

# **Chronic Granulomatous Disorder**

*A guide for patients  
and families*

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# Introduction

It is estimated that one in 250,000 babies is born with chronic granulomatous disorder (CGD), although symptoms of the condition may not appear until after 3 months of age. Thanks to advances made in diagnosis and treatment, most people with CGD can now expect to live a full life – some of the first patients diagnosed with CGD have now finished school, and are working, raising families and leading relatively normal lives.

The medical literature refers to the condition as chronic granulomatous disease. However it is perhaps more accurate to describe it as a disorder in the way certain bone marrow genes function, and this is how we will refer to the condition here.

This short guide to CGD tries to answer the common questions that are often asked by parents and guardians of children with CGD, and by the children themselves.

# Contents

	<b>Page</b>
What is CGD? .....	5
How do phagocytes kill microbes? .....	6
What happens in CGD .....	7
How is CGD Diagnosed? .....	7
What types of infections are common in CGD? .....	8
How often do these infections occur? .....	10
How do people acquire CGD? .....	10
X-linked CGD .....	10
Autosomal recessive CGD .....	12
Having children .....	12
How likely are people with CGD to have children with CGD? ..	14
Do carriers of CGD experience any medical problems? .....	15
How are people with CGD looked after? .....	15
What does the Clinical Nurse Specialist do? .....	17
Preventing infection .....	17
Treating infection .....	18
Bone Marrow Transplantation .....	20
Gene Therapy .....	23
Signs of Infection .....	24
How can a patient help prevent these infections? .....	25
Precautions for CGD patients .....	26
How does CGD affect a person's quality of life? .....	29
Can CGD affect the growth and development of children? .....	30
What about the emotional strain that CGD places on patients and their families? .....	30
What other information is available? .....	32
Conclusion .....	32
Contact details .....	33

# What is CGD?

CGD is a rare disorder that affects the immune system. The human immune system is made up of a complex network of specialised cells and organs that protect us from disease. If any part of this network has a fault, it will interfere with our general state of health and ability to fight off infection.

The World Health Organisation recognises some 80 different primary disorders of the immune system. Primary disorders of the immune system are caused by an intrinsic failure in the system itself – that is, by a genetic or chemical defect, rather than by an outside agent, such as a virus or chemotherapy. These primary disorders vary widely in incidence and severity. Perhaps the best known of these conditions is the ‘baby in the bubble’ syndrome, where a baby is born with virtually no immunity.

CGD is one of these primary immunodeficiencies. The fault in this condition is found in special cells, called phagocytes, which are made by the bone marrow.

The killing process in phagocytes is triggered whenever they come into contact with bacteria or fungi. First the phagocytes will surround and engulf (or ‘eat’) the invader and then attack them with chemicals, which are very similar to bleach. In fact the phagocytes can be described as ‘mini bleach factories’, as they produce toxic oxygen-containing substances, such as hydrogen peroxide and a form of oxygen called superoxide (Figure 1). In effect, these chemicals disinfect the cell and kill the invading bacteria or fungi. During this process the phagocytes show a sudden intake of oxygen, which is called the ‘respiratory burst’.

**What is a phagocyte?**  
The phagocytes (which mean ‘cell eaters’) are the white blood cells that circulate in the blood and kill fungal and bacterial (microbe) invaders.



**Figure 1(a)**  
In CGD, phagocytes locate intruders...



**Figure 1(b)**  
they can also engulf them...



**Figure 1(c)**  
but they cannot kill them, so the infection is not stopped.

The above illustration is reproduced by kind permission of Kees Waas, taken from his booklet "The immune system and its deficiencies", written for IPOPI (International Patient Organisation for Primary Immunodeficiencies).

In CGD patients the phagocytes, whilst able to engulf the invaders, cannot produce the bleach-like chemicals to kill them. This means that people with the condition are at risk of developing serious, potentially life-threatening, bacterial and fungal infection. Infection can take the form of abscesses, enlarged lymph glands, unusual pneumonias or bone infections. People with CGD may also experience chronic inflammation, which can, for instance, result in swollen gums, or, where there is chronic inflammation in the bowels, in chronic diarrhoea.

Problems may also be caused by granulomas, which are lumps of white cells clustered together. These form when white cells collect in one area. Granulomas can be troublesome if they form in the walls of narrow tubes where they cause obstruction, such as in the digestive tract where they can cause problems with swallowing or in the urinary tract where they can block the flow of urine from the bladder or kidneys.

## How do phagocytes kill microbes?

When an invader needs to be killed genes 'switch on' a system of four proteins, which make up the bleach factory. This system is called NADPH oxidase and is responsible for

the formation of the superoxide and hydrogen peroxide (bleach-like chemicals) that combine with other chemicals to kill the invading bacteria or fungi.

## What happens in CGD?

In CGD, one of the proteins of NADPH oxidase is either missing or defective. Although all four proteins have different parts to play in the system, if one does not work properly the whole system breaks down and oxygen is not activated. Because of this, phagocytes are unable to kill bacteria or fungi normally. CGD can be caused by a defect in any one of the four proteins in NADPH oxidase (Table 1).

