

### Review questions

Three related review questions were addressed. All considered safety, quality and minimising avoidable harm in the provision of midwifery services:

1. What is the evidence on the impact of community care vs centralisation of care during pandemics, for childbearing women, newborn infants, families, staff, and resources?
2. How to optimise availability of midwifery expertise when staffing becomes heavily affected by the midwifery workforce being off sick, self-isolating, fear of pandemic or other major unavoidable events?
3. What is the evidence on viral load of SARS-COV-2 in domestic settings and hospitals, relevant to informing the safety of community and hospital settings for health professionals?

**Principles for equitable, safe, effective, quality maternal and newborn care in a pandemic** were developed to inform this review, derived from evidence and key resources:

- Continue to provide evidence-based, equitable, safe, compassionate and respectful care for physical and mental health, wherever and whenever care takes place, by remote access if necessary
- Protect the human rights of women and newborn infants, unless and only unless the public health imperative makes this impossible
- Ensure strict hygiene measures and social distancing when possible
- Ensure birth companionship
- Prevent unnecessary interventions
- Do not separate mother and newborn infant unless absolutely necessary
- Promote and support breastfeeding
- Protect and support staff, including their mental health needs

**Key findings and recommendations** on each review question are briefly presented, including **strategies for maintaining essential components of quality care in a pandemic situation**. Detailed information on all sources identified is then presented.

NB. This is a very fast-moving situation and new information will emerge on an ongoing basis; regular updates to this review will be needed.

## Introduction

Childbearing women and newborn infants are a unique population. The majority are healthy, experiencing a health event that, while not an illness, brings clinical, psychological, and social vulnerabilities. Women and newborn infants therefore require access to quality midwifery care, and to multidisciplinary services and to additional care for complications including emergencies if needed. They need special consideration during the current COVID-19 pandemic. When staff and services are under extreme stress there is a real risk of increasing avoidable harm, including an increased risk of infection and reductions in the overall quality of care. Safety, quality, and avoiding harm must be key priorities in decision-making.

## Review questions

Three related review questions were addressed. All considered safety, quality and minimising avoidable harm in the provision of midwifery services:

1. What is the evidence on the impact of community care vs centralisation of care during pandemics, for childbearing women, newborn infants, families, staff, and resources?
2. How to optimise availability of midwifery expertise when staffing becomes heavily affected by the midwifery workforce being off sick, self-isolating, fear of pandemic or other major unavoidable events?
3. What is the evidence on viral load of SARS-COV-2 in domestic settings and hospitals, relevant to informing the safety of community and hospital settings for health professionals?

These overarching questions require consideration of related issues including:

- Optimising maternal and newborn outcomes
- Reducing/preventing infection for women, newborn infants, families, staff
- Maintaining essential aspects of quality in a time of health service, social, and economic turbulence
- Optimising transfer
- Maximising workforce capacity and capability
- Optimising staff health and wellbeing and reducing staff fear
- Identifying novel or additional forms of care delivery or modifications in care

## Principles for equitable, safe, effective, quality maternal and newborn care in a pandemic

These principles are critical in a pandemic. They were developed for this review, drawing on evidence of essential components of quality care (Renfrew *et al.*, 2014) and incorporating the latest information from the World Health Organisation (WHO 2020), the International Confederation of Midwives (International Confederation of Midwives, 2020), and the Royal College of Obstetricians and Gynaecologists (RCOG, 2020) on COVID-19:

- Continue to provide evidence-based, equitable, safe, compassionate, quality respectful care for physical and mental health, wherever and whenever care takes place, by remote access if necessary
- Protect the human rights of women and newborn infants, unless and only unless the public health imperative makes this impossible

- Ensure strict hygiene measures and social distancing when possible
- Ensure birth companionship
- Prevent unnecessary interventions
- Do not separate mother and newborn infant unless absolutely necessary
- Promote and support breastfeeding
- Protect and support staff, including their mental health needs

## Methods

This was a rapid analytic scoping review. Timing precluded a full systematic approach, but a structured approach was used and is summarised in the Appendix.

