Understanding Chronic Myeloid Leukaemia (CML)

A guide for patients and families
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The Leukaemia Foundation values feedback from people who have been affected by CML and the health care professionals working with them. If you would like to make suggestions, or tell us about your experience of using this booklet, please contact the National Manager, Support Services at info@leukaemia.org.au.

The Leukaemia Foundation gratefully acknowledges Novartis Oncology and Bristol-Myers Squibb for their support in the production of this booklet through an unrestricted educational grant.

February 2013
INTRODUCTION

This booklet has been written to help you and your family understand more about CML.

Some of you may be feeling anxious or a little overwhelmed if you or someone you care about has been diagnosed with CML. This is normal. Perhaps you have already started treatment or you are discussing different treatment options with your doctor and your family. Whatever point you are at, we hope that the information contained in this booklet is useful in answering some of your questions. It may raise other questions, which you should discuss with your doctor or specialist nurse.

You may not feel like reading this booklet from cover to cover. There is a lot of information contained here and it can be quite difficult to absorb it all. It might be more useful to look at the list of contents and read the parts that you think will be of most use at a particular point in time.

We have used some medical words and terms which you may not be familiar with. These are highlighted in *italics*. Their meaning is explained in the booklet or in the glossary of terms at the back of the booklet.

In some parts of the booklet we have provided additional information you may wish to read on selected topics. This information is presented in the shaded boxes. Some of you may require more information than is contained in this booklet. We have included some internet addresses that you might find useful. In addition, many of you will receive written information from the doctors and nurses at your treating hospital.

It is not the intention of this booklet to recommend any particular form of treatment to you. You need to discuss your particular circumstances at all times with your treating doctor.

Finally, we hope that you find this information useful and we would appreciate any feedback from you so that we can continue to serve you and your families better in the future.
THE LEUKAEMIA FOUNDATION

The Leukaemia Foundation is the only national not-for-profit organisation dedicated to the care and cure of patients and families living with leukaemias, lymphomas, myeloma and related blood disorders. Since 1975, the Foundation has been committed to improving quality of life and survival for people diagnosed. The Foundation does not receive direct ongoing government funding, relying instead on the continued and generous support of individuals and corporate supporters to develop and expand its services.

The Foundation provides a range support services at no cost to people who are affected by a blood cancer and their loved ones. This support may be offered over the telephone, face to face at home, hospital or at the Foundation’s office or accommodation centres, depending on the location and individual needs.

Support may include providing information, education seminars and programs, provide a forum to promote peer support, consumer representation, practical assistance, accommodation, transport, and emotional support.

The Leukaemia Foundation funds leading research into better treatments and cures for leukaemias, lymphomas, myeloma and related blood disorders. Through its National Research Program, the Foundation has established the ALLG Leukaemia and Lymphoma Tissue Bank at the Princess Alexandra Hospital, and the Leukaemia Foundation Research Unit at the Queensland Institute for Medical Research. In addition, the Foundation also funds research grants, scholarships and fellowships for talented researchers and health professionals.
Support Services

“Foundation staff provide patients and their families with information and support across Australia”

The Leukaemia Foundation has a team of highly trained and caring Support Services staff with qualifications and experience in nursing or allied health that work across the country. They can offer individual support and care to you and your family when it is needed.

Support Services may include:

**Information**

The Leukaemia Foundation has a range of booklets, fact sheets, DVDs and resources that are available free of charge. These can be ordered via the form at the back of this booklet or downloaded from the website.

**Education & Support programs**

The Leukaemia Foundation offers you and your family CML-specific and general education and support programs throughout Australia. These programs are designed to empower you with information about various aspects of diagnosis and treatment and how to support your general health and well being.
Emotional support

A diagnosis of CML can have a dramatic impact on a person’s life. At times it can be difficult to cope with the emotional stress involved. The Leukaemia Foundation’s Support Services staff can provide you and your family with much needed support during this time.

Online discussion forum

The Foundation has established an on-line information and support network for people living with leukaemia, lymphoma, myeloma, or a related blood disorder. Registration is free and participants can remain anonymous, see www.talkbloodcancer.com

Telephone Discussion Forums

This support service enables anyone throughout Australia who has or has had CML to share their experiences, provide tips, education and support others in a relaxed forum. Each discussion is facilitated by a member of the Leukaemia Foundation Support Services Team who has a background in haematology nursing.

Accommodation

Some people need to relocate for treatment and may need help with accommodation. The Leukaemia Foundation staff can help you to find suitable accommodation close to your hospital or treatment centre. In many areas, the Foundation’s fully furnished self-contained units and houses can provide a ‘home away from home’ for you and your family at no charge.

Transport

The Foundation also assists with transporting people to and from hospital for treatment at no charge. Courtesy cars and other services are available in many areas throughout the country.

Practical Assistance

The urgency and lengthy duration of medical treatment can affect you and your family’s normal way of life and there may be practical things the Foundation can do to help. In special circumstances, the Leukaemia Foundation provides financial support for patients who are experiencing financial difficulties or hardships as a result of their illness or its treatment. This assistance is assessed on an individual basis.
Contacting us

The Leukaemia Foundation provides services and support in every Australian state and territory. Every person’s experience of living with CML is different. Living with CML is not always easy, but you don’t have to do it alone. Please call 1800 620 420 (Freecall) to speak to a local support service staff member or to find out more about the services offered by the Foundation. Alternatively, contact us via email by sending a message to info@leukaemia.org.au or visit www.leukaemia.org.au
Bone marrow

Bone marrow is the spongy tissue that fills the cavities inside your bones. Most of your blood cells are made in your bone marrow. The process by which blood cells are made is called haemopoiesis (or haematopoiesis).

As an infant, haemopoiesis takes place at the centre of all bones. In later life, it is limited to ‘flat bones’ such as the hips, ribs and breastbone (sternum). Many of you may have had a bone marrow biopsy taken from the bone at the back of your hip (the iliac crest).

You might like to think of the bone marrow as the blood cell factory. The main workers at the factory are the blood stem cells. They are relatively small in number but are able, when stimulated, to reproduce vital numbers of red cells, white cells and platelets. All blood cells need to be replaced because they have limited life spans.

There are two main families of stem cells, which develop into various types of blood cells.
Growth factors and cytokines

Growth factors and cytokines control the process of blood cell formation. Different growth factors stimulate the blood stem cells in the bone marrow to produce different types of blood cells.

These days some growth factors can be made in the laboratory (synthesised) and are available for use in people with blood disorders. For example, granulocyte-colony stimulating factor (G-CSF) stimulates the production of white cells called neutrophils while erythropoietin (EPO) stimulates the production of red cells.
Blood

Blood consists of blood cells and plasma. Plasma is the straw coloured fluid part of the blood that blood cells use to travel around your body, and also contains important proteins.

![Plasma and Blood Cells]

**Blood Cells**

*Red cells and haemoglobin*

Red cells contain haemoglobin (Hb), which gives the blood its red colour and transports oxygen from the lungs to all parts of the body. The body uses this oxygen to create energy.

| The normal haemoglobin level for a man is | approximately 130 - 170 g/L |
| The normal haemoglobin level for a woman is | approximately 120 - 160 g/L |

Red cells are by far the most numerous blood cell and the proportion of the blood that is occupied by blood cells is called the haematocrit. A low haematocrit suggests that the number of red cells in the blood is lower than normal.

| The normal haematocrit for a man is | between 40 and 52% |
| The normal haematocrit for a woman is | between 36 and 46% |
Anaemia

Anaemia is a reduction in the number of red cells or low haemoglobin. Measuring either the haematocrit or the haemoglobin will provide information regarding the degree of anaemia.

If you are anaemic you will feel run down and weak. You may be pale and short of breath or you may tire easily because your body is not getting enough oxygen. In this situation a red cell transfusion may be given to restore the red cell numbers and therefore the haemoglobin to more normal levels.

White cells

White cells, also known as leukocytes, fight infection. There are different types of white cells which fight infection together and in different ways.

<table>
<thead>
<tr>
<th>Neutrophils</th>
<th>mainly kill bacteria and fungi.</th>
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<tbody>
<tr>
<td>Eosinophils</td>
<td>mainly kill parasites.</td>
</tr>
<tr>
<td>Basophils</td>
<td>mainly work with neutrophils to fight infection.</td>
</tr>
<tr>
<td>Monocytes</td>
<td>mainly work with neutrophils and lymphocytes to fight infection; they also help with antibody production and act as scavengers to remove dead tissue. These cells are known as monocytes when they are found in the blood and macrophages when they migrate into body tissues to help fight infection.</td>
</tr>
<tr>
<td>T-cells</td>
<td>mainly kill viruses, parasites and cancer cells; produce cytokines</td>
</tr>
<tr>
<td>B-cells</td>
<td>mainly make antibodies which target microorganisms</td>
</tr>
</tbody>
</table>

When your white cell count drops below normal you are at risk of infection.

The normal adult total white cell count varies between 3.7 and 11 x 10⁹/L
Neutropenia

*Neutropenia* is the term given to describe a lower than normal neutrophil count. If you have a neutrophil count of less than 1 ($1 \times 10^9/L$) you are considered to be neutropenic and at risk of developing frequent and sometimes severe infections.

*The normal adult neutrophil count varies between 2.0 and 7.5 $\times 10^9/L$*

Platelets

Platelets are irregular-shaped fragments that circulate in the blood and play an important role in clot formation. They help to prevent bleeding. If a blood vessel is damaged (for example by a cut) the platelets gather at the site of injury, stick together and form a plug to help stop the bleeding. Platelets will also then release chemicals (clotting factors) to promote the blood clotting process.

