

Bacterial infection can be diagnosed and the severity evaluated using WBC count and left shift

In the event of bacterial infection, large numbers of neutrophils migrate from the blood to the infected site in order to destroy the invading microorganism and thus protect the host. The neutrophils removed from the peripheral blood are then replaced by other neutrophils, at various stages of maturation, from the bone marrow pool. The total number and composition of neutrophils in the blood are therefore altered dramatically at this time.

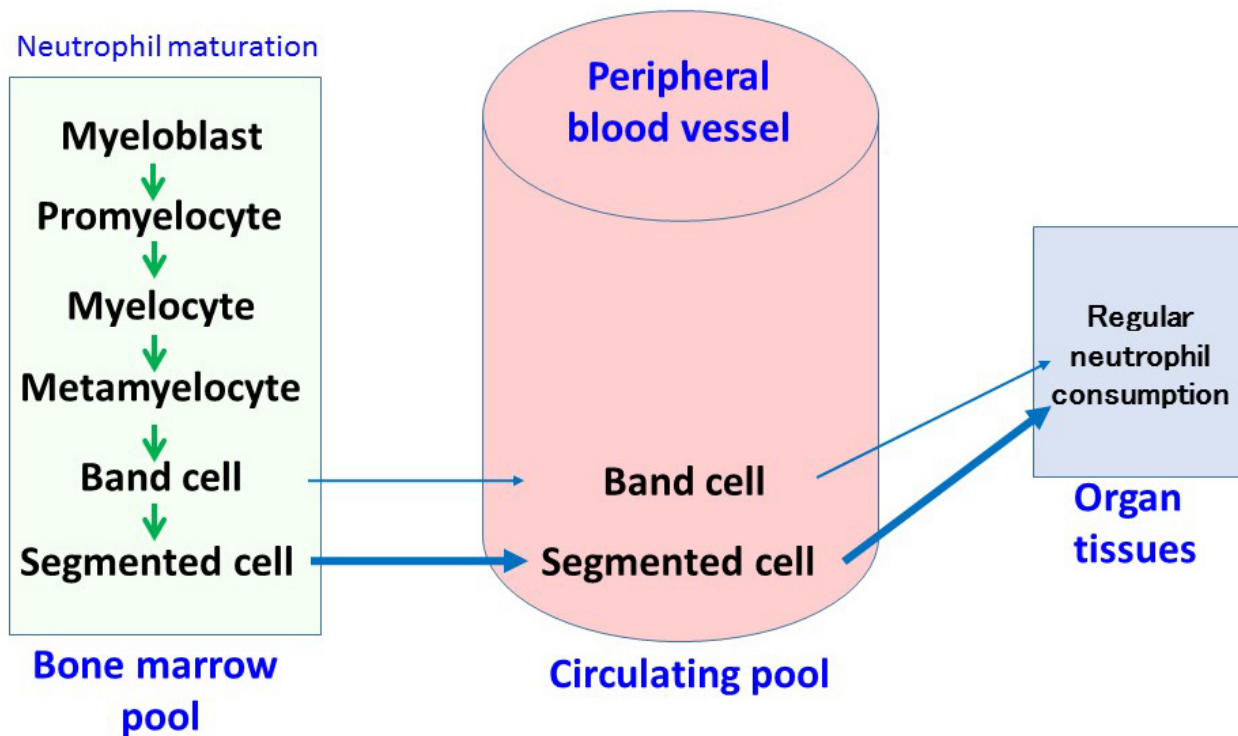


Fig. 1. Neutrophil consumption by tissues in the absence of bacterial infection. Neutrophils, primarily segmented neutrophils and to a lesser extent band neutrophils, migrate from the bone marrow into peripheral blood, before infiltrating organ tissues.

It generally takes seven days for neutrophils to mature in the bone marrow, and the bone marrow pool contains neutrophils at various maturation stages, from immature myeloblasts, through promyelocytes, myelocytes, metamyelocytes, and non-segmented/band neutrophils, to segmented neutrophils, the most mature type of cell (Fig.1). During bacterial infection, the shortage of mature neutrophils in the peripheral blood means that more immature cells, such as myelocytes, metamyelocytes, and band neutrophils are also released; this phenomenon is called 'left shift' (Fig. 2).

The course of a bacterial infection can be divided into four phases using a combination of the white blood cell (WBC) count, which is almost the same as the neutrophil count, and the degree of left shift. During the first phase, occurring between 0 and 20 hours after the onset of infection, the neutrophil count, whether considering the left shift or not, briefly falls below the reference range. The consumption of neutrophils at the site of bacterial infection exceeds the capacity of the bone marrow to produce replacements. At the early stage, a left shift is not observed. During the second phase, which occurs between one and several days after the onset of infection, the neutrophil count increases as the supply from the bone marrow exceeds consumption at the infection site, and a left shift is observed. During the third phase, which occurs in the days following the second phase, high neutrophil counts continue to be seen, but without a left shift, as sufficient cells can be supplied to the infection site without increasing production in the bone marrow. By this stage, the bacterial infection is largely eliminated. During the fourth and final phase, occurring in the days following the third phase, the neutrophil count gradually decreases until it reaches the reference range, and no left shift is observed. At this stage the infection has been eliminated, and a large neutrophil population is no longer necessary.

