Dr Terry Ferns Choking and Acute Care Podcast Transcript

Welcome to the University of Greenwich podcast series.
We hope you will enjoy our selection of podcasts,
which are linked to various interesting topics and
A-level syllabuses, and will hopefully trigger thoughts
and discussions around the various points raised.

Thank you for inviting me my name is Dr Terry Ferns
I work as a senior lecturer at the University of Greenwich.
I work in the Faculty of Education and Health and the
Department of Adult Nursing and Paramedic Science.
I spend most of my time lecturing in areas of acute care
to pre-registration student nurses and student paramedics
and post qualified nurses working in acute specialities such as
intensive care. By acute care, I'm referring to people experiencing
life threatening changing events, people who presents with
heart attacks, heart failure, serious trauma, sepsis, renal failure,
asthma, pneumonia those types of life-threatening events
and I thought today I'd use my time to talk about a relevant
A-level biology topic and the respiratory system and link it to
the concept of severe choking, which is a life threatening
emergency situation. I've chosen choking for a
number of reasons, first of all let's say what is choking?
Choking is the inability to breath because the trachea is
blocked constricted or swollen shut. It's a medical emergency.
When a person's choking air cannot reach the lungs if the airway
cannot be cleared death follows rapidly, and what we're
going to talk about today is link the respiratory system
to what happens when people choke, how people
present when they choke and essentially why people die

when they choke. Choking is an important condition for us to consider for a number of reasons. Government statistics from the UK suggests that in England, Wales and Scotland in 2016 there was a 17% increase in the number of people who choked to death, over 280 people died from choking over that time period in England, Scotland and Wales. In America over 5000 people a year die from choking. It's the 4th leading cause of unintentional injury due to death.
It's also a personal topic as the government has recently announced that all children are to be taught CPR in the school curriculum by 2020 and choking can lead to death via cardiac arrest. Personally, I'm also interested in it because of some my personal heroes, in particular
Bon Scott from ACDC unfortunately died following an experience of choking. So we're in the really beautiful University of Greenwich campus in Stockwell Street.
It's a very famous and fantastic area Greenwich.
Greenwich was the birthplace of the Tudor monarchs Henry VIII, Mary I and Elizabeth I. It was believed to have been the favourite place of Henry VIII. It's been very closely associated with naval history and it's also very famous for the concept of Greenwich Mean Time.
Greenwich Mean Time is an important starting point for my talk today because the first person I'm gonna refer to, is a famous Russian scientist Dmitri Mendeleev.
I've chosen Dmitri Mendeleev because essentially, one could argue, he was a time traveller. If he wasn't a time traveller at least he could see in the future because when he produced his periodic table of the elements in 1869 he was able to chart the properties of elements that hadn't been discovered

at that point elements like gallium, scandium, or germanium
at pretty impressive stuff for an 1869 scientist.
We've chosen Mendeleev because we're going to chat
and focus on an important element, I'll give you a clue
what that element is: it's the first most abundant element
in the universe, it's 8th on the periodic table,
it comprises 21% of the earth atmosphere.
What do you think? Yeah, I'm hoping you all saying it's oxygen.
That's right, oxygen 8th on the periodic table, mainly associated
with the English scientist Joseph Priestley, who discovered
oxygen in 1774 and its name comes from the French scientist
Antoine Lavoisier, from the Greek "oxys" meaning acid
and "genes" mean forming. It's interesting that Priestley
tends to get the credit for oxygen and the discovery of oxygen
that's just because he published his work first.
So yes we humans breathe in air containing approximately
21% oxygen, 20.98% oxygen if we want to be precise,
and we breathe out around about 16.5% oxygen
which is significantly less. In comparison we breathe in 0.04%
of carbon dioxide and we breathe out 4% carbon dioxide.
100 times more carbon dioxide is breathed out than breathed
in because we are essentially carbon dioxide producers and oxygen
users what we really gonna look at today is why oxygen
is so important. Why do we need oxygen for ourselves
to work? What is the consequence of not being able to
breathe in oxygen? How oxygen is linked to the famous
energy currency that crucial to life in human beings:
adenosine triphosphate. We're gonna connect the respiratory
system to oxygen, oxygen to adenosine triphosphate,
adenosine triphosphate to choking and explain why people
die when they choke. So we're just gonna quickly