*The normal adult platelet count varies between 150 and 400 $\times 10^9/L$*

*Thrombocytopenia*

Thrombocytopenia is the term used to describe a reduction in the platelet count to below normal. If your platelet count drops below 20 ($20 \times 10^9/L$) you are at risk of bleeding, and tend to bruise easily. Platelet transfusions are sometimes given to bring the platelet count back to a safe level.

The normal *blood counts* provided here may differ slightly from the ones used at your treatment centre. You can ask for a copy of your blood results, which should include the normal values for each cell type.
In children, some normal blood cell counts vary with age (see table below).

**Normal range of blood values for children**

<table>
<thead>
<tr>
<th></th>
<th>1 month</th>
<th>1 year</th>
<th>3 years</th>
<th>5 years</th>
<th>9 years</th>
<th>16 years</th>
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<tr>
<td>Haemoglobin g/L</td>
<td>102-130</td>
<td>104-132</td>
<td>107-136</td>
<td>110-139</td>
<td>113-143</td>
<td>115-165 F</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>130-180 M</td>
</tr>
<tr>
<td>White cell count x 10⁹/L</td>
<td>6.4-12.1</td>
<td>5.4-13.6</td>
<td>4.9-12.8</td>
<td>4.7-12.3</td>
<td>4.7-12.2</td>
<td>3.5-11</td>
</tr>
<tr>
<td>Platelets x 10⁹/L</td>
<td>270-645</td>
<td>205-553</td>
<td>214-483</td>
<td>205-457</td>
<td>187-415</td>
<td>150-450</td>
</tr>
<tr>
<td>Neutrophils x 10⁹/L</td>
<td>0.8-4.9</td>
<td>1.1-6.0</td>
<td>1.7-6.7</td>
<td>1.8-7.7</td>
<td>1.8-7.6</td>
<td>1.7-7.0</td>
</tr>
</tbody>
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Ask your doctor or nurse for a copy of their blood results which should include the normal values for each blood type for a male or female child of the same age.
WHAT IS LEUKAEMIA?

Leukaemia is the general name given to a group of cancers that develop in the bone marrow. Leukaemia originates in developing blood cells, which have undergone a malignant change. This means that they multiply in an uncontrolled way and do not mature as they are supposed to. Because they have not matured properly, these cells are unable to function properly. Most cases of leukaemia originate in developing white cells.

Types of leukaemia

There are several different types, and subtypes of leukaemia.

Leukaemia can be either acute or chronic. The terms ‘acute’ and ‘chronic’ refer to how quickly the disease develops and progresses.

**Acute leukaemias** develop and progress quickly and therefore need to be treated as soon as they are diagnosed. Acute leukaemias affect very immature blood cells, preventing them from maturing properly.

**Chronic leukaemias** develop slowly, during the early stages of disease, and progress slowly over weeks or months. Chronic leukaemias generally involve an accumulation of more mature but abnormal white blood cells.

Leukaemia can also be either myeloid or lymphoid (‘lim-foid’). The terms myeloid and lymphoid refer to the types of cells in which the leukaemia first started.

When leukaemia starts somewhere in the myeloid cell line, it is called myeloid (myelocytic, myelogenous or granulocytic) leukaemia.

When leukaemia starts somewhere in the lymphoid cell line it is called lymphocytic (lymphoblastic or lymphatic) leukaemia.

(See figure Blood Stem Cells page 9)
Therefore, there are four main types of leukaemia:

1. Acute myeloid leukaemia (AML)
2. Acute lymphoblastic leukaemia (ALL)
3. Chronic myeloid leukaemia (CML)
4. Chronic lymphocytic leukaemia (CLL)

Both adults and children can develop leukaemia but certain types are more common in different age groups.

Each year in Australia around 2,891 adults and around 255 children are diagnosed with leukaemia. The most common types of leukaemia in adults are CLL and AML.

ALL is the most common type of leukaemia in children (0 to 14 years), and the most common type of childhood cancer.

Overall, chronic leukaemias are more common in adults than acute leukaemias. They rarely occur in children.
WHAT IS CHRONIC MYELOID LEUKAEMIA (CML)?

*Chronic myeloid leukaemia* (CML) is a type of leukaemia that affects developing *granulocytes* (neutrophils, eosinophils and basophils). Granulocytes are *white blood cells* that normally help the body to fight infection and disease. They are called granulocytes because they look grainy under a microscope. CML initially presents as a relatively slow-growing (indolent) disease where the bone marrow produces too many white cells. These cells spill out of the bone marrow, circulate around the body in the bloodstream and accumulate in various organs like the *spleen* and liver.

CML can change into a more aggressive type of disease where the bone marrow produces an excessive number of immature granulocytes, known as *blast cells* or *leukaemic blasts*. These cells expand rapidly crowding the bone marrow and preventing it from making adequate numbers of red cells, normal white cells and platelets. This makes people with CML more susceptible to anaemia, recurrent infections and to bruising and bleeding easily. One of the aims of current treatment is to prevent CML changing into this more aggressive phase.

Chronic myeloid leukaemia is also known as *chronic myelogenous leukaemia*.

HOW COMMON IS CML AND WHO GETS IT?

Each year in Australia around 280 people are diagnosed with CML. CML can occur at any age but it is more common in adults over the age of 40 years, who account for nearly 70 per cent of all cases. CML is slightly more common in men than women, and is rarely diagnosed in children. It is considered a rare cancer.
THE PHASES OF CML

CML is recognised as having two to three distinct stages or phases: the chronic phase, accelerated phase, and blast (crisis) phase.

Chronic phase

Most people (more than 90 per cent) are diagnosed in the early chronic phase of CML during which time the disease progresses slowly. Blood counts remain relatively stable and the proportion of blast cells in the bone marrow and blood is low (5 per cent or less). Most people are generally well at this stage and have few if any troubling symptoms of their disease.

Many people have an enlarged spleen (splenomegaly) and a raised white cell count when they are first diagnosed with CML, but these are usually easily controlled with treatment.

Before imatinib (Glivec®) became standard therapy for CML, the chronic phase usually lasted between three to five years. For most people these days, the duration of this phase may be prolonged indefinitely, and most people are expected to have a normal life expectancy.

While you are in the chronic phase of CML regular blood tests are used to carefully monitor your health and to see how well your disease is responding to treatment.

Accelerated phase

Medicines called tyrosine kinase inhibitors (TKIs) such as imatinib, nilotinib and dasatinib are used to treat CML. These medicines usually work very well, but in a small number of cases the disease is poorly controlled. In such individuals, there is a risk that CML can change from a relatively stable disease into a more rapidly progressing one. This is known as the accelerated phase of CML. During this time your blood counts become increasingly abnormal and the proportion of blast cells may start to increase in your bone marrow and circulating blood. These signs that your disease is progressing are usually picked up during a routine blood test. These days, second generation treatments (e.g. nilotinib or dasatinib) are proving to be very effective when imatinib is not, or as first line therapy, by preventing the disease from entering the accelerated phase.
Blast phase

In those people with poorly controlled CML, it can transform into a rapidly progressing disease resembling acute leukaemia. This is known as the blast phase or blast crisis. It is characterized by a rapid increase in the number of blast cells in the bone marrow and blood (usually 30 per cent or more) and by the development of more severe symptoms of your disease. Normal blood cell production is impaired and severe shortages of normal blood cells leads to an increased susceptibility to bleeding, infections and anaemia. Blast cells may accumulate in various parts of the body including the spleen, which can become rapidly enlarged, the lymph nodes, skin and central nervous system (brain and spinal cord).

The vast majority of people with CML who can take their TKI medications everyday remain stable for a long time and do not have many symptoms. Unfortunately for others, it can progress rapidly, transforming from a relatively stable disease into a rapidly progressing one. CML may progress from the chronic to the blast phase of disease without moving through the accelerated phase.

In about two thirds of cases, blast transformation involves immature blood cells from the myeloid cell line, and CML transforms into a disease resembling acute myeloid leukaemia (AML)*. In the remainder it involves immature blood cells from the lymphoid cell line, and CML transforms into a disease resembling acute lymphoblastic leukaemia (ALL)*. In a small number of cases, the blast cells are said to be undifferentiated or mixed.

Information regarding the type of blast cell involved is important because it helps to guide decisions regarding the most effective treatment for your disease.

Treatment during the accelerated and blast phases of disease is usually more intensive and is aimed at re-establishing the chronic phase and treating any symptoms of your disease.

* There are separate Leukaemia Foundation booklets called ‘Understanding acute myeloid leukaemia (AML)’ and ‘Understanding acute lymphoblastic leukaemia (ALL)’.
WHAT CAUSES CML?

Many people who are diagnosed with CML ask the question “why me?” Naturally, they want to know what has happened or what they might have done to cause their disease. The truth is that no one knows exactly what causes CML. We do know that it is not contagious. You cannot ‘catch’ CML by being in contact with someone who has it. We also know that CML is not inherited, passed down from one generation to the next.

Like other types of leukaemia, CML is thought to arise from an acquired mutation (or change) in one or more of the genes that normally control the growth and development of blood cells. This change or changes will result in abnormal growth. The original mutation is preserved when the affected stem cell divides and produces a ‘clone’; that is a group of identical cells all with the same defect. As such CML is regarded as a clonal blood stem cell disorder.

Why these mutations occur in the first place remains unknown but there are likely to be a number of factors involved. In some cases exposure to benzene, or exposure to very high doses of radiation, either accidentally (nuclear accident) or therapeutically (to treat other cancers) may be involved. However in most cases there is no evidence of a high exposure to radiation and the cause is unknown.