## Key findings and recommendations

Detailed findings and references collated in the following section

### Centralisation versus community services

1. **No papers have been identified that recommend centralisation of maternity and newborn services in hospitals**, whether research studies or experience from relevant situations.
2. To ensure those in most need have access to critical care for those who need it, and to minimise infection risk, **community based care for most people has been recommended** following many massive emergencies (pandemics, earthquakes, tsunamis), including COVID-19 (Wang, Hsu and Chen, 2009, Nacoti *et al.*, 2020, Dashraath *et al.*, 2020). There is no evidence of increased neonatal mortality or morbidity associated with increasing access to community services including birth for healthy women and newborn infants during epidemics/pandemics.
3. Current International Confederation of Midwives recommendations for maternity care during COVID-19 **support community birth for healthy women and newborn infants** (International Confederation of Midwives, 2020).
4. **Unintended consequences** of centralising services include increases in freebirthing, and reduced access for, and therefore disproportionately worse outcomes for, marginalised women and newborn infants (Jones *et al.*, 2016).
5. There are **existing models from this and other pandemics of cross-infection reduction** in both hospital and community settings that could provide templates for the current situation (Dashraath *et al.*, 2020).
6. **WHO COVID-19 maternity care guidelines** are relevant wherever maternity care takes place, including continued provision of maternity care at all stages of the continuum (virtually if necessary), access to birth companionship, keeping the mother with the newborn infant, support for breastfeeding, and using clinical interventions only where required.
7. **Optimal service configuration needs to be context-specific** (World Health Organisation, 2020a) eg rural/urban contexts, transport options.

8. **Optimal service configuration needs to take into account the needs of specific population groups** (Sphere, 2020) eg women who are vulnerable to COVID-19 because of pre-existing conditions, or are in prison, refugees and asylum seekers, living in poverty, gypsy travellers, from a BAME group, or have mental health problems; staff who are vulnerable because of pre-existing conditions, and women and staff who test positive for COVID-19.
9. **No evidence was identified to inform transport for complications and obstetric emergencies. Solutions are likely to be context-specific**, dependent on eg urban/rural context, and the extent of pressure on the ambulance services. Practical approaches are identified below (Strategies section)
10. **Midwives are important in responding to humanitarian crises** in part because of local knowledge, and in part because of their proven contribution to quality care for all women and newborn infants (Renfrew *et al.*, 2014). Continuing to provide quality care is important in a crisis situation (Beek, McFadden and Dawson, 2019, UNFPA, 2017).
11. **Maternal mental health is important**; problems with maternal mental are associated with maternal mortality (Knight *et al.*, 2019); reducing stress, fear and uncertainty should be a consideration in service changes, and communication should be a priority to reduce uncertainty (The British Psychological Society, 2020, Kelly *et al.*, 2020).

### Optimising availability of midwifery expertise in a pandemic

1. **Midwifery staff need to feel supported, listened to and cared for** by their employers in these very challenging times (Dashraath *et al.*, 2020, Garde *et al.*, 2019, Nacoti *et al.*, 2020).
2. **Trusting relationships between employer and employee based on openness, reflexivity and accountability are vital** for effective emergency responses, including addressing staff fears (Ryan, Giles-Vernick and Graham, 2019)
3. **Psychological and physical health and wellbeing of midwives must be supported** in order to optimise wellbeing and prevent absenteeism (Devnani, 2012, Koh *et al.*, 2005, McNeill *et al.*, 2020)
4. **Gender is an important consideration**. Midwifery is a predominantly female profession and staff may have significant family concerns and responsibilities that are affected by the pandemic (Papp 2020).
5. **Health workers have the right to expect that employers and managers will provide comprehensive occupational safety and health measures** to optimise their wellbeing, including PPE, appropriate working hours and breaks, and psychological support (Nacoti *et al.*, 2020, World Health Organisation, 2020b).
6. **Midwives should remain working in the essential service of maternity care**. Pregnancy and birth continue regardless of national emergencies, and the need for quality care to prevent complications and to recognise and respond effectively to these remains. It could be argued that preventing emergency situations such as postpartum haemorrhage through good quality care is even more important in the current situation. Reserving midwives' skills to work in maternity care will also reduce cross-infection (International Confederation of Midwives, 2020, World Health Organisation, 2020a).