run through the oxygen journey as any A-level student will probably know, it frequently comes up in A-level exams. So, let’s imagine we take a breath in. When we take a breath in, our respiratory muscles contract, the rib cage expands the diaphragm contraction flattens, pressure in the thoracic cavity drops below atmospheric and we start to inhale air and oxygen passively into the upper airways. And we just think about that journey going from the person’s nose to their alveoli, as they breathe in the air passes over the nasal passages or the oral cavity and then the nasopharynx the oropharynx that laryngopharynx, the larynx just behind the Adam's Apple the trachea and then the trachea splits into the right and left bronchus as the respiratory system get smaller and smaller it's viewed as a bronchial tree and what we have when the trachea splits is a right and left bronchus then a secondary bronchus, a tertiary bronchus bronchioles, terminal bronchioles, respiratory bronchioles, and in the end point, there eventually reaches the primary site of gas exchange the alveoli. The distance between the nose and the alveoli is frequently referred to in the medical literature as Dead Space, because this is essentially conducting space no gas exchange takes place in this area, the whole point of the respiratory tree is to deliver oxygen to the alveoli. The alveoli is the primary site for gas exchange this is where we find the blood gas barrier, which is the interface between the respiratory system and the cardiovascular system. This interface is massive in size you have approximately 500 million alveoli in the lungs, it gives the surface area of the lungs and a 40 times bigger surface area than the skin. It's also an extremely thin barrier somewhere in the region of 600 nanometers to two micro-meters, that's incredibly small when we think that a nanometer is a billionth of a metre. The reason why the lungs need such a large surface area and needs such a very thin membrane between the respiratory system and the cardiovascular system is in order for diffusion to take place. Diffusion is the movement of oxygen from high concentration in the alveoli to low concentration in the blood stream. It's mainly associated with the famous German scientist Adolf Fick, probably the second most famous Adolf in history. He came up with a mathematical concept Fick's Laws in 1855 and diffusion is an absolutely crucial concept to understand in biology, it's important because it explains how you breathe in oxygen, it also explains how you breathe out carbon dioxide it explains with degree how your nervous system works, explains to agree how your heart generates electricity it's a really important area for A-level biology students to understand. So we've said that diffusion is the movement of molecules from region of high concentration to a region of low concentration and in this point were talking about oxygen movement from a high concentration to a low concentration and we just emphasising that the lungs have a really, really good adaptation for allowing diffusion to take place. So for example the lungs have a very large surface area, the membrane which oxygen moves across is extremely thin as a pressure gradient, so you have a high amount of oxygen in the alveoli and a low amount of oxygen in the blood stream and that allows oxygen to move smoothly through the blood gas barrier

and move into the circulatory system.
Once oxygen diffuses through, into the circulatory system it binds with haemoglobin. It's been well understood by haemoglobin has a crucial role to play in oxygen carriage because this was emphasised as far back as 1840, by the German scientists Fredrich Hundfeld haemoglobin has a fantastic ability to carry oxygen in the form of oxyhaemoglobin.
Some of the numbers that we think about when we think about biology are crazy numbers and it is worth mentioning that Adolf Fick, originally started his career as a mathematician rather than a physiologist. When you think about oxygen carriage it's crazy to believe we think at any one point in our circulatory system we have somewhere in the region of 20-30 trillion red blood cells carrying oxygen. A pinhead of blood contains 5 million red blood cells. We actually make somewhere in the region of 2.5 million red blood cells every second.
So, mathematics is very important concept in biology and although these crazy numbers are very difficult sometimes to get a grip of, mathematics does make an understanding of biology a little bit simpler.
For example: if you want to see your GP and they measured your haemoglobin, haemoglobin is measured through units of measurement called a decilitre, so normal haemoglobin in the blood stream of a man is 12-15g a decilitre for a woman it's 12-14g a decilitre by a decilitre we mean a 10^{th} of a litre which is 100ml. What that means is every 100ml of a typical adult male carries 15g of haemoglobin. And what's interesting about that 15g of haemoglobin is we know that 1 gram of haemoglobin can carry 1.34ml of oxygen so if you have 15g of haemoglobin