Almost all people with CML (around 95 per cent) have a distinctive genetic abnormality known as the Philadelphia (Ph) chromosome. This is an abnormal chromosome formed when part of chromosome 9 (the abl gene) breaks off and attaches itself to part of chromosome 22 (the bcr gene) in a process known as translocation. This translocation t(9;22) produces an overactive enzyme called a tyrosine kinase. The name of this particular tyrosine kinase is BCR-ABL. This signals the cell to divide repeatedly, leading to an excess of leukaemic cells in the blood and bone marrow. The Ph chromosome is only found in blood cells and bone marrow cells. It is not passed down from parent to child (inherited). Instead, it is acquired over time.
WHAT ARE THE SYMPTOMS OF CML?

Most people are diagnosed during the chronic phase of CML and have few if any symptoms of their disease. In these cases CML may be accidentally picked up during a routine blood test or physical examination. Initial symptoms may be vague and nonspecific, becoming more pronounced as the disease progresses.

Symptoms of an enlarged spleen (splenomegaly) are common and include feelings of discomfort, pain or fullness in the upper left-side of the abdomen. An enlarged spleen may also cause pressure on the stomach causing a feeling of fullness, indigestion and a loss of appetite. In CML the spleen enlarges as the leukaemic cells grow within the spleen. In some cases the liver may also be enlarged (hepatomegaly).

CML may also cause a painless swelling of the lymph nodes (glands) in your neck, under your arms or in your groin. This is usually a result of white cells accumulating in these tissues. Other symptoms may include headaches, fevers, excessive sweating at night and unintentional weight loss.

Symptoms caused by anaemia, due to a lack of red cells may include:

- Persistent tiredness and fatigue
- Weakness
- Shortness of breath with minimal exercise
- Looking pale
HOW IS CML DIAGNOSED?

CML is diagnosed by examining samples of your blood and your bone marrow.

When you first see your general practitioner (GP), he or she will take your full medical history, asking questions about your general health and any illness or surgery you have had in the past. The doctor will conduct a careful physical examination looking for any signs of disease, such as an enlarged spleen, liver or lymph nodes, and take a routine blood test to check your blood count.

**Full blood count**

The first step in diagnosing CML requires a simple blood test called a full blood count (FBC) or complete blood count (CBC). This involves taking a sample of blood from a vein in your arm, and sending it to the laboratory for examination under the microscope. The number of red cells, white cells and platelets, and their size and shape, is noted as these can all be abnormal. Most people with CML have an abnormally high white cell count (leucocytosis) when they are first diagnosed. Blast (immature) cells are occasionally seen. A proportion of 10 per cent or more blast cells in the blood usually indicates a more advanced phase of disease. Anaemia is a common finding. This is usually mild in the chronic phase becoming progressively more severe as the disease progresses. Some people with CML will also have a higher than normal number of platelets in their circulating blood. This is known as thrombocytosis. These platelets may not function properly, increasing the risk of easy bruising and bleeding.

Your full blood count will be checked regularly both during and after treatment to see how well your disease is responding.

If the results of your blood tests suggest that you might have CML, a small sample of bone marrow will need to be examined to help confirm the diagnosis and to provide important additional information about your disease.

**Bone marrow examination**

A bone marrow examination (bone marrow biopsy) involves taking a sample of bone marrow, usually from the back of the iliac crest (hip bone) or from the sternum (breast bone) and sending it to the laboratory for examination under the microscope.
A diagnosis of CML is usually confirmed by the detection of the Philadelphia (Ph) chromosome or the bcr-abl gene in the bone marrow cells. Other findings may include a very active marrow filled with large numbers of mature and immature white cells and platelets. In healthy adults the bone marrow contains less than 5 per cent blast (immature) cells. This is frequently higher in people with CML, particularly in more advanced stages of disease.

The bone marrow examination may be done in the haematologist’s rooms or clinic under local anaesthesia or, in selected cases, under a short general anaesthetic in a day procedure unit. A mild sedative and a pain-killer is given beforehand and the skin is numbed using a local anaesthetic; this is given as an injection under the skin. The injection takes a minute or two, and you should feel only a mild stinging sensation. After allowing time for the local anaesthetic to work, a long thin needle is inserted through the skin and outer layer of bone into the bone marrow cavity. A syringe is attached to the end of the needle and a small sample of bone marrow fluid is drawn out - this is known as a ‘bone marrow aspirate’. Then a slightly larger needle is used to obtain a small core of bone marrow which will provide more detailed information about the structure of the bone marrow and bone - this is known as a ‘bone marrow trephine’.

Because you might feel a bit drowsy afterwards, you should take a family member or friend along who can take you home. A small dressing or plaster over the biopsy site can be removed the next day. There may be some mild bruising or discomfort, which usually is managed effectively by paracetamol. More serious complications such as bleeding or infection are very rare.

Cytogenetic and molecular genetic tests

Cytogenetic (‘cy-to-gen-etic’) tests provide information about the genetic make-up of the leukaemic cells, in other words, the number, structure and abnormalities in the chromosomes present. Chromosomes are the structures that carry genes. Genes are collections of DNA, our body’s blueprint for life. Standard cytogenetic tests involve examining the chromosomes under
the microscope. These are used to detect the presence of the Ph chromosome at diagnosis, and at regular intervals during and after treatment to check the status of your CML.

Molecular genetic tests (for example *polymerase chain reaction* or *PCR* tests and *fluorescent in situ hybridization* or *FISH*) are more sophisticated genetic tests that may be used to assess how well your disease has responded to treatment. These tests are capable of measuring minute traces of leftover (residual) leukaemic cells not normally visible under the microscope. This gives the doctor some indication of the likelihood of future relapse (return of the original disease). Using this highly sensitive technology, subtle changes in your disease can be detected earlier and where necessary treated earlier. This test may be done either with a blood or a bone marrow sample.

**Other tests**

Other tests provide information about your general health and how well your kidneys, liver and other vital organs are functioning. These may include a combination of blood tests and imaging tests (for example a chest *x-ray* or CT scan). These tests are important because they provide a baseline set of results regarding your disease and general health. They may be important in selecting the best treatment for you. They can also be compared with later results to assess how well you are progressing.

*Waiting around for tests can be both stressful and boring. Remember to ask beforehand how long the test will take and what to expect afterwards. You might like to bring a book, some music, or a friend for company and support.*
PROGNOSIS

A prognosis is an estimate of the likely course of a disease. It provides some guide regarding the chances of curing the disease or controlling it for a given time.

If you have CML your overall prognosis will depend on a number of factors. These include clinical and laboratory features of your disease at diagnosis and, more importantly, how well your disease responds to treatment.

*Your doctor is the best person to give you an accurate prognosis regarding your leukaemia as he or she has all the necessary information to make this assessment.*

The Sokal scoring system provides an initial estimate of the severity of your disease, in other words how quickly it is likely to progress once you have been diagnosed.

This system takes different *prognostic* factors into account including your age, spleen size, platelet and peripheral blood blast cell count at diagnosis. These factors are given individual scores, which are then tallied to give your overall score. Depending on your score, you are regarded as being in either the *low, intermediate* or *high-risk* group. The likelihood of achieving the desired response to treatment (a complete cytogenetic response) has been closely correlated to the Sokal score. In other words more people in the low risk group (with a low score) are expected to achieve a complete cytogenetic response to treatment than those in the high-risk group.

A more important factor however in determining your overall prognosis is how well your disease is responding to your TKI treatment. These days, standard disease monitoring techniques (regular full blood counts, cytogenetic tests, and PCR testing) and desired response parameters are used to assess your disease on a regular basis. If it is not responding as well as expected, your doctor may adjust your treatment. This is to ensure that you are receiving the best possible treatment at all times for your particular situation.
Commonly used terms
The following terms may be used to describe how well your CML has responded to treatment.

Complete haematological (blood) response
The proportion of blast cells in the marrow has been reduced to less than 5 per cent. There are no blast cells present in the circulating blood and the full blood count has returned to normal. (The Ph chromosome may still however be present).

Minor cytogenetic (cellular) response
The Ph chromosome can be detected in between 35 to 75 per cent of blood and bone marrow cells.

Major cytogenetic (cellular) response
The Ph chromosome can be detected in 35 per cent or less of blood and bone marrow cells.

Complete cytogenetic response (CCR)
The Ph chromosome cannot be detected using standard laboratory tests.

Major molecular response (MMR)
The level of bcr-abl, the marker for the Ph chromosome has fallen 1,000 fold (3 log) below the average starting level. This is a deeper level of response than a complete cytogenetic response.

Complete molecular response (CMR)
The presence of bcr-abl cannot be detected in blood and bone marrow cells using the most sensitive of tests. Some people can also call this PCRU or PCR “Undetectable” - because we cannot currently definitively confirm that there are no leukaemic cells in the body with current technologies. For this reason, the term ‘remission’ is not generally used in relation to CML.

The length of time that a response lasts varies from person to person, and the leukaemia may well re-appear (relapse) over time.

Cure
This means that there is no evidence of leukaemia and no sign of it re-appearing, even after many years, without ongoing treatment. In most cases CML may not be able to be cured but there are effective treatments that can help to control it and prevent it from progressing for a long time, possibly permanently.
TREATING CML

The treatment chosen for your CML largely depends on the phase of your disease, your age and general health and the availability of a suitable stem cell donor.