## Viral load of SARS-COV-2 in domestic settings and hospitals

1. The infective dose is the number of viruses needed to cause infection in a host. The viral load is the number of viruses in a host and this varies throughout the course of the infection.
2. There is insufficient evidence as yet that viral load is associated with worse outcome following infection. However it seems likely that high viral load is associated with increased infectivity and poorer outcomes.
3. **Healthcare workers can be exposed more often** due to exposure to numerous infected individuals.
4. **It is clear that the virus can be carried asymptotically (or with symptoms so minor they do not raise suspicion) therefore individuals can spread the virus before symptoms appear.** That people can have and spread the virus asymptotically is highly relevant to midwives working both in hospital and the community.
5. **The virus is very stable and it is believed that it can live on surfaces for up to 7 days.** This is an issue for household spreading.
6. **The highest risk of infection appears to be associated with contamination with inhaled droplets from naso-pharyngeal passages during medical procedures, such as intubation.** In such situations the recipient may receive a large dose of virus giving it a 'jump start'. Midwives rarely attend or perform such procedures.
7. **The infective dose of COVID-19 appears to be low.** This means that the virus is highly infectious. People who are symptom free may be shedding the virus. Midwives and health care professionals must observe high standards of hand hygiene at all times and should maintain recommended distance in attending women and partners who do not have COVID-19 symptoms in all settings where this is clinically appropriate. Where symptoms are present other guidance applies and should be adhered to.
8. **In situations where midwives are working in close proximity with women and partners (even those who show no symptoms), for example during intrapartum care, PPE should be worn.** The Centre for Evidence-Based Medicine, Oxford suggest that  
'standard surgical masks are as effective as respirator masks (e.g. N95, FFP2, FFP3) for preventing infection of healthcare workers in outbreaks of viral respiratory illnesses such as influenza' (Greenhalgh *et al.*, 2020).  
No COVID-19 specific evidence is available.
9. **There are implications for long shifts:** midwives should not undertake 12 hour shifts in situations where close contact with women and partners is inevitable (such as intrapartum care), even in symptom free women. Rotation of staff between intense and less intense work areas would be prudent.

## Strategies to maintain essential components of quality maternal and newborn care in a pandemic situation

1. There are examples from across the UK of community services continuing in the current situation. Lessons can be learned from these examples about safe practice, emergency

transport arrangements and other factors and **a repository of practical learning and experience should be established.**

2. It is important to consider new ways of maintaining essential components of maternal and newborn care when services responding to/managing a pandemic – eg collaborating with the voluntary sector, virtual consultations (Cancedda *et al.*, 2016). There are examples of such developments from across the UK, and lessons could be learned for scaling up.
3. Virtual technology can be a helpful aid, especially for antenatal and postnatal care, and continuity of care can continue by virtual communication. Guidance will be needed in regard to its use (Odendaal *et al.*, 2020, Ames *et al.*, 2019).
4. Community services for maternity care including birth can be developed, including community hospitals and hotel facilities, as well as women's own homes, all with appropriate safeguards.
5. Strategies can include changing the schedule of visits, separate entrances for maternity units, and establishing alternative community sites for birth (Rasmussen *et al.*, 2009), Longer stays at home in early labour with access to midwifery support could help to keep women out of hospital for as long as possible (Spiby *et al.*, 2008a, Spiby *et al.*, 2008b).
6. Novel approaches tried in this and other countries include:
  - Training community health workers to support existing services (Haines *et al.*, 2020)
  - Using dedicated taxis for transfer (Bryan *et al.*, 2017)
7. In regard to transport for complications and emergencies, lessons can be learned from localities where community services for birth continue during the current crisis. Examples include use of dedicated taxis for non-emergency complications, and use of private and army ambulances for emergency transport.
8. Psychological support for staff wellbeing is essential for optimising the availability and motivation of the workforce. Staff support should be accessible for all, such as virtual provision of emotional wellbeing support. Encourage social connectedness via virtual informal staff support groups.
9. A lead with responsibility for staff psychological wellbeing in each unit is recommended.
10. If emotional support resources are limited, those perceived as being at most risk should be a priority e.g. those working with women suspected or testing positive for COVID-19
11. Midwives who are themselves in high-risk categories for complications of COVID-19 may need to be reassigned to work that reduces risk of exposure.
12. Appropriate working hours with breaks for all staff should be maintained.
13. Reconsider 12-hour shift working – this has potential for increased viral load, increased physical and psychological stress for staff and is not supportive of attending to home responsibilities.
14. The midwifery workforce should not be moved out of maternity care to meet other service demands.