Protein	% of CGD patients	Genetic Inheritance	Patients affected
Gp91	60%	X-linked inheritance	Males only
p22	5%	Autosomal recessive	Both sexes
p47	30%	Autosomal recessive	Both sexes
p67	5%	Autosomal recessive	Both sexes

**Table 1**  
*The four different types of CGD*

## How is CGD diagnosed?

CGD would be suspected in a patient suffering from certain severe or recurrent bacterial or fungal infections or enlarged lymph nodes. To confirm diagnosis, the doctor will usually ask for a blood test. This test shows if the cells are unable to produce the bleach-like chemicals. There are two different methods used to do this test – NBT (nitroblue tetrazolium) test or a ‘flow test’. Doctors may often want to do both of these tests, in order to confirm the diagnosis of CGD. Other tests can also show the efficiency of the patient’s

**How does the doctor make a diagnosis?**  
He/she will ask for a blood test. There are two tests and well recognised laboratories can offer both methods.

phagocytes in killing bacteria. Once CGD is diagnosed, special X-rays, blood and urine tests may be necessary depending on the individual patient's symptoms. Baseline blood tests are also carried out when the patient is healthy. The results from these tests can be compared with the results from later tests, to find out if any of the responses are faulty and causing illness. Patients with CGD should have regular blood tests so that any problems can be found and treated early.

## What types of infections are common in CGD?

Common types of bacteria include *Staphylococcus aureus*, *Salmonella*, and *Pseudomonas*, and fungi such as *Aspergillus*.

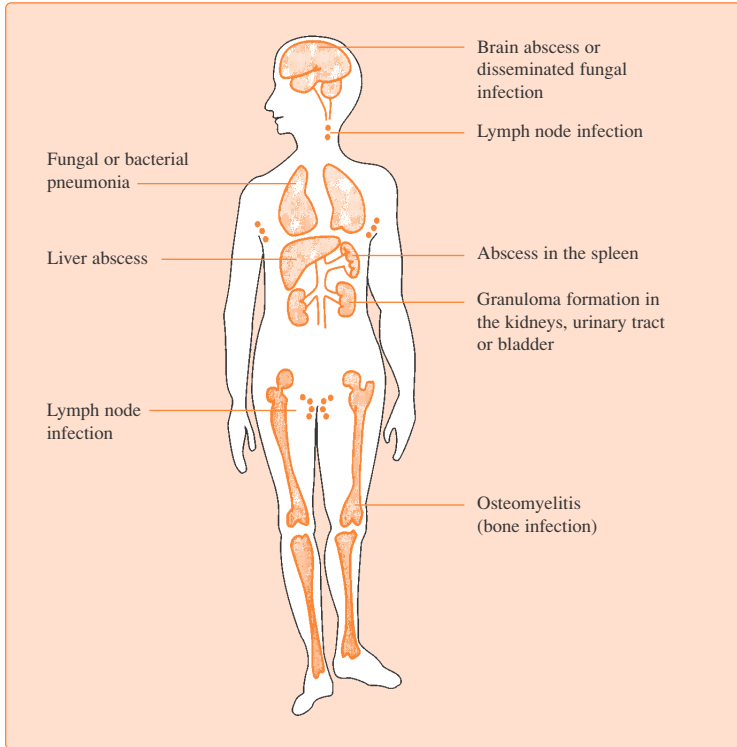
Although these bacteria and fungi can cause infections virtually anywhere in the body, they most often target the lungs, lymph nodes, skin, liver, intestines, nostrils, mouth, or bones in the arms and legs. Common signs and symptoms of these infections are abscesses, diarrhoea, boils, sore skin around or inside the nose, oozing or scaly skin and scalp rashes, ulcer-like sores, gum disease, sores near the anus, local areas of pain and tenderness, swollen lymph nodes, fever, persistent cough, and deficiency conditions because food is not absorbed properly in the intestines.

Some antibiotic or antifungal medications need to be given intravenously (into a vein) and often it is necessary to continue giving these over a long period of time. When this happens patients may need to have a special tube inserted in their neck or chest (often called a central or Hickman® line), which allows long-term medications to be given into a



Where can I find more info on treatment of infections.

You will find this on page 18



**Figure 2**  
Common sites  
of infection

vein. These tubes can also be used for the frequent blood tests that patients on these medicines often need.

However the tubes can cause other problems and so should be removed once the immediate need for them has passed.

Patients quite often find that they lose their appetite during long-term treatment. This sometimes means that they need extra nutrition, which can be taken in the form of milkshake drinks or given via a special feeding tube in the nose or stomach. Very occasionally patients may need to be fed intravenously through a central line, for a short time.

*Do you need more information on diet or dietary issues?*  
Contact the CGD Research for a fact sheet and to get the contact details of the CGD Clinical Nurse Specialist.

## How often do infections occur?

CGD patients who are treated preventatively with antibiotics have, on average, one serious infection every 3-4 years, although this varies from patient to patient.

Many patients also have frequent minor infections. About half of all CGD patients have chronic inflammation of the gums (gingivitis), and three-quarters have frequent ulcer-like sores in the mouth. Although these infections are not life-threatening they can be annoying and uncomfortable.

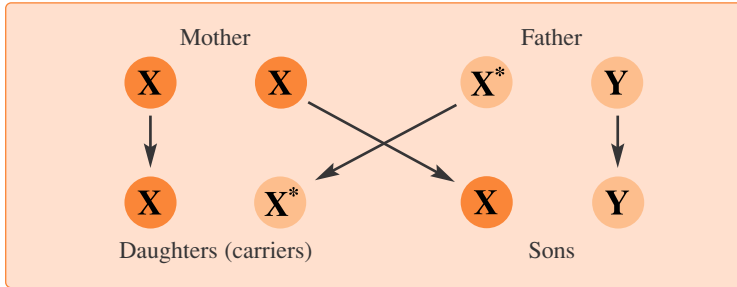
## How do people acquire CGD?

