FIRST OPTION
safety consultants

THE CHAIN OF INFECTION

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The 'chain of infection' paradigm is principally applied to tackling HAIs (healthcare associated infections - we're not supposed to call them 'hospital-acquired' infections' anymore; poor PR, apparently) but it is a very useful framework for thinking about stopping COVID in non-healthcare settings too.

The Chain of Infection describes a **sequence of events** and doesn't just apply to HAIs; it applies to *any* infectious process, irrespective of the environment or the particular infection.

The point is, *it's a sequence*. All the separate elements need to be present. If **just one** is missing the chain is broken and the infection can't be transmitted from one person to another.

It's similar to HACCP in food hygiene; identify the critical points and put hurdles / controls in place – for example monitoring fridge temperatures is a critical control.

In healthcare settings the 'breaking the chain of infection' mantra is crucial for effective infection prevention and control. There are six links - and the more links in the chain you can break the better. Here we go.

1. A Pathogen

The first link in the chain of infection is you need an infectious agent (pathogen). No pathogen? No infection.

Pathogens could be viruses such as flu or COVID, bacteria like *Salmonella* or MRSA, fungi such as thrush, parasitic protozoan diseases such as malaria or toxoplasmosis or prions that cause mad cow disease or CJD.

The success of *any* pathogen depends on a combination of its pathogenicity - ability to produce disease – its virulence - severity or harmfulness – and its invasiveness - or tendency to spread. So, if a pathogen isn't present, no infection. And in the case of COVID it's not like measles, airborne almost indefinitely on a mote of dust or like some sub-microscopic, invisible, demented mosquito trying to fly up your nose, it hangs in respiratory droplets that fall to the floor or other surfaces.

2. A Reservoir

A reservoir is the principal habitat in which a pathogen lives, flourishes **and is able to multiply**. Common reservoirs for infectious agents include humans or animals or insects or the environment.

For COVID in humans (we can ignore bats, pangolins and camels for our purposes) there are two forms of reservoir: acute clinical cases (someone who is infected and is displaying signs and symptoms of the disease), and carriers (someone colonised with an infectious agent but does not appear unwell).

Acute clinical cases are more likely to be diagnosed and treated so the patient's contacts and normal activities will normally be restricted. Carriers, obviously, can present more of a risk to those around them because they do not display any signs or symptoms of illness.

With COVID-19 there is a chance people can spread it 2-3 days before symptom onset. The capacity for completely asymptomatic carriers to spread it is unknown but likely low. There have been a few cases of asymptomatic 'superspreaders' but these are likely outliers.

COVID Barriers: keeping known potential reservoirs (symptomatic individuals and their contacts) isolated and standard hygiene measures – especially droplet precautions – to help prevent asymptomatic spread.

3. A Portal of Exit

The portal of exit is any route which enables a pathogen to leave the reservoir or host. In humans the key portals of exit are:

- Alimentary - via vomiting, diarrhoea or biting (yes, in healthcare you do get 'biters' and spitters);
- Genitourinary - via sexual transmission;
- Respiratory - through coughing, sneezing and talking;
- Skin - via skin lesions;
- Transplacental - where transmission is from mother to foetus.

In the case of COVID-19 this is almost exclusively respiratory droplets. Viral RNA has been recovered from stool (and is being monitored in sewage to predict local outbreaks) but not live virus. Ditto blood.

COVID Barriers: droplet precautions.

4. A Mode of Transmission

The two main ways that an infection can be transmitted from its reservoir to a susceptible host are *direct transmission* or *indirect transmission*.

Direct transmission tends to be instantaneous and occurs when there is direct contact with the infectious agent. Examples include tetanus, glandular fever, respiratory diseases and sexually transmitted diseases.

Indirect transmission can occur through animate mechanisms such as fleas, ticks, flies or mosquitoes or via inanimate mechanisms such as food, water, biological products or surgical instruments.

Indirect transmission can also be airborne, in which tiny particles of an infectious agent are carried by dust or droplets in the air and inhaled into the lungs. There is an argument best left in biology dept coffee rooms whether droplet transmission is direct or indirect – Spoiler Alert: it can be both.

COVID Barriers: droplet precautions plus general hygiene to prevent fomite transmission (droplets falling on an inanimate object then someone touching it).

5. A Portal of Entry

The portal of entry is the means by which an infection is able to enter a susceptible host.

Portals of entry into the human body include inhalation, absorption (via mucous membranes, eyes or naughty bits), ingestion (via the gastrointestinal tract), inoculation (as the result of puncture or trauma) or introduction (insertion of medical devices). With COVID-19 the principal portal of entry is inhalation of droplets – while fomite transmission is entirely possible as has been demonstrated with other coronaviruses the evidence suggests this less prevalent than direct transmission of respiratory droplets.

COVID Barriers: droplet precautions including masks plus general hygiene to prevent fomite transmission (droplets falling on an inanimate object then someone touching it).

6. A Susceptible Host

The last link in the chain of infection is the susceptible host. How susceptible any host will be depends on a variety of factors: age, other illnesses or meds that make them less able to fight off an infection (you can add nutrition, crowding and socioeconomic factors here too). Sometimes there may be genetic or ethnic overlays too – we don't know yet with COVID - but this virus is very infectious no matter who you are.

The Importance of Breaking the Chain

This paradigm was devised for healthcare environments where already at-risk groups can be exposed to infection risks that they may not encounter elsewhere and may not be in top shape to fight off.

In healthcare there are opportunities to break or disrupt the chain at any link: though the rapid and accurate diagnosis of an infectious disease; the prompt treatment of infected patients; the safe disposal of waste; the sterilisation and disinfection of medical equipment or the implementation of an environmental decontamination strategy.

But understanding how infections become established and how they are transmitted is essential for effective infection prevention and control outside healthcare too.

In the case of COVID the ABC in the Yellow Book is your friend and remember to concentrate on the large, manageable risks rather than disproportionately on the small ones.