15. Build trust through sensitive conversations between managers and clinical staff that explore staff fears and concerns.
16. Continuity of care models should reduce the number of women and their partners with whom midwives will come into contact, thus reducing viral load.
17. Consider whether additional practical support can be provided for midwives, eg ensuring childcare facilities are available, help with transport, support with shopping.

## Detailed findings and discussion

### Service provision

- Evidence from multiple sources indicates the essential components of quality that have an impact on maternal and newborn mortality, and physical and mental health. These have been incorporated in the key principles for this review. Sources of high quality information include (Renfrew *et al.*, 2014, Sandall *et al.*, 2016, Birthplace in England Collaborative Group, 2011).
- A strong message from the epicentre of the current COVID-19 outbreak is that care for sick people should be provided in the community as much as possible, to preserve hospital resources for those who need them, to minimise exposure of staff to viral load, and to optimise well-being for the community. They identified the importance of deployment of outreach services, community clinics, and home care rather than the centralisation of services (Nacoti *et al.*, 2020).

‘For example, we are learning that hospitals might be the main COVID-19 carriers, as they are rapidly populated by infected patients, facilitating transmission to uninfected patients. Patients are transported by our regional system, which also contributes to spreading the disease as its ambulances and personnel rapidly become vectors. Health workers are asymptomatic carriers or sick without surveillance; some might die, including young people, which increases the stress of those on the front line.

This disaster could be averted only by massive deployment of outreach services. Pandemic solutions are required for the entire population, not only for hospitals. Home care and mobile clinics avoid unnecessary movements and release pressure from hospitals. Early oxygen therapy, pulse oximeters, and nutrition can be delivered to the homes of mildly ill and convalescent patients, setting up a broad surveillance system with adequate isolation and leveraging innovative telemedicine instruments. This approach would limit hospitalization to a focused target of disease severity, thereby decreasing contagion, protecting patients and health care workers, and minimizing consumption of protective equipment.....We urgently need humanitarian agencies who recognize the importance of local engagement’.

- A report from obstetricians in Singapore showed that it is important to maximise the midwifery and multidisciplinary workforce and to keep them protected from exposure to high-risk environments (Dashraath *et al.*, 2020). This requires the establishment of separate maternity services, keeping maternity staff separate from those providing care for ill patients:

‘...we focus on keeping frontline obstetric care providers safe while continuing to provide essential services. Our clinical service model is built around the principles of workplace segregation, responsible social distancing, containment of cross-infection to healthcare providers, judicious use of personal protective equipment and telemedicine. Our aim is to share a framework which can be adopted by tertiary maternity units managing pregnant women in the flux of a pandemic while maintaining the safety of the patient and the healthcare provider at its core’

'In a pandemic, social distancing measures have proven to be effective in reducing disease transmission. Obstetric care can be served by this model, as our own experience attests to, by streamlining medical care providers into self-sufficient groups, each minimally comprising the attending, resident, intern and nursing or midwifery staff'. This report provides details of their very structured approach.

- There is little evidence on maternity services in particular to date, though a 2009 report of Taiwan's experience during the SARS epidemic demonstrated that their response – which was to increase the use of local community hospitals to avoid infection risk in maternity care - did not increase neonatal mortality (Wang, Hsu and Chen, 2009).

Similar findings were reported after the recent earthquake in Japan, though with small numbers (Sugawara *et al.*, 2016)

'Satisfactory perinatal outcomes were maintained. Emergency obstetric transport increased to approximately 1.4 fold the number before the disaster. Twenty-three women had prehospital childbirths, indicating a marked increase to approximately three times the number of the previous year'.