CGD is an inherited disorder, which means that it is passed from parents to their children. Most cells in the body contain over 100,000 genes, which are grouped together on chromosomes (long strings of genes). Each gene contains a code that can be translated by the cell to make a certain protein. The type of protein that is made will decide a particular characteristic of a person (e.g. colour of eyes, blood type, production of phagocytes). Each characteristic is governed by a pair of genes – one inherited from each parent.

There are, however, a few characteristics that are governed by only one gene, rather than by a pair. These characteristics are controlled by genes on the X and Y chromosomes, which determine the sex of a person.

## X-linked CGD

Women have two X and no Y chromosomes, and men have one X and one Y chromosome. In 60% of cases the defective gene that causes CGD is located on the X chromosome. Because the gene is found on the so-called sex chromosomes,

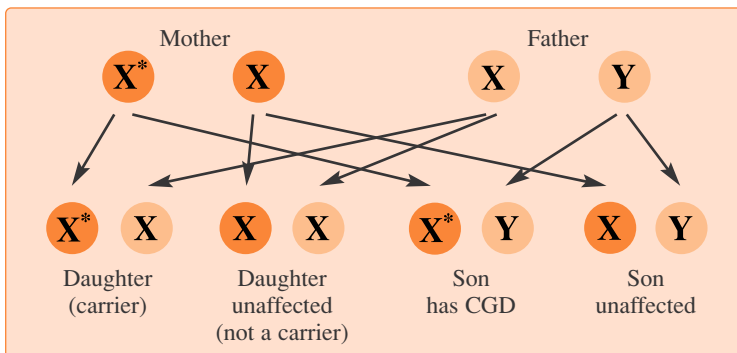


**Figure 3**  
*A father with CGD passes on his defective X chromosome (\*) only to his female children. In this case, however, these children did not develop CGD as they have inherited an active chromosome from their unaffected mother. They do, however, become carriers.*

the disorder is said to be sex- or X-linked.

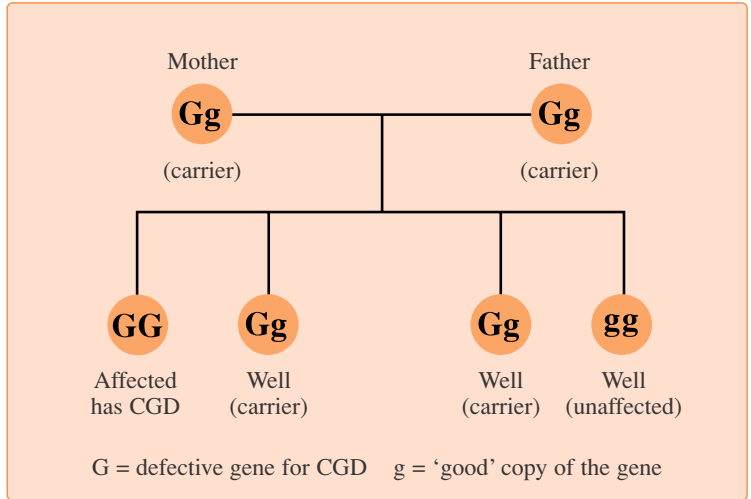
Women inherit one of their mother's two X chromosomes and their father's only X chromosome. The CGD gene is a recessive gene, so women who inherit only one copy of the defective gene (from either parent) do not develop CGD, because normal phagocytes are produced from the gene on the other 'good' X chromosome (Figure 3). These women may be called carriers, because they do not have CGD but, because they still have a defective gene in all their cells, they can pass it on to their children. Carriers seem to be prone to mouth ulcers and certain types of skin rashes (see page 15).

Men inherit one of their mother's two X chromosomes and their father's only Y chromosome. If a man inherits a faulty X chromosome from his mother he will develop CGD. Because of this, there are more men with CGD than women.



**Figure 4**  
*X-linked inheritance from carrier mother to baby.*

**Figure 5**  
*Autosomal  
Recessive  
Inheritance*



## Autosomal recessive CGD

CGD is also caused by defective genes on chromosomes other than sex chromosomes (i.e. on chromosomes which are called 'autosomes'). In this type of CGD the defective genes are termed 'recessive'. This is because the phagocyte only needs one good copy of the gene. Individuals who have only one defective gene will not be affected by the disorder. They will, however, be carriers.

For a child to have autosomal recessive CGD they must have two defective genes. If the child inherits the defective gene from both Mum and Dad then he or she will have CGD.

## Having children

Women with CGD can become pregnant and have babies without adverse effects to their health. Some of the drugs used to treat the infections common in CGD patients can be passed from a pregnant woman to her baby, and may cause

birth defects or miscarriage. However, there are suitable alternatives that are safe to use in pregnancy.

Women with CGD should discuss these issues with their doctor prior to becoming pregnant so that plans for alternative medication can be made and women can be sure they are in optimum health.

When this is not possible women should inform their doctor as soon as they know they are pregnant. It is crucial that women with CGD should not simply stop taking their preventative medication as this may place both them and their baby at risk. Any potential infection, and the treatment it may entail, is potentially more harmful than taking appropriate preventative medication.

Another consideration is the possibility of parents passing on CGD to their children. Blood tests and a family history can be used to estimate the likelihood that a child will inherit the disorder. CGD patients and families may find that a hospital genetic counselling service can offer valuable guidance and advice on family issues.

A prenatal test on tissue (chorionic villus sampling, 'CVS',) or fluid (amniocentesis) from the womb during early pregnancy can show whether the baby will have CGD.

A technique called Pre-Implantation Gender Determination (PIGD) which involves using IVF (in vitro-fertilisation) treatment, can be used to enable couples to choose the sex of their baby. This is a new and rather complicated technique, which is currently offered by only a few centres. Again, a hospital genetic counselling service is the best source of advice and information about this technique. Staff will be able to refer couples to a centre that offers a PIGD service.

