Case 5

J.K. is a 15 year-old white female high school student who presented to the emergency room with complaints of vomiting, nausea, fever and a "sunburn-like" rash on her soles and palms. J.K. was in good health except for occasional heavy menstrual bleeding necessitating hyperabsorbent tampons. Three days prior to admission, after the onset of menses, she developed nausea, vomiting and a feeling of weakness when she stood up. She felt feverish and had severe chills. The next day she noted an erythematous[1] scaly rash on her palms and soles that gradually spread to the remainder of her extremities (Fig. 1). One day prior to admission she noted a white vaginal discharge.

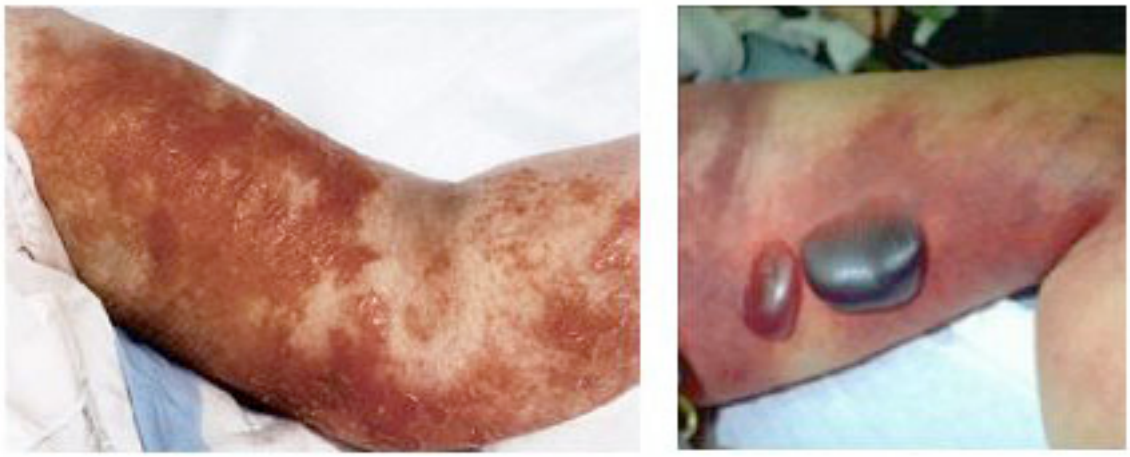

Fig. 1. Characteriistic rash of severe toxic shock syndrome. Erythematous rash on upper extremety (*left*) and lower extremety (*right*) are shown; note appearance of bullae superimposed on macular rash.

J.K. presented to the ER. After waiting 10 minutes, she collapsed and was found to have a barely palpable blood pressure of 70. She had a temperature of 105°F, a pulse of 120, and respirations of 26. She had a diffuse erythematous rash. Her chest examination was notable for râles[2] over both lung fields and her abdominal exam revealed mild hepatomegaly (enlarged liver). She had a white vaginal discharge. She was treated with intravenous hydration, norepinephrine[3] and broad-spectrum antibiotics. Her BP improved within several hours. Laboratory examination revealed a WBC of 24,000[4] with 45% lymphs (lymphocytes) and 50% polys (polymorphonuclear leukocytes). Her chest X-ray showed bilateral diffuse infiltrates in her lower lung fields. Special immunology tests revealed the following: serum levels of IL-1, IL-2 and TNF-α were markedly elevated. Analysis of her lymphocytes by flow cytometry demonstrated 75% $CD3^+$ cells with 55% $CD4^+$ and 20% $CD8^+$ cells; 65% of her T cells were $V_\beta 2$. Cultures of her vagina, urine and blood were obtained; the only positive culture was from the vaginal discharge, which wrevealed an oxacillin-sensitive TSST-1^+ *Staphylococcus aureus* and the patient's antibiotics were switched to oxacillin. A diagnosis of toxic shock syndrome was made. The patient recovered completely.

[1]Red

[2]Velcro-like lung sounds, usually upon inspiration. This physical sign is non-specific, but is typical of abnormalities such as pulmonary edema (excess lung water) that can accompany specific types of shock.

[3]A pressor, or agent that raises the blood pressure, which is used in the treatment of many forms of shock. Due to its relatively weak β-agonist activity, its major effect on the circulation is to act as a vasoconstrictor, rather than to enhance the contractility of the heart directly.

[4]cells/μl

Questions for Case 5

(1)The toxin designated TSST-1 is produced by the majority of *S. aureus* isolated from patients with the toxic shock syndrome (TSS). The other major baceria that produces superantigens is Group A *Streptococcus pyogenes*. How are superantigens defined and to what do they bind? What mechanisms accounted for the high percentage of $V_\beta 2$ T cells in J.K.'s blood?

(2) How does the TSST-1-induced expansion of $CD4^+$ T-cells result in high fevers, hypotension and rash?

(3) TSST-1 is one of many factors expressed by virulent forms of *S. aureus*. Another virulence factor is extracellular adherence protein "Eap" (otherwise called the major histocompatibility class II analogue protein, or "Map"). One recognized ligand of Eap/Map is intercellular adhesion molecule-1 (ICAM-1). How might Eap/Map contribute to the virulence of *S. aureus*?

(4) Design potential drugs that may be useful in treating the TSS.