- Current ICM recommendations for countries where the health systems can support homebirth are that healthy women experiencing a normal pregnancy and with support from qualified midwives, with appropriate emergency equipment, may be safer birthing at home or in a primary maternity unit/birth centre than in a hospital where there may be many patients (including non-maternity patients) with COVID-19 (International Confederation of Midwives, 2020).
- It is important to avoid circumstances in which some women do not access health services at all. This may be an unintended consequence of centralisation, because of, for example, fear of infection, distance from home, not knowing the staff, or the women's preferred birth partner not being allowed to accompany her (Jones *et al.*, 2016).
- A relevant 2016 paper from Sierra Leone showed that during the Ebola epidemic, fewer women accessed health care, and more women died as a result. Accessible, available, appropriate services are essential to maximise access (Garde *et al.*, 2019).
- There is very little direct evidence on midwives' role in a pandemic, but midwives are important in responding to humanitarian crises and quality care matters in a crisis situation, as has been shown in reports including a 2019 international review and a 2017 report from Syria (UNFPA, 2017; Beek, McFadden and Dawson, 2019).
- Equity is essential any service reconfiguration, yet some groups will be especially vulnerable to moving care out of community settings. This include asylum seekers, refugees, women in prisons, those living in poverty who may not have the resources to travel, and women with mental health problems. This 2020 international statement on humanitarian standards during the coronavirus pandemic provides guidance on rights, information, and community engagement (Sphere, 2020).
- Maternal mental health is important. Stress and uncertainty should be reduced as much as possible, as described in 2020 guidance from the British Psychological Society (The British Psychological Society, 2020). But the current situation means

women are dealing with several different kinds of uncertainty; there is a helpful 2020 report from Brazil on experiences in the Zika virus epidemic (Kelly *et al.*, 2020) . Several factors related to reconfiguring services are likely to result in increased stress for women, for example anxiety about meeting unknown staff, travelling a distance, concern about other children, not having their preferred companion in labour, and fear of becoming infected with COVID-19.

### **Optimising availability of midwifery expertise in a pandemic**

- It is critical to maximise the midwifery and multidisciplinary workforce, and to keep them protected from exposure to high-risk environments:

Lessons from Singapore (Dashraath *et al.*, 2020)

'...we focus on keeping frontline obstetric care providers safe while continuing to provide essential services. Our clinical service model is built around the principles of workplace segregation, responsible social distancing, containment of cross-infection to healthcare providers, judicious use of personal protective equipment and telemedicine. Our aim is to share a framework which can be adopted by tertiary maternity units managing pregnant women in the flux of a pandemic while maintaining the safety of the patient and the healthcare provider at its core'

'In a pandemic, social distancing measures have proven to be effective in reducing disease transmission. Obstetric care can be served by this model, as our own experience attests to, by streamlining medical care providers into self-sufficient groups, each minimally comprising the attending, resident, intern and nursing or midwifery staff '.

Lessons from Sierra Leone (Garde *et al.*, 2019)

'A model of screening, isolation, and care specifically for maternity'

Lessons from Italy (Nacoti *et al.*, 2020)

'In hospitals, protection of medical personnel should be prioritized. No compromise should be made on protocols; equipment must be available. Measures to prevent infection must be implemented massively, in all locations and including vehicles. We need dedicated COVID-19 hospital pavilions and operators, separated from virus-free areas'.