**Table 2**  
*How likely are people with CGD to have children with CGD?*

X-Linked CGD	Chance of developing condition (%)		Chance of being a carrier (%)	
	Boys	Girls	Boys	Girls
CGD father Unaffected mother (i.e. not carrier or autorecessive)	0%	0%	0%	100%
Unaffected father (i.e. not carrier or autorecessive) Carrier mother	50%	0%	0%	50%

Men who have X-linked CGD cannot pass on the disorder to their children, although all their daughters will be carriers of CGD.

## How likely are people with CGD to have children with CGD?

Both men and women can pass the condition on to their children. The chance of a child of a CGD parent developing CGD varies considerably with the type of CGD involved (X-linked or autorecessive) and is also dependent upon whether the other parent has any genetic links with CGD. There are many connotations and some are summarised in Table 2.

### Autosomal recessive CGD

It would be extremely unlikely that an individual with autosomal recessive CGD would go on to have a child with CGD. There is a 50% chance of any children being carriers. However a carrier would only have a child with CGD if their partner carried the same genetic defect, which would, again be very unlikely indeed unless the parents of the child are close family members.

## Do carriers of CGD experience any medical problems?

Mothers of males with CGD may be carriers of the X-linked form of CGD. Carrier status can be determined by a simple blood test (NBT). In general carrier mothers are healthy although in some cases may get recurrent mouth ulcers or even regular skin infections. If these are troublesome, prophylactic antibiotics could be tried. Occasionally carrier mothers may have a condition called lupus.

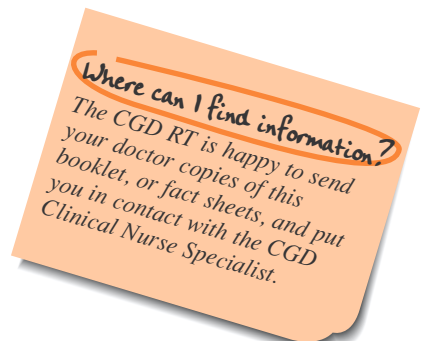
There are two common forms of lupus. One form, Discoid Lupus (or DLE) is largely confined to the skin. A second form of this disease, Systemic Lupus Erythematosus (SLE) is more generalised. SLE is a disease in which an individual's own immune system attacks part of the body. The common symptoms of this condition are skin rashes and joint pains, but may include inflammation of internal organs such as the lungs, heart, nervous system and kidneys.

Mothers with appropriate symptoms who are concerned should discuss this in the first instance with the family GP or family practitioner. It is important to tell them there is a known link as they may not be aware of this.

## How are people with CGD looked after?

### Medical Advice

CGD is a rare condition so don't be surprised if some doctors and nurses are not familiar with it.



## Who takes care of the patient?

It is important to have a good point of reference at your local hospital that you can turn to when you need advice. Another important source of advice is the Clinical Nurse Specialist.

You should be referred by your GP to the local children's or adult hospital where you will be seen by a consultant. For many people this is likely to be an immunologist. It is a good idea to have regular appointments with this consultant to keep an eye on your general health and to make sure any problems, for example with drug levels or side effects, are picked up early. Regular blood tests will help to monitor your state of health.

*Is there anything I should do when I visit the doctor/clinic?*

*It is handy to take a note of any infections, antibiotics and symptoms that you have had since the last visit. This will help you to give your doctor the complete picture.*

## Should I see anyone else?

In the UK, the CGD consultants offer a system of 'shared care'. This joint care system means that you see your local consultant regularly *and* make an annual visit to the CGD consultant. The CGD consultant has the advantage of seeing a number of affected patients and will know about new developments in treatment. The CGD consultant will be able to provide an 'overview' of management and care and will liaise with the local consultant or other specialist, such as a gastro-enterologist, to whom you may be referred, on treatment options.

## How is this arranged?

In the UK you need to ask your local consultant to refer you to a specialist centre, or your child to a paediatric CGD specialist. You could ring the CGD Clinical Nurse Specialist if you feel you need some advice about this. (Please see page 33 for contact details.)

The consultants will keep your GP informed; the GP's support can be important and you will need help with repeat prescriptions, vaccinations and home visits, if these are necessary.

## What does the Clinical Nurse Specialist (CNS) do? And how can she help?

The CNS offers support and clinical advice to patients and families at home across the UK and also acts as a resource for local healthcare professionals, such as hospital doctors, GP's and District Nurses. If you have any concerns or need advice or want to chat things through, she is happy to hear from you by phone. The CNS makes home visits, can help in arranging appointments for UK specialist clinics and can accompany you to regional clinics.

**Have you any worries?**  
Phone or email the CNS, who is a great help on every sort of problem! Whether it is a clinical concern or a niggling worry, she will be only too pleased to help. (See page 33).

## Preventing Infection

It is very important for people with CGD to take daily antibiotic and antifungal medication (known as prophylaxis) as a preventative measure against infection. Whilst these medicines do not provide an absolute guarantee against infections, taking antifungal and antibacterial medication each and every day is key to reducing the number and severity of infections that people with CGD encounter.

### Antibiotics

The antibiotic most commonly used in CGD for preventing infection, is Co-Trimoxazole (also called Septrin). Co-Trimoxazole is used because it provides protection against a number of bugs that can cause problems in CGD and is generally well tolerated. It is quite unusual for CGD patients to find that they do not tolerate Co-Trimoxazole but if this does happen it is possible to use another, similar antibiotic.