That said, some severe bacterial infections, including meningitis, infective endocarditis, and abscesses, may not show a left shift because the neutrophils in the blood are not continuously depleted, and so the production and release of immature neutrophils into the peripheral blood by the bone marrow is unnecessary.

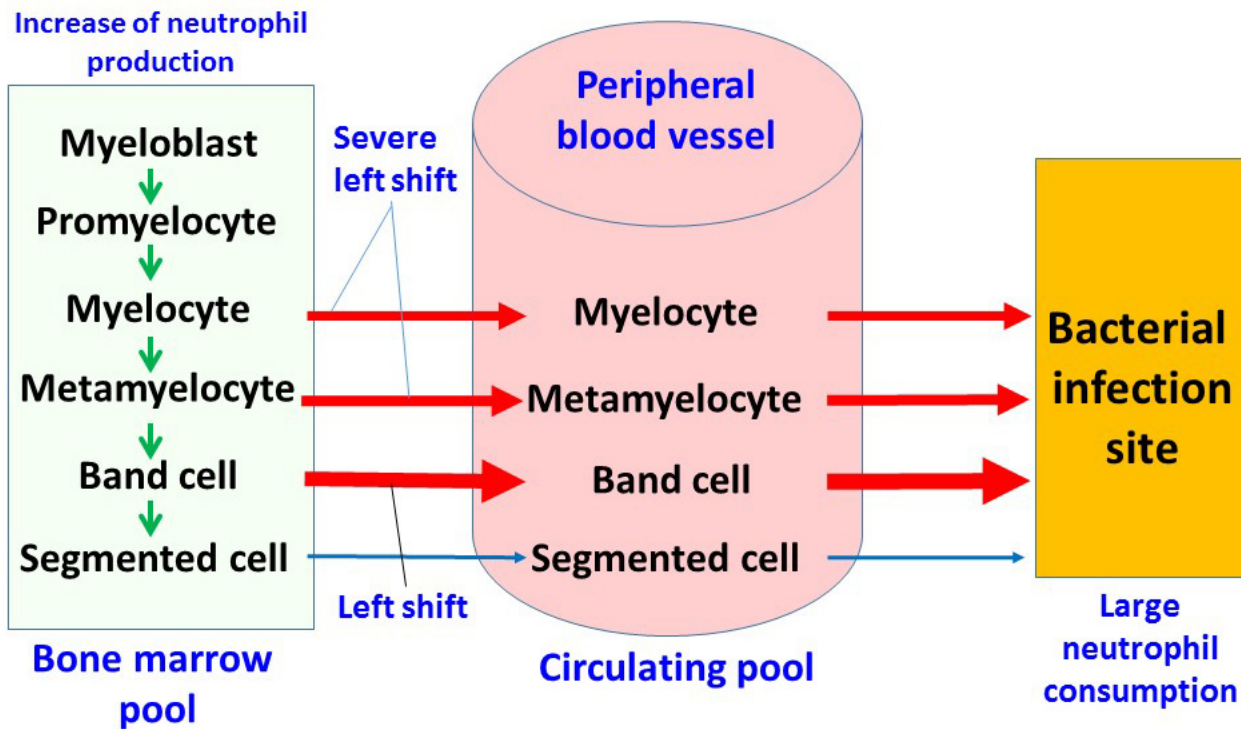


Fig. 2. High neutrophil consumption during bacterial infection. A large population of neutrophil cells, comprised of metamyelocytes and myelocytes in addition to

segmented neutrophils and band neutrophils, migrate from the bone marrow into the peripheral blood before infiltrating the site of bacterial infection.

Generally, there are dramatic changes in left shift and WBC count over the course of a bacterial infection, and a combination of these factors can be used for diagnostic purposes. Therefore, a time-series analysis of these parameters, comprising a minimum of two points, could improve the sensitivity and specificity of both the diagnosis of a bacterial infection and the evaluation of its progression. The left shift principally depends on the response of the bone marrow to neutrophil depletion from the blood, and so can be used to diagnose bacterial infections with high specificity. Therefore, if a left shift is observed upon admission, a bacterial infection should be suspected, and if this value increases within a few hours, a diagnosis of a bacterial infection can be made. Additionally, an assessment of both the left shift and WBC count can be used to evaluate the severity of bacterial infection and whether antibiotic treatment is appropriate.

Takayuki Honda

*Department of Laboratory Medicine, Shinshu University School of Medicine, Asahi 3-1-1,
Matsumoto, Japan*

Publication

[Neutrophil left shift and white blood cell count as markers of bacterial infection.](#)

Honda T, Uehara T, Matsumoto G, Arai S, Sugano M

Clin Chim Acta. 2016 Jun 1