- The welfare of midwifery staff is key to ensuring the wellbeing of women and their newborn infants. To optimise the contribution of midwifery expertise, we need to protect staff and ensure that they feel supported, listened to and cared for by their employers in these very challenging times. Evidence from other pandemics shows that trusting relationships between employer and employee are vital for strengthening the effectiveness of emergency responses and should be based on 'openness (a willingness and genuine effort to incorporate multiple perspectives), reflexivity (flexibly responsive to context and ongoing dialogue) and accountability (taking responsibility for local contexts and consequences)', taking into account local priorities (Ryan, Giles-Vernick and Graham, 2019)
- Psychological health of midwives must be supported in order to optimise wellbeing and prevent absenteeism. Stress, burnout and PTSD are commonly reported in studies of health care workers in other pandemics and major national/global emergencies (Koh *et al.*, 2005). Absenteeism of staff has been reported which is not just linked to the need to self-isolate, but also related to perceived personal threat and fears for family safety (Chaffee, 2009; Devnani, 2012; McNeill *et al.*, 2020). This

is likely to be even more important for a predominantly female workforce such as midwifery, where staff may have significant other family concerns and caring responsibilities that are affected by the pandemic eg shopping, childcare, care of elders (Papp 2020).

- Studies indicate that health workers are less likely to be willing to work in a flu pandemic if they are female, work part-time, have concern for family and loved ones, and have personal obligations (Seale *et al.*, 2009; Wong *et al.*, 2010; Devnani, 2012; Park, Behrouz-Ghayebi and Sury, 2015). However, being employed in a professional rather than a supporting role enhanced willingness to work (Devnani, 2012). The study by Wong *et al* (2010) showed that, in the H1N1 influenza pandemic, community nurses in Hong Kong reported higher levels of unwillingness to work than their hospital counterparts. The authors postulate that this may be related to fears about home visiting and the perceived lack of a protective environment.
- All these concerns will need to be explored with staff. If midwifery staff express fears about continuing to work in the COVID-19 pandemic, it is important that managers explore their concerns with sensitivity and respect. Midwives could be reassured by informing them that the current evidence indicates that those under 60 are much less likely to experience severe or fatal illness than those over 60, and it is very low (4/1000 or less) in those under 50; that there are very few reports of severe illness in children; and that at all ages women are up to half as likely to experience severe or fatal illness than men (ie, maybe 2/1000 for a woman under 50) (Worldometers, no date; Purdie *et al.*, 2020).
- This does not mitigate the need for proper protection for staff, but may reassure them that even if they do become infected, the risk of this being severe or fatal in a largely female workforce that is mostly under the age of 60, or that they will trigger severe illness in healthy family members who are not elderly, is low. However, midwives who are in high-risk categories for complications of COVID-19 or who have caring responsibilities for elderly relatives may need to be reassigned to work that should reduce their risk of exposure (World Health Organisation, 2020a)
- Health workers have the right to expect that employers and managers will provide comprehensive occupational safety and health measures to optimise workers' wellbeing including 'maintaining appropriate working hours with breaks; providing access to mental health and counselling resources' (World Health Organisation, 2020a) and 'full access for all personal protective equipment (PPE), sanitation and a safe and respectful working environment' (International Confederation of Midwives, 2014)
- Midwives should remain working in the essential service of maternity care. Pregnancy and birth is an essential health service that will continue regardless of national emergencies (World Health Organisation, 2020a). Midwives should not be deployed in other areas. ICM warns:  
"Midwives, whether based in the community or in hospitals, are essential health workers providing a critical service to childbearing women and their newborn infants. Deploying midwives away from maternity services to work in public health or general medical areas during coronavirus pandemic is likely to increase poor maternal and newborn outcomes" (International Confederation of Midwives, 2014)

## Viral load of SARS-COV-2 in domestic settings and hospitals

### Expert comment from Dr Angus Gain

'It's important to be clear about the difference between the infective dose and the viral load before starting. The infective dose is the number of viruses needed to cause infection in a host. The viral load is the number of viruses in a host and this varies throughout the course of the infection. For this reason when talking about viral load it is necessary to say at what time point you are referring and this is usually defined in relation to symptom onset.

What is reasonably clear that looking at what has been published about this for SARS COV2 is that we do not have enough evidence to say for sure that viral load is associated with worse outcome following infection. Likewise, there is not enough evidence to say that SARS COV2 viral load is associated with infectiveness.

The studies that have been done so far are limited by small sample sizes and their retrospective nature among other things and further research will be required.