## Antifungals

The antifungal medication currently recommended to prevent infection in CGD is Itraconazole (also called Sporonox) as it is effective in preventing fungal infections caused by *Aspergillus*. Itraconazole is also relatively well-tolerated. A few people find that it gives them abdominal pain or diarrhoea. In this instance a change of dose or how the medicine is taken, is usually sufficient to solve these problems. Regular liver function checks, in the form of blood tests, are advised if you are taking Itraconazole.

## Treating Infection

Infections in CGD need to be treated promptly with appropriate antibiotics or antifungal agents where necessary. These may often need to be given via an intravenous drip to ensure that they work quickly and effectively. The particular combination of antibiotics and antifungals will depend on the type of infection and where it is in the body.

## Antibiotics

In CGD antibiotics often have to be given even if the doctors can't be sure exactly which bug is causing the infection. In this case antibiotics that are effective against a number of likely bugs are used. These can be changed later to more specific antibiotics if a particular bug is identified as causing the infection.

## Antifungals

A medicine called Amphotericin B (or Ambisome) is currently the most common form of treatment used in fungal infection. This particular medicine has to be given via an intravenous drip and is given once a day. It is often used in combination with other antifungal medications, most of

which can be taken by mouth. Two new drugs, Voriconazole and Caspofungin are giving encouraging results; additional useful drugs are currently being developed.

Fungal infections can also be quite hard to detect and sometimes it is not possible to prove for sure that a fungus is causing a particular infection. As fungal infections can be very serious doctors will treat an infection as fungal if they have sufficient reason to think that it is there, from the symptoms that the patient has and from what can be seen from X-rays, scans etc. Fungal infections can be hard to get rid of and treatment is often required for many weeks or months.

### Interferon Gamma

Interferon (IFN) gamma is sometimes used in CGD as a preventative against infection. It is more commonly used as a preventative in the United States, whereas in the UK and Europe it is generally reserved for use in difficult infections or complications when it is used in conjunction with antibiotics and other treatments. This is because the exact way in which IFN works is not yet known and it's usefulness in preventing infection is not certain, particularly when compared to the use of preventative antibiotics. IFN is also less 'user-friendly' as a preventative, as it has to be given by injection, usually three times a week and causes flu-like symptoms in many of the people who receive it.

### White cell transfusions

Transfusions of normal white cells from healthy donors are only occasionally used in the treatment of serious or difficult infections that are not responding to other forms of treatment. (There is still quite a lot that isn't known about using white cell transfusions in regard to exactly how effective they are and what is the best dose to give). They can cause reactions

in some patients similar to those that can occur with standard blood transfusions. This is more likely to happen if a patient has received previous transfusions of white cells. In addition, the number of cells needed to be effective hasn't been well researched and getting enough from donors can be very difficult. Hence, white cells are used rarely and with caution.

## Treating Inflammation

Some of the problems that people with CGD have are caused by inflammation rather than infection. These include colitis (inflammation of the large bowel), problems with vomiting or swallowing, and cystitis (inflammation of the bladder).

These inflammatory problems are treated with anti-inflammatory medicines, including steroids.

For complications such as cystitis and swallowing problems, steroids are generally only needed for a few days. In other circumstances a longer course of treatment may be necessary.

## Bone Marrow Transplantation

Bone marrow is the soft, spongy tissue found in the centre of bones. It is responsible for producing the three main types of blood cells: red blood cells, white blood cells, (including neutrophils) and platelets. All of these start off as immature cells called 'stem cells'. These cells mature in the bone marrow and are then slowly released into the blood stream. A bone marrow or stem cell transplant involves collecting healthy cells from a donor and introducing them into the patient.

Bone marrow transplant for CGD involves replacing the defective neutrophils. A patient receives bone marrow from a compatible donor who shares the same 'tissue type' (or cell type) as them and is therefore called a 'match'. This donated bone marrow contains new healthy stem cells from which,

once inside the patient, new healthy neutrophils will develop.

In order to allow for these new cells to grow and develop the patient has to undergo 'conditioning'. In conditioning the patient is given several powerful medicines, called chemotherapy, which works in two ways:

- 1) to make space for the new stem cells
- 2) to suppress the immune system in order to encourage acceptance of the new cells

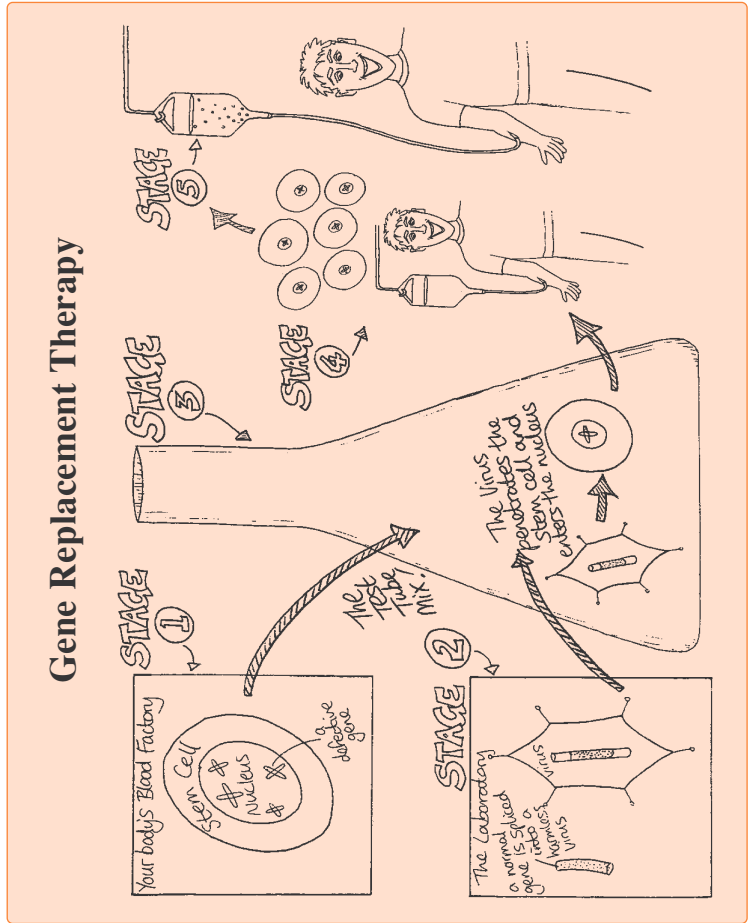
Having a bone marrow transplant involves a 6-8 week stay in hospital during which time the patient is looked after in an isolation room on a transplant ward. This ward will have more restrictions on visiting, diet and hygiene than a general ward. This is because during transplant the patient's immune system is low and a few extra precautions are necessary to protect them from infection.

