Treatment Development of Chronic Myeloid Leukemia

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Chronic Myeloid Leukemia (CML) is a hematopoietic stem cell disorder leading to myeloproliferation and its attendant consequences [1]. CML typically evolves in 3 distinct clinical phases; An indolent or chronic phase (CP) course easily controlled with therapy that can last for 3 to 5 years and accelerated phase (AP) that lasts for less than 12 months and blast phase (BP), characterized by rapid expansion of a population of myeloid or lymphoid blasts of at least 30% in the peripheral blood or bone marrow resulting in the patient’s death within 4 to 6 months [2]. Busulfan is the oral anti-CML alkylating agent in the 1950s and was convenient to administer and inexpensive but associated with severe and prolonged myelosuppression. Busulfan was largely replaced by hydroxyurea in 1970s. Hydroxyurea was the available and effective anti-CML agents in the 1980s. These were able to control the clinical manifestations of the disease, but were rarely, if ever, capable of eliminating the malignant clone. In 1990s the interferon alpha has constituted first-line therapy for patients with CML resulted in major cytogenetic responses of 25% [3]. The combination of interferon alpha with hydroxyurea or with Ara-C was effective in clinical practice and induces cytogenetic remissions in some patients [4].

Treatment of chronic myeloid leukemia improved dramatically with the development of tyrosine kinase inhibitors (TKIs), especially the introduction of imatinib (Gleevec) in May 2001 into the clinical practice. Imatinib is the golden standard tyrosine kinase inhibitor target therapy in CML and considered the first-line drug of choice in the chronic phase of CML [5]. However, up to 33% of patients will not achieve optimal response. This led researchers to develop new second and third generation tyrosine kinase inhibitors.

In 2006 dasatinib (Sprycel) represents a promising treatment option for patients in all phases of chronic myeloid leukemia and also as a second line treatment for patients with CML if imatinib therapy fails and for Philadelphia chromosome-positive acute lymphoblastic leukemia (Ph+ALL) [6,7].

In 2007 FDA approved for use nilotinib (Tasigna) as a selective treatment for Philadelphia positive chronic myeloid leukemia. Until recently, it had been used mostly and quite successfully as a second-line agent, and it is now licensed for first-line use at a dose of 300 mg twice a day and can be replaced instead of imatinib without any complications [8].

In September 2012, FDA approved bosutinib (Bosulif) for the treatment of adult patients who have chronic, accelerated, or blast phase Philadelphia chromosome positive (Ph+) chronic myeloid leukemia. Bosutinib was found to inhibit the proliferation of CML progenitors about 200 times better than imatinib and demonstrated durability of clinical outcomes among patients with chronic phase who had previously treated with imatinib and dasatinib or nilotinib [9].

In December 2012 FDA approved ponatinib (Including) as pan-BCR-ABL tyrosine kinase inhibitor for treatment of chronic phase , accelerated phase, or blast phase chronic myeloid leukemia (CML) who are resistant to dasatinib or nilotinib or intolerant to dasatinib or nilotinib and in Philadelphia chromosome positive acute lymphoblastic leukemia resistant to imatinib, dasatinib, or nilotinib [10].

The monitoring of tyrosine kinase inhibitor target therapy can be performing according to laboratory recommendations for scoring molecular responses by using either molecular or cytogenetic tests, or both, depending on the available facilities. Molecular testing performed by RQ-PCR onuffy coat of 10 ml blood to measure BCR-ABL1 transcript level, which is expressed as BCR-ABL1% on the International Scale (IS). The monitoring should be performed every 3 months until a MMR is achieved, then every 6 months [11]. The standardization of monitoring techniques is expected to affect both the use of health care resources and outcome (Table 1).

CCyR: complete cytogenetic responses, MMR: Major molecular response AP; Accelerated phase, BP; Blast phase

Kantarjian et al (2010) reported in Dasision study that, the response were more better with dasatinib than imatinib, including higher response at 12 months rate of complete cytogenetic response (CCyR) in dasatinib 83% vs. 72% in Imatinib (P. 0.0001) and higher response at 24 months rate of major molecular response (MMR) 64% in Dasatinib vs. 46% in Imatinib (P 0.001) [12]. Saglio et al. report the response of nilotinib was better than imatinib and the higher cytogenetic response rate (CCyR) at 24 months was 87% in nilotinib vs. 77% in imatinib and MMR response rate at 24 months was 71% in nilotinib vs. 44% in imatinib [8]. Cortes et al. reported there were no significant difference between the imatinib and bosutinib in CCyR response rate at 12 months study, while the MMR rate at 12 months study was significantly higher with bosutinib better than imatinib (41% vs. 27%; P<0.001) [13].

The development of resistance toward TKI is the most common problem in the treatment of chronic myeloid leukemia. In Imatinib resistance, second generation TKIs and allogeneic stem cell transplantation are excellent treatment options. The second generation TKI is the best choice for all CML patients developed drug resistance [7]. Bone marrow transplantation considered the best option for CML patients developed resistance for second generation TKIs.

<table>
<thead>
<tr>
<th>Results in months</th>
<th>DASISION, %</th>
<th>ENESTnd, %</th>
<th>BELA, %</th>
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<tbody>
<tr>
<td>Imatinib</td>
<td>Dasatinib</td>
<td>Nilotinib</td>
<td>Bosutinib</td>
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<tr>
<td>CCyR at 12 months</td>
<td>73</td>
<td>85</td>
<td>65</td>
</tr>
<tr>
<td>CCyR at 24 months</td>
<td>82</td>
<td>95</td>
<td>77</td>
</tr>
<tr>
<td>MMR at 12 months</td>
<td>28</td>
<td>46</td>
<td>27</td>
</tr>
<tr>
<td>MMR at 24 months</td>
<td>46</td>
<td>64</td>
<td>44</td>
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<tr>
<td>Progression to AP/BP</td>
<td>3.5</td>
<td>1.9</td>
<td>4</td>
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<tr>
<td>PFS at 24 months</td>
<td>92</td>
<td>93</td>
<td>95</td>
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<tr>
<td>OS at 24 months</td>
<td>95</td>
<td>95</td>
<td>96</td>
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</tbody>
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Table 1: Comparison of the results of imatinib with other TKIs [8,12,13].

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