It seems likely that viral load is associated with worse outcomes and increased infectivity. The largest current study found investigating this was from China. It showed poorer outcomes with higher viral load. This has also been demonstrated for similar infections such influenza (in humans) and SARS (animal models). A greater viral load allows more copies of the virus to be produced in a given time. The more viruses that exist, the more work the immune system has to do to clear the infection. The situation is complicated by the fact that many factors influence an individual's viral load. These are not well understood for COVID-19 but we can get some idea of what might be important for viral infections which have been around for a bit longer. It should be noted that in many infections, the host does more damage than the infectious agent (see the new definition of Sepsis for more on this). The immune response may be the main driver of pathology in a manner independent of viral load and this has been demonstrated in some viral infections. While it seems likely viral load plays a role, it is almost certainly not the only important factor.

The viral load may also correlate with increased infectivity and shedding. Again we are lacking strong evidence of this at the moment. Precedent from previous viral infections suggests it is likely to be important though. The more virus you shed the higher the chance the person infected will get a dose above the infectious dose and become infected. Again, it is not always so straightforward and for H1N1 influenza the situation was much more complicated. I believe for previously studied coronaviruses though this has been the trend (but not sure).

One thing that is clear is that you can carry the virus asymptotically (or with symptoms so minor they could not raise suspicion) and you can spread the virus before you have symptoms.

With relation to domestic settings then - people can both have and spread the virus asymptotically. This is obviously causing problems with people breaking the rules because they 'know' they don't have it. I believe the virus is also very stable and can live on surfaces for around 7 days which is obviously an issue for household spreading. For healthcare settings, an association between viral load and severity would be a bit of a disaster. It has been suggested that this is why some relatively fit healthcare professionals have died of the virus. In particular, there is a theory that if the infective dose is massive (such as an inhaled droplet during an aerosol generating medical procedure) the capacity of the hosts innate immune system will be vastly exceeded allowing the virus to replicate so quickly that serious infection developed before the hosts adaptive immune response has time to mobilise against the virus. Given that we know similar viruses show a relationship between viral load and severity of illness it would be prudent to assume there is such an association with SARS COV2. Being slightly cynical some of our systems are designed poorly. For example, if we suspect viral load and a high infectious dose may be associated with a poorer outcome why are the rotas of

medical staff being designed so they do prolonged stints (2 weeks at a time) in 'dirty' clinical areas (areas which are full of patients with or suspected of having the virus)? Surely it would make more sense to rotate staff through on shorter shifts. This is bad for patient continuity (however the cases are relatively medically simple as treatment options are so limited). This would reduce the viral load exposure of medics and nurses. If we assume viral load is bad this is also an issue for patients who are sent to assessment areas if they are suspected of having the virus. Some patients without the infection will inevitably end up in such areas and then contract the disease from this concentrated area of Covid positive people.

In summary, there isn't enough evidence to know for sure how viral load associates with infectivity and prognosis. Early evidence and similar viruses suggest though that they are likely to be important. If we assumed a relationship it would suggest we need to change some things that we are doing'.

- **Does a high viral load or infectious dose make COVID-19 worse?**

The infective dose for COVID-19 appears to be low given the current speed of spread. This suggests that relatively low exposure to the virus will cause infection. The correlation between viral load and symptom severity is not yet known. High viral load may not lead to more severe symptoms but is likely to result in increased shedding of the virus increasing the likelihood of infecting others (Geddes L, 2020).

- **SARS-COV-2 Viral load and the severity of COVID-19**

This paper discusses current evidence on viral load and severity of SARS-COV-2 symptoms (Heneghan C, Brassey J, 2020). It suggests that peak viral load can result in poorer outcomes and that the disease is more severe in individuals with a higher viral load. The amount of virus exposure at the point of infection may increase the severity of the illness. This has implications for healthcare workers who may come into contact with numerous infected individuals some of whom may be asymptomatic and where use of PPE is suboptimal. The paper suggests that: 'Reducing the frequency and intensity of exposure to SARs-C-2 might reduce the infectious dose and result in less severe cases'.

Current evidence is limited due to the poor quality and small size of available studies.