Over the last few years, there has been slow steady but significant progress in bone marrow transplantation techniques and recent results for patients affected by CGD have been very good. However, bone marrow transplant is not without risk. There are 2 main risks associated with BMT for patients with CGD. The first of these is that the powerful medicines used as 'conditioning' may damage the lungs and liver, and leave the patient vulnerable to life-threatening infection for some weeks after the transplant.

The second is associated with Graft-versus-Host disease (GvHD). In GvHD the new bone marrow from the donor may recognise the patient's cells as 'foreign' to it and react against them. GvHD can cause problems with the skin, liver and bowels.

How do you determine a person's tissue type?

Determining a person's tissue type involves taking a blood sample which is then analysed to determine the exact cell type.



**Figure 6 – Gene Replacement Therapy.**

**Stage 1** – All blood cells are made by mini blood factories called ‘stem’ cells. These cells are found in the bone marrow and the blood. Some of the patient’s stem cells (containing the defective gene) are removed by taking a small amount of bone marrow or blood. **Stage 2** – The normal, healthy gene is duplicated using genetic engineering in the laboratory. This new gene is ‘spliced’ into a safe virus (viruses are very good at getting into other cells, as you know from the last time you had a cold!). **Stage 3** – The patient’s stem cells and the virus containing the new healthy gene are mixed together in a test tube. The virus penetrates the stem cell, adding the new healthy gene. **Stage 4** – The patient is given some form of conditioning (please see page 21) before the new cells are given back. **Stage 5** – The corrected stem cells are re-injected into the patient’s blood stream. Gradually they are absorbed back into the bone marrow where they carry on their work of manufacturing blood cells – cells that are now capable of fighting infections.

A number of factors determine whether BMT might be a suitable treatment in individual cases. These include the age and current health of the patient and the availability of a sibling who is an exact match for the patient and can act as a donor. It is likely that over the next few years, techniques using a matched donor who is not related to the patients will become more and more successful.

BMT is not suitable for all patients, and the doctors and nurses will discuss the suitability and risk factors involved for each person with them and their family.

## Gene therapy

In gene therapy the patient's own stem cells are removed. The defective gene inside the cells is replaced with a new functioning gene before the cells are returned to the patient.

The procedure followed for gene therapy is very similar to that for bone marrow transplant. Gene therapy also requires a lengthy stay in hospital and a period of isolation. Some 'conditioning' with chemotherapy is also necessary but much less than is required for bone marrow transplant. For this reason the risks of gene therapy are lower than those associated with a standard bone marrow transplant, although the patients will still undergo a period where they are at increased risk of infection due to the chemotherapy. As it is the patient's own cells that are used in gene therapy, graft versus host disease is not a problem.

At the time of printing this booklet gene therapy is in its very early stages, being offered to a very few people as part of a clinical trial. It is hoped that it will soon be possible to offer it, like BMT, as a treatment if doctors think it is appropriate.

Would you like to know more about Bone Marrow Transplant (BMT)?

Talk to your doctor about it and then contact the CGD Research Trust for more information.

## Signs of infection

CGD patients will suffer colds and other viral infections like any other person and this part of their immune system will respond normally. Consequently it can be difficult to identify those infections that are 'normal' from those that are a result of CGD. It can be very hard to determine what is a cause for concern and what may be a common cold, particularly when you are first diagnosed with CGD. **If you are not sure, always ask!**

How do I know if ~~we~~ need to tell the doctor?

*If in doubt, contact your consultant or the clinical nurse specialist to talk it over and ask for advice.*

It is extremely important that doctors are contacted immediately if a patient with CGD develops an infection. In this way treatment can be started early and less time should be required to clear the infection.

Therefore, CGD patients should be on the lookout for the following signs of infection:

- A fever of 38°C or above
- Warm, tender or swollen areas
- Hard lumps
- Sores with pus or rashes
- Persistent cough or chest pain
- Persistent diarrhoea
- Frequent/persistent headaches
- Night sweats
- Loss of appetite
- Weight loss
- Vomiting shortly after eating, more or less consistently
- Pain or difficulty on urinating
- Difficulty swallowing food

Where a CGD related infection is suspected, it is best treated early and it often needs intra-venous (IV) treatment. This can be a little upsetting for patients and parents but it is worthwhile to prevent the infection taking hold. It may well reduce the length of treatment period. IV treatment often

requires a hospital stay. Sometimes the patient may leave the hospital during the day and return for overnight infusions. In some instances the patient can have their drugs administered at home.