Most people with CML will be treated with a TKI medication like imatinib, nilotinib or dasatinib. This dramatically lowers the number of leukaemic cells in the body. They are usually very effective at controlling the disease, but they do not cure it. While these drugs can reduce the number of leukaemic cells to very low levels, they will usually increase if the drug is stopped. For this reason treatment is currently required to be continued for life.

A stem cell transplant, using donated blood stem cells, is currently the only option for curing CML. However this treatment carries serious risks and requires a suitably matched donor. This is why treatment with drugs to control (but not cure) the disease is usually recommended instead.

Information gathered from hundreds of other people around the world who have had the same disease helps to guide the doctor in recommending the best treatment for you. Promising new and experimental treatments are being developed for CML all the time. Some of these treatments are currently being used in clinical trials in Australia and other parts of the world. Your doctor will be able to discuss with you all of the treatment options suitable for you.

Remember that no two people are the same. In helping you to make the best treatment decision, your doctor will consider all the information available including the details of your particular situation.

Standard therapy

Standard therapy refers to a type of treatment which is commonly used in particular types and stages of disease. It has been tried and tested (in clinical trials) and has proven to be safe and effective in a given situation.

Clinical trials

These trials (also called research studies) test new treatments or ‘old’ treatments given in new ways to see if they work
better. Clinical trials are important because they provide vital information about how to improve treatment by achieving better results with fewer side effects. **Clinical trials often give people access to new therapies not yet funded by governments.**

If you are considering taking part in a clinical trial make sure that you understand the reasons for the trial and what it involves for you. You also need to understand the benefits and risks of the trial before you can give your informed consent. Talk to your doctor who can guide you in making the best decision for you.

### Informed consent

Giving an informed consent means that you understand and accept the risks and benefits of a proposed procedure or treatment. It means that you agree that you have adequate information to make such a decision.

Your informed consent is also required if you agree to take part in a clinical trial, or if information is being collected about you or some aspect of your care (data collection).

If you have any doubts or questions regarding any proposed procedure or treatment please do not hesitate to talk to your doctor or nurse again.

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**Chronic phase**

While you are in the chronic phase of CML, treatment is aimed at controlling your disease, prolonging this phase and delaying the onset of symptoms and complications for as long as possible.

**Initial treatment at diagnosis**

When you are first diagnosed with CML you may be given chemotherapy in tablet form to reduce the number of white cells in your circulating blood. In most cases a drug called hydroxyurea is used. During this time you will also be given a drug called allopurinol. This is not a chemotherapy drug. It is used to help prevent a build-up of breakdown products of the destroyed leukaemic cells and to help your kidneys excrete them safely.

Some people with CML are diagnosed with an extremely high white cell count. These cells need to be quickly removed from the
bloodstream as they can otherwise accumulate and slow down the rate of blood supply to various organs and tissues. This can cause symptoms including difficulty breathing, blurred vision and confusion. Excess white cells are removed using a process known as leukopheresis. During this process all of your blood is passed through a special machine called a cell separator. The blood is drawn from a cannula (plastic needle) placed in a vein in one arm. The machine spins the blood very quickly and removes the excess white cells. This is a continuous process. While white cells are being removed the rest of your blood is being returned to you via another cannula, placed in your other arm. If your veins are not suitable for this procedure, a special line called a central venous catheter (central line) may be used instead. This allows blood to be drawn from one of the bigger veins in your body.

Leukopheresis is usually carried out in an outpatient department of the hospital. It is a painless procedure that usually takes about two hours to complete.

**Accelerated and blast phase**

If the disease progresses, treatment is aimed at re-establishing the chronic phase of CML, and reducing any troublesome symptoms. There are several treatment options which may be used depending on your particular circumstances. These include more intensive chemotherapy using a combination of drugs similar to those used to treat acute leukaemia, a stem cell transplant, imatinib mesylate, or another tyrosine kinase inhibitor. Some patients may benefit by participating in a clinical trial.

Treatments to reduce symptoms of CML may include blood transfusions, antibiotics and other drugs to help keep you as well and comfortable as possible during this time.

**TYROSINE KINASE INHIBITORS (TKIS)**

*Imatinib mesylate - Glivec® (Gleevec® in USA)*

Whilst some patients may initially receive a short course of hydroxyurea, nearly all patients will be treated with TKIs. Tyrosine kinase is an enzyme that sends signals to enhance cell growth. TKIs work by blocking the activity of tyrosine kinase, thereby preventing the growth and proliferation of leukaemic cells.
The first clinically available TKI was a drug called imatinib mesylate (imatinib). It made a huge leap forward in the effectiveness of how we treated people’s CML.

Imatinib produces a rapid and complete haematological response (controlling the blood count) in most patients with Ph chromosome positive disease in chronic phase. It also produces a high rate of cytogenetic responses, prolonging the chronic phase, while reducing the rate of progressing to blast phase for the majority of people.

Despite achieving an excellent early response to imatinib some people become resistant to this drug and eventually progress to more advanced phases of CML. The risk of developing resistance is much lower for patients who receive imatinib in the first few months after diagnosis, and for those who take imatinib every day without missing doses. Furthermore the risk of resistance lessens with longer treatment.

Over 80% of patients will achieve effective control of their disease (complete cytogenetic response) with standard dose imatinib and many will continue to enjoy a stable disease state for at least the first 10 years. Very few patients have received imatinib for longer than 10 years so we don’t yet know the stability of the response to this drug beyond this time. However, there is currently no evidence to suggest that these patients will not continue to respond to imatinib beyond this time frame.

Research is continuing all the time into ways to improve the outlook for people with CML.

**Possible side effects**

Side effects are usually mild. They can vary however from person to person depending on the dose given and how an individual responds. There is no doubt that side effects can be very unpleasant at times but it’s good to remember that most of them are temporary and reversible. It is important that you report any side effects you are experiencing to your nurse or doctor because many of them can be treated successfully, reducing any unnecessary discomfort for you.

Possible side effects of imatinib include nausea and vomiting, diarrhoea, fluid retention and swelling, muscle cramps and an itchy skin rash. Imatinib can also affect the bone marrow’s ability to
produce adequate numbers of blood cells resulting in a temporary reduction in the number of white cells, platelets and red cells circulating in your blood. This can make you more susceptible to infections, symptoms of anaemia, and to bruising and bleeding more easily. It is important that you contact your doctor or the nursing team for advice immediately (at any time of the day or night) if you are feeling very unwell, or if you experience a temperature of 38° C or over and/or an episode of uncontrolled shivering (a rigor). You also need to contact them if you have unexplained bleeding or bruising, for example blood in your urine, bowel motions, coughing up blood, bleeding gums or a persistent nose bleed. Your nurse and doctor will tell you about the side-effects you might experience and how they can be best managed.

To help prevent nausea and vomiting it is important to take your imatinib in the middle of a substantial meal, with a large glass of water. Imatinib should not be taken on an empty stomach.

Imatinib interacts with many other drugs. Drug interactions may interfere with the effectiveness of imatinib, or other drugs, by increasing or decreasing their concentration in your blood. Because drug interactions may be harmful to you, it is important that you speak to your doctor before using any other drugs while you are having imatinib therapy. These include prescription drugs, over-the-counter drugs, and herbal remedies. St John’s Wort and grapefruit juice can also interact with imatinib, and should generally be avoided. Your imatinib medication box should have an information sheet inserted – please ensure you read this for more information about product safety.
It is strongly recommended that you or your partner do not become pregnant as imatinib might harm the developing baby. As such, you need to ensure that you or your partner uses a suitable form of contraception if either of you are having this treatment. It is possible to have children with a diagnosis of CML, but it is very important to discuss this with your doctor first. In addition, it is not known if the active ingredient, imatinib, passes into the breast milk. Because this medicine could affect your baby, breast-feeding is not recommended.

It is important that you don’t stop taking imatinib unless you are instructed to do so by your doctor. To be effective imatinib needs to be taken every day.
Other Tyrosine Kinase Inhibitors

In recent years several new drugs that are similar to imatinib have been developed. These drugs also work by inhibiting tyrosine kinase and are sometimes called second or third generation TKIs. These include dasatinib and nilotinib. It is likely that following clinical trials other new tyrosine kinase inhibitors will become available in the next few years. Nilotinib or dasatinib are more potent drugs than imatinib. In clinical studies, patients taking these drugs have a lower risk of disease progression, though the chances of survival at this stage appear equivalent regardless which drug the patient takes. Both nilotinib and dasatinib are available alongside imatinib through Medicare for treatment of CML.

**Nilotinib** (Tasigna®) has a similar mode of action to imatinib. It is effective in newly diagnosed patients and for some people who have become resistant or intolerant to imatinib. It is taken by mouth in the morning and evening. It is very important that nilotinib is taken on an empty stomach – no food should be eaten for 2 hours before AND 1 hour after taking each nilotinib dose.

Most people have only mild side-effects with nilotinib, although some patients have more troubling side-effects. The more common side-effects include rash, itching, nausea and constipation. Less commonly nilotinib can cause anaemia, a low platelet count, or a low white blood cell count. Both nilotinib and dasatinib can cause an abnormal heart rhythm called QT prolongation in a small number of people. This risk is increased by imbalance of the electrolytes in the blood (low potassium and magnesium levels) and taking other medications that also cause QT prolongation. Your doctor will monitor this carefully.

It is recommended that you or your partner use a suitable form of contraception while taking nilotinib. Mothers are advised not to breast feed while taking nilotinib.

**Dasatinib** (Sprycel®) is also a tyrosine kinase inhibitor, with activity in newly diagnosed disease as well as disease resistant to imatinib. It is a tablet that is swallowed either once or twice daily and can be taken with or without a meal.