per 100ml of blood that means that each 100ml
of your blood carries approximately 20ml of oxygen. Now if
100ml of your blood carries 20ml of oxygen 1ltr of
your blood is gonna carry 200ml of oxygen and 5ltr
of blood which is the normal circulatory volume for human adult
and will carry 1000ml of oxygen. What that simply means
is we have 5ltr of blood in our circulatory system,
our respiratory system is able to deliver oxygen to the
circulatory system, and then circulatory system is able to carry that
1000ml of oxygen to your tissues, and what we're
going to do is explain how oxygen is used to make
adenosine triphosphate. We mentioned choking at the
beginning as well, and a couple of good points that we
can now make about the symptoms of choking: one
of the first things that you classically we see with
people who choke, and it's quite important that most
people who choke choking is witnessed because
people frequently choke when they ingest food.
If you meet the person who's choking, one of the first things
that you may notice about them is they will have an
inability to make any sound, they're not able to make
any sound because if their airway is completely blocked,
no air is able to move over the vocal cords, if no air
moves over the vocal cords the vocal cords don't open,
close, or vibrate and the vocal cords don't open,
close or vibrate you don't get any sound emission
from the patient, so classically someone who looks
like they're trying to cough but they're not making any
sounds at all at a really good indicator that that person
may will be choking. Second symptom that you classically see
is a change in the person's colour. If the person

has white skin and is choking their colour deteriorates and they frequently changed to a purplish-blue colour, if they got darker skin, they tend to change to a grey colour. That’s because if they are not able to breathe any oxygen in they're not able to deliver any oxygen to haemoglobin and haemoglobin that is deoxygenated that doesn't have any oxygen connected to it, is purpley-blue in colour and if the person’s unable to breathe as the amount of the deoxygenated haemoglobin - haemoglobin carrying no oxygen - goes up the purplish colour or grey colour starts to reflect in the person’s colour of their skin. So making no sound and changing colour, two classic symptoms that the person is choking. Moving back to the oxygen journey now, I often think that the textbooks about the oxygen journey and the respiratory system are written backwards. After a typical A-level student has opened up their textbook and started to learn about the nasopharynx, the oropharynx, the laryngopharynx, the larynx, the trachea, the bronchus, the bronchioles, the terminal bronchioles, the alveoli, after they've talked about diffusion and the carriage of oxygen, and don't forget we're only skimming over the respiratory system, we’re not talking really about the function of the upper and lower the respiratory system, we haven't touched upon classic respiratory concepts like the cilia, macrophages, goblet cells, mucus the role of the respiratory system in immunity, the role of the respiratory system in terms of muscular tone, very often I find that A-level students become completely exhausted. It's a massive amount of information to take on board. In fact I remember my own biology teacher when I was studying A-level biology, explaining to me that biology isn't about factual recall, however when I looked at the biology book it actually looked like it is about factual recall and as a massive amount of facts that we need to we need to take on board. The problem with the respiratory system is when you reach a typical respiratory system textbook, it's only at the end of the textbook or the chapter on the respiratory system when you find out what you really need oxygen for. If you're going to know anything about the role of the respiratory system, what's important is when that oxygen arrives via the circulatory system at the cells, the oxygen diffuses through the cell membrane into the cytoplasm of the cell and glycolysis, the krebs cycle an electron transport phosphorylation all take place. Those three concepts are referred to as aerobic-respiration and the endpoint of aerobic-respiration is oxygen allows the human cell to produce ATP adenosine triphosphate, heat, water and carbon dioxide. First thing to mention very briefly is carbon dioxide, we said right at the beginning of this talk that humans breathe in 0.04% carbon dioxide and breathe out 4% carbon dioxide. The reason why we breathe out 4% carbon dioxide is because we make carbon dioxide during aerobic-respiration. We're using oxygen to make adenosine triphosphate as a by-product we’re making carbon dioxide. Because we make

carbon dioxide, we end up breathing a lot of carbon dioxide out. Okay so we've said that when the oxygen arrives at the cell glycolysis takes place, glycolysis basically the splitting of sugar. In aerobic-respiration what you get in cell level is a combination of sugar and oxygen. First components of aerobic-respiration is the splitting of sugar, that's literally what glycolysis means and when the sugar splits you end up with two pyruvates. The second stage of aerobic cellular respiration is the krebs cycle. What happens in aerobic-respiration is: the pyruvate enters the krebs cycle. The krebs cycle is able through a series of cyclical chemical changes to produce a variety of high energy bonds and it's the high energy bonds that move into the third stage of aerobic-respiration - electron transport phosphorylation - that results in the production of adenosine triphosphate.
We've said that this takes place in three stages but all of these things are taking place simultaneously and some textbooks say there aren't three stages, there's four stages, it doesn't really matter 3 or 4 stages, the point that matters is: the endpoint electron transport phosphorylation is ATP production.
We mentioned the krebs cycle, it's worth just pointing out there's another second famous German: Hans Krebs.
He was the person who identified the krebs cycle, it sometimes called the citric acid cycle but it's more closely associated with Hans Krebs. It's at the electron transport phosphorylation chain that oxygen has such a crucial role to play. What happens during