All spots containing pus should be investigated. Your doctor may want to take a sample of the pus and send it to the lab to identify the bacteria causing the infection.

Occasionally, a sample of tissue (biopsy) is taken from an infected area (usually using a fine, needle-like tube) to trace the cause of an infection. Sometimes, infected tissue must be removed or drained if the infection does not respond to antibiotics, so drainage tubes may be put in the patient's chest, abdomen or other sites. Patients usually stay in the hospital for this.

Your consultant may use other techniques such as ultrasound, X-ray, CT scan or MRI scan to investigate a suspected infection.

If your consultant is not sure of a diagnosis or treatment, encourage him/her to make contact with the CNS or with a relevant centre of excellence who may be able to help. Contact the charity – please see page 33 for details.

## How can a patient help prevent these infections?

**Most importantly, keep taking your daily medication!**

A list of precautions for CGD patients is given in Table 3.

Children with CGD should have the usual immunisations, including vaccinations against polio, rubella, measles and

**Not sure? Don't panic!**

*Help is always on hand!  
Contact your consultant, the  
CNS or, outside the UK, the  
medical professional who  
looks after you/your child.*

**Table 3.**  
**Precautions for**  
**CGD patients**

### **Precautions for CGD patients**

- To avoid inhaling high levels of fungi, do not work with or around mulch, hay, wood chips, grass clippings, other garden waste or firewood that has dry rot or old fungi on it
- Stay out of barns, caves and other dusty or damp areas because of the danger of disturbing harmful fungal spores
- Keep all recommended immunisations up to date to prevent major illnesses
- Be careful with personal hygiene; use mild moisturising soap; brush teeth twice daily; use mouthwash to reduce occurrence of gingivitis
- Take additional antibiotics before and after dental work to attack harmful bacteria that may invade the body during treatment
- Wash all cuts and scrapes thoroughly with soap and water and observe for signs of infection – see page 28.
- Do not drink to excess as this interferes with your medication
- Don't smoke as this weakens the lungs and reduces the body's ability to fight off infection
- Don't smoke marijuana as you may inhale fungal spores
- Avoid swimming in lakes, rivers and canals because harmful bacteria live in the water which may cause stomach upset or infect a wound
- It is inadvisable to go barefoot outside
- Do not use playgrounds with wood chips under play areas as this can contain fungal spores. Choose playgrounds with plain dirt or gravel
- If you must garden, try to wear a surgical mask to filter the air

### *Precautions for CGD patients continued*

- Avoid re-potting houseplants – mould frequently grows in the soil
- If you have fresh flowers, add a teaspoon of bleach to the water to prevent mould and algae
- Do not renovate old buildings or go inside a newly renovated building until it has been thoroughly cleaned as the dust may irritate the lung and can contain fine spores of aspergillus
- Avoid a newly constructed or renovated building until it has been thoroughly cleaned
- Do not rip up or replace carpets or tiles. Have rooms cleaned thoroughly with disinfectant (normal household cleaner) before living in them. Do not sleep in the building until this has been done
- Pets are fine, but do not use wood shavings, hay, straw or sawdust as bedding as this can harbour fungus and bacteria; make sure pets are up to date on all recommended immunisations; keep water dishes and bedding clean to prevent mould growth
- If you use a vaporiser, empty it daily and wash it with bleach to prevent mould
- Fever, especially if accompanied by a cough, should always be reported immediately to your doctor as this may be the first sign of infection

### *Things you can do*

At first sight it seems that there are many ‘don’ts’!

In fact there are many interests and activities that people can pursue.

Bike rides, micro-scooting, theatre club, youth club, visits to the cinema, ten-pin bowling, fencing, art and crafts, walks and visits to play parks with non-bark chipping surfaces are all examples.

Families find it is best to concentrate on the activities they can follow. In a family with affected and non-affected siblings, parents can give each a ‘treat’, by allowing each child to take part in suitable activities at different times. Do take care to present this in a positive light and keep a balance between the level of ‘treats’ for each child.

mumps. It is advisable for people with CGD to avoid the BCG vaccine (many people will, however, have received this vaccine as babies without it causing a problem). CGD patients have a perfectly normal system to fight off viruses. Sometimes influenza can be complicated by bacterial infection and so it is a good idea for people with CGD to have the flu vaccine (if over the age of 6 months).

People with CGD should be careful in their personal hygiene to help prevent minor skin and mouth infections. Because their skin is often sensitive, they may benefit from using mild soap or fragrance-free cleansers and skin care products and plenty of moisturiser.

Dental hygiene is very important in CGD as it is easy for infection to enter through the mouth. Teeth should be brushed thoroughly twice a day with a standard commercial toothpaste. Some patients may also find that using a mouthwash (containing chlorhexidine gluconate) regularly helps to keep gum inflammation at bay. Sugary drinks and sweets can cause a lot of damage to teeth, particularly in children, if taken as snacks throughout the day. It is much better for teeth to keep sweets and sugary drinks to a minimum and save them to be enjoyed at mealtimes.

People with CGD should take antibiotic cover for all dental procedures that are likely to cause bleeding as this can allow bacteria to enter the blood stream. Patients should discuss this with their dentist and doctor before going ahead with dental work. CGD patients should take a course of antibiotics before and after such work.

Cuts should be washed promptly with soap and water and observed for any signs of infection (redness, swelling, hot to touch, pus) which should be reported to a doctor or nurse straightaway.