Many people have only mild side-effects with dasatinib, although some patients have more troubling side-effects. The common side-effects include fluid retention, diarrhoea, rash, headache, nausea, easy bruising and bleeding, and fatigue. Some people taking
Dasatinib may develop fluid in the space around the lungs, called a pleural effusion. If identified early, pleural effusion may be well managed. This may require treatment with a steroid medicine, dose reduction, temporarily stopping dasatinib, or occasionally a procedure to drain the fluid. Once again, suitable contraception is recommended and mothers are advised not to breast feed while taking dasatinib.

**Remember that no two people are the same. In helping you to make the best side-effect treatment decision, your doctor will consider all the information available including the details of your particular situation.**

<table>
<thead>
<tr>
<th>Potential Side Effects</th>
<th>Potential Remedies</th>
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<tbody>
<tr>
<td></td>
<td>Important: Always check with your haematologist before making any interventions to alleviate side effects</td>
</tr>
<tr>
<td>Eyes:</td>
<td></td>
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</tbody>
</table>
| - Swelling; excessive watery or dry eyes; bleeding in whites of eyes | • Avoid high sodium (salt) foods  
• Prescription steroid eye drops  
• Mild diuretic  
• No treatment available for bleeding whites of eyes – avoid heavy lifting/straining  
• Diet with plenty of fruit and vegetables |
| Fluid Retention        |                    |
| - Common in hands, feet, legs and occasionally around heart and lungs | • Avoid high sodium (salt) foods  
• Diuretics and steroids may be prescribed  
• For pleural effusion (fluid around the lungs, a dose reduction and/or interruption may be required |
| Nausea and Vomiting    |                    |
|                        | • Take imatinib with at least 240ml of water and additional bland food  
• Anti-nausea drugs may be required  
• Take imatinib (Glivec) after substantial meal, nilotinib (Tasigna) on an empty stomach, and Dasatinib (Sprycel) with or without food. |
<table>
<thead>
<tr>
<th>Symptom</th>
<th>Precautions/Actions</th>
</tr>
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| Heartburn    | • Avoid overeating and spicy foods  
• Reduce caffeine and alcohol consumption  
• Remain upright or sitting for 1-2 hours after taking TKI  
• Antacids 2 hours before/after imatinib or dasatinib – NOT recommended for use with nilotinib |
| Diarrhoea    | • Avoid sorbitol, mannitol, maltitol (common ingredients in ‘sugar-free’ foods)  
• Psyllium seed – increases fibre  
• Anti-diarrheal medications eg. Loperamide |
| Constipation | • Increase fruits and vegetables in diet  
• Drink plenty of fluids  
• Stool softeners and laxatives may be required  
• Increase insoluble fibre intake |
| Muscle Cramps| • Often helped by taking electrolyte replacements such as: Calcium, potassium (especially if on diuretics), magnesium. Refer to your haematologist before commencing these electrolyte replacements  
• Tonic water (low dose quine) may prove effective  
• Adequate hydration |
| Muscle/Joint/Bone pain | • Usually resolves within days to weeks  
• May be relieved by non-steroidal anti-inflammatory drugs  
• Short-term opioids may be required  
• Consider drug interactions e.g., simvastatin |
| Skin problems                 | • Dry/itching skin – apply moisturising lotion after bathing; don’t use soap-based materials, use baking soda in bath water, may require a steroidal cream  
|                              | • Rash – may require stronger steroidal cream and oral prednisone if severe; antihistamines may be appropriate; moisturiser.  
|                              | • Skin Tears / Abrasions – protect skin with clothing (long sleeves)  
|                              | • Sun sensitivity – Slip, slop, slap! Sunburn with imatinib can be severe! |
| Fatigue                      | • Check for anaemia  
|                              | • Check thyroid function  
|                              | • Moderate regular exercise  
|                              | • Rest **before** you are exhausted  
|                              | • Take a daily nap if you need it  
|                              | • Meditation and yoga may be helpful |
| Foetal development impairment | • Do not become pregnant while taking TKIs  
|                              | • If you are considering having a baby, speak with your doctor to discuss your options. Interferon may be the drug of choice during pregnancy. |

**Adherence to treatment**

Adherence also commonly called compliance, to treatment regimes for CML is very important for the drugs to work effectively. If there is not enough drug in the body, it is possible that the CML cells may mutate, potentially making treatment much more difficult in the future. Some mutations do not respond as well to TKIs and therefore your options for treating your CML are more limited. It is important not to make any changes in your treatment regime without discussing it first with your haematologist. Your doctor will be able to give you the best advice for your particular situation.
Interferon alpha

Interferon alpha used to be standard treatment for CML before imatinib was developed. These days it is not used very often. It may still have a role in a minority of cases (e.g. during pregnancy), and researchers are investigating whether it provides extra benefit when combined with imatinib.

Interferon alpha may be given as a small injection under the skin on a daily basis, or several times a week. It can have significant side effects including flu-like symptoms - chills, fevers, aches and pains and weakness. It can also cause other unpleasant symptoms such as nausea, loss of appetite and depression. These symptoms are usually temporary. Your doctor or nurse will explain any side effects you might experience if you are having this form of treatment and how they can be managed.

Chemotherapy

Chemotherapy literally means therapy with chemicals. Many chemotherapy drugs are also called cytotoxics (cell toxic) because they kill cells; especially ones that multiply quickly like cancer cells.

Chemotherapy for CML in chronic phase usually involves hydroxyurea, a drug which can be taken in tablet or capsule form at home and has been found to be very effective at controlling a high white cell count. The dose of the drug may be easily adjusted to the response of the white cells and also the response of other blood cells such as red cells and platelets. For example, sometimes a balance has to be made between lowering your white cell count and increasing your risk of anaemia and thrombocytopenia (low platelet count); this is why blood counts need to be monitored more regularly when you are receiving chemotherapy. Most people tolerate hydroxyurea very well. It does not usually cause nausea or significant hair loss, although it can cause dry skin.

Other chemotherapy drugs used to be given for CML. Nowadays, tyrosine kinase inhibitors are used instead for almost all patients in chronic phase. These newer drugs have less side-effects than the older chemotherapy drugs. This allows many people with CML to continue working and performing other important activities in their lives.
On the other hand, people in accelerated or blast phase CML may benefit from more intensive anti-leukaemia therapy. This commonly involves the use of a combination of chemotherapy drugs given intravenously (into a vein). The drugs chosen are tailored to treat the type of leukaemic transformation which has occurred (acute myeloid leukaemia (AML) * or acute lymphoblastic leukaemia (ALL) *). This treatment is given in hospital and the side-effects can be more severe. Not everyone is suitable for this form of treatment, especially if they are elderly or not well enough to tolerate the potential side effects, and other more suitable treatment options will be considered.

If you are having chemotherapy your doctor and nurse will tell you about the side-effects you might experience and how they can be best managed.

<table>
<thead>
<tr>
<th>Potential side effects of chemotherapy in accelerated phase and blast crisis</th>
</tr>
</thead>
<tbody>
<tr>
<td>➢ Feeling sick - nausea and vomiting</td>
</tr>
<tr>
<td>➢ Feeling tired and weak</td>
</tr>
<tr>
<td>➢ Hair loss and thinning</td>
</tr>
<tr>
<td>➢ Infections</td>
</tr>
<tr>
<td>➢ Mouth problems</td>
</tr>
<tr>
<td>➢ Diarrhoea or constipation</td>
</tr>
<tr>
<td>➢ Skin problems</td>
</tr>
<tr>
<td>➢ Drop in blood counts</td>
</tr>
<tr>
<td>➢ Fertility problems</td>
</tr>
</tbody>
</table>

*There are separate Leukaemia Foundation booklets called ‘Understanding acute myeloid leukaemia (AML)’ and ‘Understanding acute lymphoblastic leukaemia (ALL)’ that provide more details on these types of treatments.*
Stem cell transplantation (*peripheral blood stem cell or bone marrow transplantation*)

An allogeneic (donor) stem cell transplant* currently offers the only chance of curing CML. This involves giving very high doses of chemotherapy, sometimes in combination with radiotherapy, in an attempt to completely destroy the abnormal stem cells in your bone marrow. These cells are then replaced with healthy stem cells which have been donated, usually from a brother or sister who has the same tissue type as yours. In some cases the donor is not a family member, but has a similarly matched tissue type. This type of transplant is called a *matched unrelated donor transplant (MUD)* or *volunteer unrelated donor transplant (VUD)*.

Donor transplants carry significant risks including death and are only suitable as the first line of therapy for a very small minority of younger patients (usually under 15 years of age), who have a suitable stem cell donor. Because imatinib and other tyrosine kinase inhibitors are so effective, stem cell transplants for CML are not often used as the first line of treatment even in this young group.

Best results are achieved when the transplant is carried out during the chronic phase of CML, and within a year of the initial diagnosis. Although this form of treatment may be offered to some patients with advanced disease, the transplant-related risks are much higher during this time. In most cases an allogeneic transplant will be used as a second or third line of therapy in those uncommon cases where TKI therapy has failed to work.

A newer approach involves using lower and therefore less toxic doses of chemotherapy and radiotherapy. This may be suitable for selected older patients and those with certain health problems who would benefit from, but might not be able to tolerate a conventional donor transplant. Using this approach, less intensive doses of chemotherapy are used to treat disease in the bone marrow and suppress the patient’s immune system sufficiently for it to accept the new, donated healthy stem cells. Meanwhile it is hoped that the donor’s immune system will attack and destroy any leftover disease. This is called a *reduced intensity*, non-myeloablative, or *mini-allogeneic (mini-allo)* stem cell transplant. Again, this is usually only undertaken in people whose CML is progressing despite imatinib and other tyrosine kinase inhibitors, or who have developed accelerated phase or blast crisis.