electron transport phosphorylation is that a proton pump is activated. What we mean is hydrogen ions are pumped out of the inner membrane of the mitochondria, the mitochondria is a cell organelle in the cytoplasm. When a hydrogen ion is pumped out of the inner lining of the mitochondria, it eventually creates a concentration gradient where more hydrogen is outside the mitochondria in a membrane than is on the inside. The important role of oxygen is, oxygen is the final electron acceptor. Without oxygen the electron transport and phosphorylation chain does not work. Without oxygen, hydrogen will not move out of the inner membrane of the mitochondria, and if hydrogen is not in the outer membrane of the mitochondria there's no hydrogen to move back in to the inner membrane of the mitochondria and it's when hydrogen moves into the inner membrane of the mitochondria that ATP is produced. What it really means is in aerobic-respiration, without oxygen ATP production will not take place. Oxygen is absolutely crucial to the third stage of aerobic-respiration that is electron transport phosphorylation. So electron transport phosphorylation uses oxygen to make adenosine triphosphate and it’s just worth pointing out how important adenosine triphosphate is. Adenosine triphosphate is viewed, in the biological literature, as the energy currency of the human being. We need ATP whenever we are using anything that requires energy. So if you're using your muscles you need energy. All of your brain activity requires energy. When your heart beats your heart needs energy in order to beat. Without ATP your brain won't function normally and without ATP your heart won't function normally and if you have a lack of ATP production that only really takes 3 or 4 minutes, starving your cells of oxygen for 3 or 4 minutes will result in no ATP production and that lack of ATP production can cause people, if we think about their brain, to have a seizure or to collapse into unconsciousness because there's no ATP to allow their brain neurons to function, or they can collapse the floor with no heartbeat. The reason why they can collapse to the floor with no heartbeat is because, the sign of which we know where the heart generates electricity requires ATP to function. If there's no ATP the heart won't beat if the heart won't beat, the person's gonna fall to the floor and collapse. So two of the serious consequences of choking is frequently a lack of consciousness. We can link that lack of consciousness to a lack of ATP production, because of a lack of oxygen delivery to the cells because the person's airway is blocked. And we can link the person's heart stopping from a lack of oxygen being delivered to the heart which means that the heart is unable to beat. If the heart's unable to beat the person collapses to the floor. They're lying on the floor with no signs of life they suddenly, they subsequently require basic life support resuscitation. And that's one of the reasons why children are gonna be taught how to resuscitate adults in 2020. Okay so just to conclude I'm just going to summarise what I've said so far about the symptoms of choking. Some of the symptoms that we've emphasised is you frequently hear no sound when people are trying to cough when they're severely choking that's because no air's moving over the vocal cords. We've said that the person can turn a purpley-grey colour, that's due to no oxygen being bound to the persons haemoglobin. We've said that the person can become unconscious that can be because of a lack of oxygen to the brain cells, the neurons, resulting in no ATP production and we've said the person can fall to the floor with no signs of life due to their heart not beating and they can die that's also due to a lack of ATP production. So, what do we do with a person who chokes or is experiencing choking? Well, the recent consultation council in the UK view severe choking as a life threatening emergency situation they encourage people to assess the area for safety around the person who's choking, and make sure that anyone who's approaching is safe themselves. It's always a good idea to ask the person who's choking: are they choking? Because, if the person is conscious and awake they will frequently nod, point, give you some indication that they are, you attend that, encourage them to try and cough and then stand behind them and give them 5 hard back blows between their shoulder blades. If the 5 hard black balls between the shoulder blades are ineffective, we do what we refer to as 5 abdominal thrusts. If the adult doesn't respond, with 5 back blows and 5 abdominal thrusts, we continue with 5 back blows and 5 abdominal thrusts

until they do respond or until they collapse
and if they collapse we initiate standard basic life
support procedures. Basic life support procedures
is probably another podcast! Okay so I'd like to
thank everybody for listening to my session today,
I just want to make 1 final comment I mentioned
a number of famous medical heroes of mine:
Austrians through Adolf Fick, Joseph Priestley an Englishman
Antoine Lavoisier a Frenchman the German scientist
Hans Krebs and this is all worth mentioning because
today January 15th 2019 is a famous day in UK history
because parliament are voting on the Brexit arrangements.
I've always thought that these heroes from all
across Europe, if they were alive today, people who've
been involved for moving history forward,
moving knowledge forward, moving education forward,
collaborating with their counterparts what would they say?
They would all say "Brexit is a mistake" and they
would all say "Say no to Brexit."
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