CGD patients should not drink to excess or smoke, as these can impair the immune system and interfere with the way preventative medications work. They should also not smoke marijuana because they may inhale the mould spores often found in this plant, which can cause a type of fungal pneumonia. They should avoid mouldy grass, mulch and hay for the same reason.

People with CGD should ideally choose sports in which they are unlikely to be cut or scratched, as these might become infected. Low physical contact sports, such as tennis, golf, badminton and swimming have a low risk of accidental injury. Swimming in **clean**, well-chlorinated pools or safe unpolluted seawater poses little risk. Lakes, rivers and canals should be avoided.

If a patient does contract an infection, they must take the full course of any prescribed antibiotics, even after symptoms have disappeared, so that the infection does not recur.

## How does CGD affect a person's quality of life?

Many people with CGD can carry on a normal life with few problems. However, patients and their families should expect, and be prepared for, frequent and sometimes long stays in hospital that may interfere with school or work. Children with CGD can often be tutored at home or in hospital to help keep up with their education. Teenagers with CGD who are planning to go to university should choose one near a medical centre that has doctors who are used to treating CGD.

## Can CGD affect the growth and development of children?

Would you like a fact sheet on growth?

Contact the CGD Research Trust.  
(See Contact details on page 33)

Some children with CGD grow and develop more slowly than their peer group. They may be smaller than other children of their age and they reach puberty later. This can be a particular worry for teenagers although it would appear that many of the CGD children catch-up with their growth later on, often carrying on growing after their peers have stopped and achieving a reasonable adult height. There is, however, the possibility that children who have received prolonged courses of steroids or who have been very unwell for a long time, may not reach the same height as their

parents when they get older. For more specialist advice a referral to an endocrinologist (doctor who specialises in growth and the way hormones work) may be appropriate. This should be discussed with your CGD consultant. The endocrinologist can further advise whether special treatments such as growth hormone should be considered.

Is there a fact sheet on nutrition?

Yes, there is! To ask for this, and for a list of fact sheets that are available, just contact the CGD Research Trust (see page 33)

## What about the emotional strain that CGD places on patients and their families?

Frequent episodes of being unwell, serious infections and long stays in hospital are stressful for both patients and their families. It is important that CGD patients and their parents/partners talk to a hospital social worker and/or a clinical psychologist who can arrange support for them.

It is usual for patients and families affected by CGD to find themselves feeling afraid, angry, frustrated or depressed. Parents of children with CGD may feel guilty about passing on the disorder, or blame themselves for the infections the child has. Parents are also often torn between the needs of their child with CGD and the needs of their other children or the demands of their jobs. All these feelings can cause stress and are absolutely normal.

Brothers and sisters of children with CGD may become jealous of the attention given to the sick child. They may feel resentful, and become increasingly demanding and dependent. They should be encouraged to talk about their feelings and worries – family counselling can help sort out these and other problems within the family. Clinical psychologists who are used to working with children and families can help to suggest ways of talking with children about their illness, or that of their sibling, and strategies that parents can use to address difficulties such as problems taking medicine or demanding behaviour.

Relaxation techniques, such as meditation, visual imagery and therapeutic massage can reduce physical and mental stress and help patients to think positively. Many hospitals offer recreational therapy, such as crafts or playing musical instruments, that can make hospital stays more pleasant and help relieve boredom.

Patients and their families can join support groups for people whose lives are affected by chronic conditions, and a list of support groups for CGD and other primary immuno-deficiency groups are listed on page 33. These can be very useful, as they allow patients and families to talk to people in a similar situation, and discuss their problems and possible solutions.

## What other information is available?

Many CGD patients and their families find it beneficial to keep informed about the advances made in understanding and treating CGD. A list of organisations that may be helpful is given overleaf in Contact details.

## Conclusion

CGD is a rare disorder of the immune system that can lead to serious and repeated infections. It can result in chronic complications as a result of inflammation at various sites in the body.

**However, in recent years the management of CGD has been transformed by the development of new drugs, new methods of diagnosis and improved knowledge amongst medical professionals. The condition is now manageable and provided that sensible precautions are followed, normal life is possible for most people.**

*I've got CGD, what will I be able to do?*

*You will still be able to do most things! Moreover, there are alternatives to higher risk activities. For more detail, look back at 'Things you can do' on page 27.*

The CGD Research Trust is working hard to improve the outlook for patients. In order to receive our regular newsletters, make sure that you (and your consultant) are on our database. (See overleaf for contact details.)

Doctors and scientists are very interested in CGD and are working hard to increase their understanding of the condition. This is good news for all of us – increased understanding leads to improved treatment and it is likely that radical progress will continue to be made.

## Contact details

### **CGD Research Trust**

UK

e-mail: [cgd@cgdrt.co.uk](mailto:cgd@cgdrt.co.uk)

website: <http://www.cgd.org.uk>

Fax/phone: 01725 517 977

For contact details of the CGD Clinical Nurse Specialist,  
please ring: 01725 517 977

### **National Institute of Allergy and Infectious Diseases**

National Institutes of Health, Bethesda, MD 20892, USA

### **Primary Immunodeficiency Association**

Alliance House, 12 Caxton St, London SW1H 0QS, UK

### **CGD Association, Inc.**

2616 Monterey Road, San Merino,  
California 91108-1646, USA

### **International Patient Organisation**

#### **for Primary Immunodeficiencies**

4 La Vigne au Chat, F-01220 Souverny, France

If your doctor is unfamiliar with CGD and is unsure of the most appropriate treatment for CGD symptoms, he or she can always write to any of the above organisations.

**For a current list of fact sheets, specialist details and sources of information please phone: 01725 517 977**

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**CGD Research Trust**  
ENGLAND

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