

## Does high dose injectable Vitamin C work as an oxidant or as an antioxidant or both in cancer treatment?

Ian Dettman<sup>1</sup>

(1) Australasian College of Nutritional and Environmental medicine

In vitro Vitamin C (Vit C) is known to kill cancer cells in a dose/concentration dependent way. In animals and patients high dose Vit C also is effective in cancer and higher dose/concentration is more effective. Protocols are used that get very high plasma concentration. There are many theories about why this works. One very popular theory is the pro-oxidant theory. Extracellular matrix (ECM) contains proteins which contain redox active metals like Cu or Fe. Vitamin C in the ECM reduces these protein bound metals ( $3^+ \rightarrow 2^+$ ). The metals then react with molecular oxygen to form superoxide ( $O_2^-$ ). 2 superoxide molecules react to form hydrogen peroxide ( $H_2O_2$ ). This is called dismutation and might require enzymes (SOD). Two superoxide molecules react to form hydrogen peroxide ( $H_2O_2$ ). This is called dismutation and might require enzymes (SOD). The pro-oxidant theory says that the presence of Vit C (a reducing molecule) forms  $H_2O_2$ .  $H_2O_2$  is an oxidizing molecule.  $H_2O_2$  causes cancer cell damage/death. This has been demonstrated many times. The pro-oxidant theory shows that the amount of  $H_2O_2$  produced increases with the amount of Vit C present. This all happens in the ECM. The  $H_2O_2$  produced diffuses over the cancer cell membrane and affects the cancer cell directly. It may turn on cell death mechanisms. This pro-oxidant effect may work with any high dose reducing agent. In cancer treatment Vit C is used because it is safe in very high doses and can get very high concentrations in the ECM in a patient. The Vit C must be in its reduced form, i.e. ascorbate. Otherwise it does not work. The vitamin C as ascorbate is a reducing agent. This means it is an electron donor (it gives an electron). This is all it does.

This is how antioxidants work. For Vit C to give an electron to form  $H_2O_2$  these must be in the ECM: Molecular  $O_2$  and A redox active protein with Cu or Fe metal ions that can react with Vit C and  $O_2$ . ECM will contain various proteins which contain redox active metals. But ECM may not contain a lot of molecular  $O_2$ .  $O_2$  is usually bound in transporters. In vitro there is always  $O_2$  present in the medium because the medium is exposed to air. The medium may also be exposed to light and some redox active proteins are activated by light. Another problem with using medium in in vitro experiments is that the medium is different to ECM. The results might not be the same as in living systems. Another problem with using medium in in vitro experiments is that the medium is different to ECM. The results might not be the same as in living systems. Another problem with using medium in in vitro experiments is that the medium is different to ECM. The results might not be the same as in living systems. Experiments in medium can produce in vitro artefacts. When experiments to test the pro-oxidant theory have been tried in animals the ECM has been extracted to test for  $H_2O_2$ . This means that the samples are exposed outside the body, the results might not be the same as what happens in the living animal. So is Vit C a pro-oxidant or an antioxidant in cancer treatment? It has been shown that in exposed solutions Vit C can produce  $H_2O_2$ . We already know this happens in in vitro cancer experiments. It also happens in TPN solutions. This does not mean that this happens in the ECM of animals or patients. This has not been proved at all. Vit C is a very reactive molecule. It produces all kinds of results in in vitro experiments that do not happen in living animals.

All that Vit C does is give an electron. In this way it is always an antioxidant. Does Vit C have a pro-oxidant effect? It has not been proved that the pro-oxidant theory is true because it has not been proved yet in living animals. High dose Vit C in patients almost never has the same spectacular effects on cancer cells seen in test tube experiments. But Vit C is effective in cancer patients. Is the Vit C doing something else in living patients?

There are many other ideas about why Vit C works in cancer patients. The pro-oxidant theory has not been proved but at present it is the most popular theory about why Vit C works in cancer.