A stem cell transplant is usually only offered if your doctor feels that it will be of benefit to you.

*There are separate Leukaemia Foundation booklets called ‘Understanding allogeneic transplants - a guide for patients and families’.*
How do I know if the treatment is working?

Regular blood tests will indicate how well your CML treatment is working.

At first, you will need a blood test at least every 1-2 weeks. This is to make sure that the high number of white blood cells that were found at diagnosis are returning to normal. It also makes sure that your platelets and red cells are alright. After this time blood tests are needed less frequently, usually every six weeks.

Once your white cell count returns to normal, your doctor uses a more sensitive blood test to detect how much leukaemia is still present. This is referred to as **BCR-ABL PCR**. This is a complicated test which depending on the laboratory can take 3-4 weeks or more to complete. It can detect tiny amounts of leukaemic cells which would not be detected by simply looking at your blood or bone marrow under the microscope. The results of the BCR-ABL PCR will give your doctor the best indication of how well the treatment is working. This test also allows your doctor to detect earlier if the disease is coming back. A blood test for BCR-ABL PCR is usually done every 3 months.

If your BCR-ABL PCR level is increasing significantly your doctor may arrange another blood test called a **mutation analysis**. This is because sometimes the leukaemic cells undergo slight changes called mutations which can affect how well the treatment works. The results of the mutation analysis can help your doctor decide whether a different tyrosine kinase inhibitor may be better for you.

A **bone marrow biopsy** is usually done at 6 and 12 months after starting treatment. This is used for cytogenetic tests and also BCR-ABL PCR.

**Treatment for relapsed and resistant CML**

Finding out that your CML has come back (relapsed) or is resistant to standard treatment can be devastating. It is important to remember however that there are still several options for treating the disease and getting it back under control. These may include a stem cell transplant or newer drugs such as dasatinib, nilotinib or a clinical trial drug.

Promising new and experimental approaches to the treatment of CML are being developed all the time. Some of these treatments are currently being used in clinical trials in Australia and other parts of the world. Your doctor will be able to discuss with you all of the treatment options suitable for you.
SUPPORTIVE THERAPIES

Supportive care plays an important role in the treatment of many people with CML. This involves making every effort to improve your quality of life, by relieving any symptoms you might have and by preventing and treating any complications that arise from your disease or treatment.

Blood transfusions, antibiotics, complementary therapies and in some cases, the use of growth factors, which promote the production of blood cells in your bone marrow, are all important elements of supportive care.

Blood and platelet transfusions

If symptoms of anaemia are interfering with your normal daily activities, your doctor may recommend that you have a red blood cell transfusion. Platelet transfusions are sometimes given to prevent or treat bleeding (for example a persistent nose bleed).

You do not need to be admitted to hospital for a red blood cell or platelet transfusion and they are usually given in the outpatient department. Transfusions these days are relatively safe and they don’t usually cause any serious complications. Nevertheless you will be carefully monitored throughout the transfusion. In the meantime, remember to call the nurse if you are feeling hot, cold, and shivery or in any way unwell, as this might indicate that you are having a reaction to the transfusion. Steps can be taken to minimise these effects and ensure that they don’t happen again.
**Antibiotics**

Infections can occur more commonly in CML. Don’t hesitate to contact your doctor or hospital if you develop **any** of the following signs of infection so that you can be treated appropriately, with antibiotics and other drugs if necessary:

- A temperature of 38°C and/or an episode of shivering (where you shake uncontrollably)
- Coughing or shortness of breath
- A sore throat and/or a head cold
- passing urine frequently or a stinging pain when passing urine
- If you are feeling generally unwell

**You also need to be seen by a doctor if you;**

- cut, or otherwise injure yourself
- If you are bleeding (for example blood in your urine, stools, sputum, bleeding gums or a persistent nose bleed) or bruising easily
- If any surgery is planned by another medical practitioner. Advice may be required from your haematologist to ensure that the surgery is completed successfully without problems due to your disease or its treatment

**Growth Factors**

Growth factors are natural chemicals in your blood that stimulate the bone marrow to produce different types of blood cells. Some of them can be made in the laboratory and may be used to help manage your CML.

**Complementary Therapies**

Complementary therapies are therapies which are not considered standard medical therapies. Many people however find that they are helpful in coping with their treatment and recovery from disease. There are many different types of complementary therapies. These include yoga, exercise, meditation, prayer, acupuncture and relaxation.
Complementary therapies should ‘complement’ or assist with recommended medical treatment for CML. **They should not be used instead, as an alternative to medical treatment.** It is important to realise that no complementary or alternative treatment alone has proven to be effective against CML. It is also important that you inform your doctor if you are using any complementary therapies or alternative therapies in case they cause any problems with your disease, or its medical treatment.

**Nutrition***

A healthy and nutritious diet is important in helping your body to cope with your disease and treatment. Talk to your doctor or nurse if you have any questions about your diet or if you are considering making any radical changes to the way you eat. You may wish to see a nutritionist or dietician who can advise you on planning a balanced and nutritious diet.

If you are thinking about using herbs or vitamins it is very important to talk this over with your doctor first. Some of these substances can interfere with the effectiveness of chemotherapy or other treatment you are having.

Patients with CML should avoid grapefruit as it can interact with TKIs.

*There is a separate Leukaemia Foundation booklet called ‘Eating Well: a practical guide for people living with leukaemias, lymphomas, myeloma and related blood disorders’. 
MAKING TREATMENT DECISIONS

Many people feel overwhelmed when they are diagnosed with CML. In addition to this, waiting for test results and then having to make decisions about proceeding with the recommended treatment can be very stressful. Some people do not feel that they have enough information to make such decisions while others feel overwhelmed by the amount of information they are given, or that they are being rushed into making a decision. It is important that you feel you have enough information about your illness and all of the treatment options available, so that you can make your own decisions about which treatment to have.

Sometimes it is hard to remember everything the doctor has said. It helps to bring a family member or a friend along who can write down the answers to your questions, prompt you to ask others, be an extra set of ears or simply be there to support you.

Before going to see your doctor make a list of the questions you want to ask. It is handy to keep a notebook or some paper and a pen handy as many questions are thought of in the early hours of the morning.

Your treating doctor (haematologist) will spend time discussing with you and your family what he or she feels is the best option for you. Feel free to ask as many questions as you need to, at any stage. You are involved in making important decisions regarding your wellbeing. You should feel that you have enough information to do this and that the decisions made are in your best interests. Remember, you can always request a second opinion if you feel this is necessary.
BODY IMAGE, SEXUALITY AND SEXUAL ACTIVITY

It is likely that the diagnosis and treatment of CML will have some impact on how you feel about yourself as a man or a woman and as a ‘sexual being’. Fatigue, skin changes, and fluid retention can all interfere with feeling attractive. *Look Good … Feel Better* is a free community service that runs programs on how to manage the appearance-related side effects of cancer treatments. You might like to visit their website at www.lgfb.org.au or free call them on 1800 650 960.

During treatment, you may experience a decrease in libido, which is your body’s sexual urge or desire, sometimes without there being any obvious reason. It may take some time for things to return to ‘normal’. It is perfectly reasonable and safe to have sex while you are on treatment or shortly afterwards, but there are some precautions you need to take. It is usually recommended that you or your partner do not become pregnant as some of the treatments given might harm the developing baby. As such you need to ensure that you and/or your partner use a suitable form of contraception. Condoms (with a spermicidal gel) offer good contraceptive protection as well as protection against infection or irritation. Partners are sometimes afraid that sex might in some way harm the patient. This is not likely as long as the partner is free from any infections and the sex is relatively gentle. Finally, if you are experiencing vaginal dryness, a lubricant can be helpful. This will help prevent irritation.

If you have any questions or concerns regarding sexual activity and contraception don’t hesitate to discuss these with your doctor or nurse, or ask for a referral to a doctor or health professional who specialises in sexual issues.
INFORMATION AND SUPPORT

People cope with a diagnosis of CML in different ways, and there is no right or wrong or standard reaction. For some people the diagnosis can trigger any number of emotional responses ranging from denial to devastation. It is not uncommon to feel angry, helpless and confused. Naturally people fear for their own lives or that of a loved one.

It is worth remembering that information can often help to take away the fear of the unknown. Due to recent medical advances, CML is now a very treatable condition. It is best for patients and families to speak directly to their doctor regarding any questions they might have about their disease or treatment. It can also be helpful to talk to other health professionals including social workers or nurses who have been specially educated to take care of people with haematological diseases. Some people find it useful to talk with other patients and family members who understand the complexity of feelings and the kinds of issues that come up for people living with an illness of this nature.

There may be a CML support group in your state or territory. You may wish to contact the Leukaemia Foundation in your state for more information.

If you have a psychological or psychiatric condition please inform your doctor and don’t hesitate to request additional support from a mental health professional.

Many people are concerned about the social and financial impact of the diagnosis and treatment on their families. Normal family routines are often disrupted and other members of the family may suddenly have to fulfil roles they are not familiar with, for example cooking, cleaning, doing the banking and taking care of children.