- **Temporal profiles of viral load in posterior oropharyngeal saliva samples and serum antibody responses during infection by SARS-CoV-2: an observational cohort study.**

A cohort study in 2 hospitals in Hong Kong found that:

'Patients with COVID-19 had the highest viral load near presentation, which could account for the fast-spreading nature of this epidemic. This finding emphasises the importance of stringent infection control and early use of potent antiviral agents, alone or in combination, for high-risk individuals' (To *et al.*, 2020)

- **Expert reaction to questions about COVID-19 and viral load** (Science Media Centre, 2020)

'We must be more concerned about situations where somebody receives a massive dose of the virus (we have no data on how large that might be but bodily fluids from those infected with other viruses can contain a million, and up to a hundred million viruses per ml), particularly through inhalation'.

'Unfortunately, we don't yet know enough about the distribution of the COVID-19 virus throughout the body of the infected patients in normal, and unusual situations'.

'Under such circumstances the virus receives a massive jump start, leading to a massive innate immune response, which will struggle to control the virus to allow time for acquired immunity to kick-in while at the same time leading to considerable inflammation and a cytokine storm.'

'For most of us, it's hard to see how we could receive such a high dose; it's going to be a rare event. In the COVID-19 clinic, the purpose of PPE is to prevent such large exposures leading to high dose infection. Situations we should be concerned about are potential high dose exposure of clinical staff conducting procedures on patients who are not known to be infected'.

'We know that the likelihood of virus transmission increases with duration and frequency of exposure of an uninfected individual with someone infected with the virus'.

- A new review of standard versus respirator masks has been published (Greenhalgh et al., 2020):

'Standard surgical masks are as effective as respirator masks (e.g. N95, FFP2, FFP3) for preventing infection of healthcare workers in outbreaks of viral respiratory illnesses such as influenza. No head to head trial of these masks in COVID-19 has yet been published, and neither type of mask prevents all infection. Both types of mask need to be used in combination with other PPE measures. Respirator masks are recommended for protection during aerosol generating procedures (AGPs). Rapid reviews on wider PPE measures, and what counts as an AGP, are ongoing.'



## Appendix: Methods

This was a very rapid scoping exercise. Searches were conducted using a range of keywords across databases including PubMed and the Cochrane Database of Systematic Reviews, and requests to national and international networks of colleagues.

To structure and guide our work on the impact of community settings versus centralised care we considered the following criteria in our searching:

Participants:

- Childbearing women at any stage of the continuum: pregnancy, labour, birth, postpartum
- Newborn infants
- Staff: all members of the multidisciplinary team
- High income countries experiencing a pandemic or epidemic: or relevant lessons from other countries

Intervention/control:

'Standard' and 'experimental' care will vary considerably according to the study context. The following contexts will be considered:

- Changes to standard maternal and newborn care provision that includes establishing or discontinuing:
  - Centralised hospital care for all including maternal and newborn care
  - Centralised hospital care for maternal and newborn care
  - Midwifery units for birth: both alongside and freestanding
  - Community units for antenatal and postnatal care
  - Home

Outcomes:

- Infection rates for women, newborn infants, and staff: including mortality from COVID19
- Patterns of infection/spread
- Maternal mortality rates
- Perinatal mortality rates
- Stillbirth rates
- Rates of interventions in labour/birth
- Quality indicators including mental health of women and of staff

All types of research design were considered, including case studies, and descriptions of relevant experience. Formal quality assessment was not conducted. Relevant statements from national and international organisations were included.

The following search strategy was conducted in **Ovid MEDLINE(R) ALL** 1946 to March 26, 2020

#	Searches	Results
1	pandemic.mp. [mp=title, abstract, original title, name of substance word, subject heading word, floating sub-heading word, keyword heading word, organism supplementary concept word, protocol supplementary concept word, rare disease supplementary concept word, unique identifier, synonyms]	22778
2	(Coronavirus or Disease outbreaks).de.	80077
3	1 or 2	98325
4	midwifery services.mp.	189
5	exp Maternal Health Services/	48409
6	4 or 5	48525
7	3 and 6	107
8	Covid-19.ti.	907
9	Covid19.ti.	4
10	8 or 9	911
11	3 or 10	99086
12	6 and 11	107

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