There are a variety of programs designed to help ease the emotional and financial strain created by cancer. The Leukaemia Foundation is there to provide you and your family with information and support to help you cope during this time. Contact details for your state office of the Leukaemia Foundation are provided on the back of this booklet.
USEFUL INTERNET ADDRESSES

• Leukaemia Foundation
  www.leukaemia.org.au

• American Cancer Society
  www.cancer.org

• Australian Bone Marrow Donor Registry
  www.abmdr.org.au

• Australian Clinical Trials Registry
  www.actr.org.au/about.aspx

• Bone & Marrow Transplant Information Network
  www.bmtinfonet.org

• Bone Marrow Transplant Network NSW
  www.bmtnsw.com.au

• Cancer Council of Australia
  www.cancercouncil.org.au

• CML Alliance
  www.cmlalliance.com.au

• Leukaemia Foundation Network for Young Adults
  www.teamrevive.org

• Leukaemia Foundation of Australia On-line Support Group
  www.talkbloodcancer.com

• Leukemia & Lymphoma Society of America
  www.leukemia-lymphoma.org

• Leukaemia Research Fund (UK)
  www.lrf.org.uk

• Look Good … Feel Better program
  www.lgfb.org.au

• MacMillan
  www.cancerbacup.org.uk

• National Cancer Institute (USA)
  www.cancer.gov/cancerinfo
GLOSSARY OF TERMS

**Accelerated Phase**
A phase of chronic Myeloid Leukaemia more advanced than chronic phase disease but less severe than blastic phase. In accelerated phase, a patient might have enlarged spleen, too many or too little platelets, and a greater number of immature cancer cells called blasts in the bone marrow and blood. This is now very rarely seen, thanks to the availability of effective treatment.

**Acute leukaemias**
Rapidly progressing cancers of the blood and bone marrow, usually of sudden onset and characterised by uncontrolled growth of immature blood cells which crowd the bone marrow and spill out into the bloodstream.

**Acute myeloid leukaemia (AML)**
A rapidly progressing cancer of the blood and bone marrow. AML affects developing blood cells on the myeloid cell line, usually white blood cells. It is more common in adults than in children.

**Allogeneic stem cell transplant**
The transplant of blood stem cells from one person to another. The donor is usually a sister or brother or an unrelated volunteer donor.

**Alopecia**
Hair loss. This is a side effect of some kinds of chemotherapy and radiotherapy. It is usually temporary.

**Anaemia**
A reduction in the haemoglobin level in the blood. Haemoglobin normally carries oxygen to all the body’s tissues. Anaemia causes tiredness, paleness and sometimes shortness of breath.

**Antiemetic**
A drug used to prevent or reduce feelings of sickness (nausea) and vomiting.

**Autologous stem cell transplant**
A type of stem cell transplant using blood stem cells collected from the patient’s own bone marrow. These cells are collected and stored in advance, at an early disease stage. They are returned to the patient at a later stage, to rescue the function of their bone marrow, after they have received high doses of chemotherapy to destroy their disease.
Blast Crisis (Blastic Phase, Blastic Transformation)

Chronic Myeloid Leukaemia presenting at a late stage, when disease has progressed. Patients at this phase of the disease are usually sicker and have identifiable immature cancer cells in the blood called blasts. This is now very rarely seen, thanks to the availability of effective treatment.

Blood count

Also called a full blood count (FBC or a complete blood count - CBC). A routine blood test that measures the number and type of cells circulating in the blood.

B-cell

A type of white cell normally involved in the production of antibodies to combat infection.

Bone marrow

The tissue found at the centre of many flat or big bones of the body. Active or red bone marrow contains stem cells from which all blood cells are made and in the adult this is found mainly in the bones making up the axial skeleton – hips, ribs, spine, skull and breastbone (sternum). The other bones contain inactive or (yellow) fatty marrow, which, as its name suggests, consists mostly of fat cells.

Bone marrow aspirate (BMA)

A procedure that involves removing a small sample of bone marrow fluid for examination in the laboratory. The fluid is drawn, under local or general anaesthetic, usually from the back of the hip, or occasionally from the breastbone.

Bone marrow biopsy (BMB)

A procedure that involves removing a small core of bone marrow for examination in the laboratory. The biopsy (or trephine) is taken under local or general anaesthetic, from the back of the hip.

Cancer

A malignant disease characterised by uncontrolled growth, division, accumulation and invasion into other tissues of abnormal cells from the original site where the cancer started. Cancer cells can grow and multiply to the extent that they eventually form a lump or swelling. This is a mass of cancer cells known as a tumour. Not all tumours are due to cancer; in which case they are referred to as non-malignant or benign tumours.
**Cannula**
A plastic tube which can be inserted into a vein to allow fluid and drugs to enter the bloodstream.

**Central venous catheter (CVC)**
Also known as a central venous access device (CVAD). A line or tube passed through the large veins of the arm, neck, chest or groin and into the central blood circulation. It can be used for taking samples of blood, giving intravenous fluids, blood, chemotherapy and other drugs without the need for repeated needles.

**Chemotherapy**
Single drugs or combinations of drugs which may be used to kill and prevent the growth and division of cancer cells. Although aimed at cancer cells, chemotherapy can also affect rapidly dividing normal cells and this is responsible for some common side-effects including hair loss and a sore mouth (mucositis). Nausea and vomiting are also common, but nowadays largely preventable with modern anti-nausea medication. Most side-effects are temporary and reversible.

**Chromosomes**
Chromosomes are made up of coils of DNA (deoxyribonucleic acid). DNA carries all the genetic information for the body in sequences known as genes. There are approximately 40,000 genes on 23 different chromosomes. The chromosomes are contained within the nucleus of a cell.

**Chronic leukaemias**
A group of cancers that affect the blood and bone marrow. Chronic leukaemias usually develop gradually and slowly progress, particularly in the early stages of disease. The leukaemia is called chronic because it the leukaemic cells are more mature than those found in acute leukaemia. Chronic leukaemias are sometimes diagnosed by chance, during a routine blood test.

**Chronic myeloid leukaemia (CML)**
A type of leukaemia which is an initially slow growing (indolent) disease where the bone marrow produces too many white cells. Without treatment over time, CML usually transforms into acute leukaemia, a more aggressive type of disease where the bone marrow produces large numbers of abnormal immature granulocytes, known as blast cells or leukaemic blasts. CML is also called chronic myelogenous or chronic granulocytic leukaemia (CGL).
Clinical trial
A controlled and carefully monitored assessment of new forms of treatment. Trials can vary in design and size from small-scale trials of experimental treatments to large national trials that compare subtle variations in current therapies. The patient will be informed and will always be given the option not to join, or not without detriment to their treatment when their treatment is part of a trial.

Clone
A population of genetically identical cells arising from a single parent cell.
Leukaemia is believed to be a clonal disease, that is, all the leukaemia cells may originate from one abnormal cell.

Complete Molecular Response
When there is no evidence of disease detectable in the body; note this is not always equivalent to a cure as relapse may still occur.

Computerised axial tomography (CT scan or CAT scan)
A specialised x-ray or imaging technique that produces a series of detailed three dimensional (3D) images of cross sections of the body.

Cure
This means that there is no evidence of disease and no sign of the disease reappearing, even many years later.

Cytogenetic tests
The study of the genetic make-up of the cells, in other words, the structure and number of chromosomes present. Cytogenetic tests are commonly carried out on samples of blood and bone marrow to detect chromosomal abnormalities associated with disease. This information helps in the diagnosis and selection of the most appropriate treatment.

Dasatinib
A relatively new drug used to treat chronic myeloid leukaemia and other Philadelphia chromosome positive (Ph+) leukaemias. Dasatinib is classified as a tyrosine kinase inhibitor. It works by targeting the abnormal bcr-abl gene thereby blocking the leukaemia-causing effects of the enzyme tyrosine kinase.
DNA (Deoxyribonucleic acid)
Molecules found in the centre of the cell that carry all the genetic information for the body. There are four different chemical compounds of DNA (bases) arranged in coded sequences called genes, which determine an individual’s inherited characteristics.

Echocardiogram
A special ultrasound scan of the heart.

Electrocardiogram (ECG)
Recording of the electrical activity of the heart.

Genes
Collections of DNA. Genes direct the activity of cells. They are responsible for the inherited characteristics that distinguish one individual from another. Each person has an estimated 100,000 separate genes.

Granulocytes
A family of white blood cells that contains granules in their cytoplasm (neutrophils, eosinophils and basophils). They protect the body by seeking out and destroying microorganisms.

Growth factors and cytokines
A complex family of proteins produced by the body to control the growth, division and maturation of blood cells by the bone marrow. Some are now available as drugs as a result of genetic engineering and may be used to stimulate normal blood cell production following chemotherapy or bone marrow or peripheral blood stem cell transplantation.

Haemoglobin
The iron containing pigment in red blood cells, which carries oxygen to all the body’s tissues.

Haematopoiesis
The processes involved in blood cell formation.

Haematologist
A doctor who specialises in the diagnosis and treatment of diseases of the blood, bone marrow and immune system.

Hickman catheter
A type of central venous catheter (see above) used for patients undergoing intensive treatment such as bone marrow or peripheral blood cell transplantation. It may have a single, double or triple tube (or lumen).
**High dose therapy**
The use of higher than normal doses of chemotherapy to kill off resistant and/or residual (left over) cancer cells that have survived standard-dose therapy.

**Imatinib mesylate (Gleevec® or Glivec®)**
A relatively new drug used to treat chronic myeloid leukaemia and other Philadelphia chromosome positive (Ph+) leukaemias. Imatinib is classified as a **tyrosine kinase inhibitor**. It works by targeting the abnormal bcr-abl gene thereby blocking the leukaemia-causing effects of the enzyme tyrosine kinase. Also known as imatinib (Gleevec® or Glivec®).

**Immune system**
The body’s defences system against infection and disease.

**Immunocompromised**
When someone has decreased immune function.

**Interferons**
A family of natural proteins produced by the immune system which play an important role in fighting infection and disease. Interferons can also be produced in the laboratory and have been found to be effective in the treatment of some blood and bone marrow cancers and related diseases.

**Leukaemia**
A cancer of the blood and bone marrow characterised by the widespread, uncontrolled production of large numbers of abnormal blood cells. These cells take over the bone marrow often causing a fall in blood counts. If they spill out into the bloodstream however they can cause very high abnormal white cell counts.

**Leukaemic blasts**
Abnormal immature blood cells that multiple in an uncontrolled manner, crowding out the bone marrow and preventing it from producing normal blood cells. These abnormal cells can also spill out into the bloodstream and accumulate in other organs.

**Leukopheresis (leucopheresis)**
A procedure that uses a special machine called a ‘cell separator’ to separate and remove white blood cells from the circulation before returning the remainder of the blood to the patient. Leukopheresis is the technique used to collect stem cells from the blood for use in a stem cell transplant. It is also sometimes used to reduce a dangerously high white cell count.
**Lymph nodes or glands**
Structures found throughout the body, for example in the neck, groin, armpit and abdomen, which contain both mature and immature lymphocytes. There are millions of very small lymph glands in all organs of the body.

**Lymphocytes**
Specialised white blood cells involved in defending the body against disease and infection. There are two types of lymphocytes: B- lymphocytes and T-lymphocytes. They are also called B-cells and T-cells.

**Lymphoid**
Term used to describe a pathway of maturation of blood cells in the bone marrow. White blood cells (B-lymphocytes and T-lymphocytes) are derived from the lymphoid stem cell line.

**Malignancy**
A term applied to tumours characterised by uncontrolled growth and division of cells (see cancer).

**Matched unrelated donor (MUD) transplant**
An allogeneic stem cell transplant where the donor is unrelated to the patient, but with a similarly matched tissue type. Also called voluntary unrelated donor (VUD) transplant.

**Mini allogeneic (mini allo stem cell transplant)**
An allogeneic stem cell transplant involving the use of reduced doses instead of high-dose chemotherapy and/or radiotherapy. Also known as a non-myelo-ablative, or reduced intensity transplant.

**Mucositis**
Inflammation of the lining of the mouth and throat, which also can extend to the lining of the whole of the gastro-intestinal tract (stomach and intestines).

**Mutation**
A change in the DNA code of a cell, caused for example by exposure to hazardous chemicals or copying errors during cell division. If mutations affect normal cell function this can lead to the development of disease due to the loss of normal function or the development of abnormal functions of that cell.
Myeloid
Term used to describe a pathway of maturation of blood cells in the bone marrow. Red cells, white cells (neutrophils, eosinophils, basophils and monocytes) and platelets are derived from the myeloid stem cell line.

Myeloproliferative Neoplasms
A group of disorders characterised by the over-production of blood cells by the bone marrow. One or more of the cell families - red, white, platelets or support tissue, may be involved and treatment varies depending on the type and severity of the disease. Includes chronic myeloid leukaemia, polycythemia rubra vera, essential thrombocythemia and idiopathic myelofibrosis.

Neutropenia
A reduction in the number of circulating neutrophils, an important type of white blood cell. Neutropenia is associated with an increased risk of infection.

Neutrophils
Neutrophils are the most common type of white blood cell. They are needed to mount an effective fight against infection, especially bacteria and fungi.

Nilotinib
A relatively new drug used to treat chronic myeloid leukaemia and other Philadelphia chromosome positive (Ph+) leukaemias. Nilotinib is classified as a tyrosine kinase inhibitor. It works by targeting the abnormal bcr-abl gene thereby blocking the leukaemia-causing effects of the enzyme tyrosine kinase.

Oncologist
General term used for a specialist doctor who treats cancer by different means, e.g. medical, radiation, surgical oncologist.

Pathologist
A doctor who specialises in the laboratory diagnosis of disease, and how disease is affecting the organs of the body.

Peripheral blood stem cell collection
The collection of stem cells from the circulating blood stream.

Petechiae
Red or purple flat pinhead sized spots on the skin, especially on the legs. They are caused by tiny bleeds under the skin, usually as a result of a severe shortage of platelets.
Peripherally inserted central venous catheter (PICC)
Peripherally inserted central venous catheter (see central venous catheter) inserted in the middle of the forearm.

Philadelphia chromosome
The abnormal chromosome present in nearly all cases of chronic myeloid leukaemia and some cases of acute lymphoblastic leukaemia (ALL). The Philadelphia chromosome (also called bcr-abl) is formed when part of chromosome 9 (the abl gene) breaks off and attaches itself to part of chromosome 22 (the bcr gene) in a process known as translocation.

Platelets
Tiny disc-like fragments that circulate in the blood and play an important role in clot formation.

Prognosis
An estimate of the likely course of a disease.

Purpura
Purple spots on the skin, often accompanied by bleeding from the gums. It is caused by a shortage of platelets as well as fragile skin.

Radiotherapy (radiation therapy)
The use of high energy x-rays to kill cancer cells and shrink tumours.

Resistant or Refractory Disease:
This means that the disease is not responding to treatment.

Remission
When there is no evidence of disease in the body; note it is difficult to classify a patient with a complete molecular response as being in “remission” as the current testing equipment does not definitively rule out the presence of leukaemia cells below this detection threshold.

Spleen
An organ that accumulates lymphocytes, acts as a reservoir for red cells for emergencies, and destroys blood cells at the end of their lifespan. The spleen is found high in the abdomen on the left-hand side. It cannot normally be felt on examination unless it is enlarged. It is often enlarged in diseases of the blood – this is known as hypersplenism or splenomegaly.
Splenomegaly
Another term used to describe an enlarged spleen.

Standard therapy
The most effective and safest therapy currently being used.

Stem cells
Stem cells are primitive cells that can give rise to more than one cell type. There are many different types of stem cell in the body. Bone marrow stem cells have the ability to grow and produce all the different blood cells including red cells, white cells and platelets.

Stem cell transplant
General name given to bone marrow and peripheral blood stem cell transplants. These treatments are used to support the use of high-dose chemotherapy and/or radiotherapy in the treatment of a wide range of cancers including leukaemia, lymphoma, myeloma and other serious diseases.

Translocation
A chromosomal abnormality in which part of the one chromosome is transferred to another.

T-cell
A type of white cell involved in controlling immune reactions.

Tumour
An abnormal mass of cells which may be non-malignant (benign) or malignant (cancerous).

Ultrasound
Pictures of the body’s internal organs built up from the interpretation of reflected sound waves.

White blood cells (White cells)
Specialised cells of the immune system that protect the body against infection. There are five main types of white blood cells: neutrophils, eosinophils, basophils, monocytes and lymphocytes.

X-ray
A form of radiation used in diagnosis and treatment.
Making a donation

The Leukaemia Foundation is the only national not-for-profit organisation dedicated to the care and cure of patients and families living with leukaemias, lymphomas, myeloma and related blood disorders.

You can help by making a donation. Please fill out the form below or visit www.leukaemia.org.au to make your gift online.

Dr/Mr/Mrs/Ms/Miss: .................................................................

Address: ..........................................................................................

.................................................................. Postcode ...................

Telephone: (h)..................................................................................

 (w) ..................................................................................

Email: ..................................................................................

Please accept my tax deductible donation for $ ......................

My cheque, made payable to the Leukaemia Foundation, is enclosed, or please charge $............... to my credit card:
  □ Bankcard    □ Visa      □ Mastercard       □ Amex      □ Diners

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Cardholder’s name: .....................................................................

Cardholder’s signature: .............................................................

Expiry date: ....../....... 

Please send to: 
  The Leukaemia Foundation
  GPO Box 9954
  in your capital city.
Please send me a copy of the following information booklets:

- Eating well: a practical guide for people living with leukaemias, lymphomas & myeloma
- Living with Leukaemias, Lymphomas, Myeloma & Related Disorders, Information and Support
- Understanding Allogeneic Transplants
- Understanding Autologous Transplants

Please send me the following:

- Regular copies of CML News
- Information on the Foundation’s activities

Or information about:

- The Leukaemia Foundation’s Support Services
- CML Telephone Forums
- Workplace giving
- Regular deduction scheme
- National Fundraising Campaigns
- Leaving the Leukaemia Foundation in my will
- Volunteering
- How I or my family/friends can help the work of the Foundation

Name: ...................................................................................................
Street or Postal Address: ..........................................................................
Suburb ...................................................................................................
State/Postcode .......................................................................................
Email: ...................................................... Tel: (....).................................

Please send to:
Leukaemia Foundation, GPO Box 9954, In Your Capital City
or Freecall 1800 620 420
or email: info@leukaemia.org.au

Further information is available on the Leukaemia Foundation’s website
www.leukaemia.org.au
Understanding Chronic Myeloid Leukaemia (CML)

A guide for patients and families

This information booklet is produced by the Leukaemia Foundation and is one in a series on blood cancers and related disorders.

Freecall: 1800 620 420
Email: info@leukaemia.org.au
Website: www.leukaemia.org.au

The Leukaemia Foundation is a non-profit organisation that depends on donations and support from the community.

Please support our work by calling 1800 620 420 or by mailing your donation to:
The Leukaemia Foundation
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in your capital city

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