the World Health Organization 86:480-487 (2008); Makani et al., "Mortality in sickle cell anemia in Africa: a prospective cohort study in Tanzania" *PloS one* 6:e14699 (2011); and McGann et al., "A prospective newborn screening and treatment program for sickle cell anemia in Luanda, Angola. *American journal of hematology* 88:984-989 (2013). In all 50 states of America, and the District of Columbia, hemoglobin screening of newborns is mandated in order to diagnose SCD early, so that, monitoring and treatment can be started immediately. In: National Institutes of Health. The Management of Sickle Cell Disease 4th Ed., *NIH Publication No. 02-2117* NIH National Heart, Lung and Blood Institute (2002).

[0006] Early diagnosis through newborn screening, followed by simple interventions, has dramatically reduced the SCD related mortality in the US. However, these strategies have not been widely available in Africa and other third world countries, due to limited resources. What is needed is a point-of-care biochip-based hemoglobin screening method.

SUMMARY

[0007] Examples described herein relate to an electrophoresis biochip and system for detecting hemoglobin disorders, such as sickle cell disease (SCD). The biochip includes a housing, first and second buffer ports, a sample loading port, and first and second electrodes. The housing also includes a microchannel that extends from a first end to a second end of the housing. The microchannel contains cellulose acetate paper that is at least partially saturated with an alkaline buffer solution. The first buffer port and the second buffer extend, respectively, through the first end and second of the housing to the microchannel and cellulose acetate paper. The first buffer port and the second buffer port are capable of receiving the alkaline buffer solution that at least partially saturates the cellulose acetate paper. The sample loading port can receive a blood sample and extends through the first end of the housing to the microchannel and cellulose acetate paper. The first electrode and the second electrode can generate an electric field across the cellulose acetate paper effective to promote migration of hemoglobin variants in the blood sample along the cellulose acetate paper. The first electrode and second electrode can extend, respectively, through the first buffer port and the second port to the cellulose acetate paper.

[0007a] In one aspect, there is provided an electrophoresis system for use in detecting hemoglobin variants, comprising:

an electrophoresis biochip that includes a housing, a microchannel, and a cellulose acetate paper at least partially saturated with an alkaline buffer solution that extends through a portion of the microchannel, the cellulose acetate paper structured to receive a blood sample;

a sample loading port for introducing the blood sample to the cellulose acetate paper;

and a first electrode and a second electrode for generating an electric field a length of the cellulose acetate paper, wherein the generated electric field induces migration and separation of hemoglobin variants in a blood sample introduced to the cellulose acetate paper that extends through a portion of the microchannel into one or more bands on the cellulose acetate paper

an imaging system structured to detect the one or more bands of the hemoglobin variants of the blood sample on the cellulose acetate paper caused by the generated electric field and to generate band detection data based on the one or more bands of the hemoglobin variants of the cellulose acetate paper, wherein the imaging system is used for visualizing and quantifying hemoglobin variant migration along the cellulose acetate; and

an imaging processor programmed to receive the band detection data to determine one or more band characteristics corresponding to the one or more bands of the hemoglobin variants of the blood sample and identify hemoglobin variants in the blood sample, wherein the image processor includes a software application that recognizes and quantifies the hemoglobin band types to make a screening decision or diagnosis.

[0008] In some embodiments, the housing can include a viewing area for visualizing the cellulose acetate paper and hemoglobin variant migration. The electrophoresis biochip

CLAIMS

1. An electrophoresis system for use in detecting hemoglobin variants, comprising:

an electrophoresis biochip that includes a housing, a microchannel, and a cellulose acetate paper at least partially saturated with an alkaline buffer solution that extends through a portion of the microchannel, the cellulose acetate paper structured to receive a blood sample; a sample loading port for introducing the blood sample to the cellulose acetate paper; and a first electrode and a second electrode for generating an electric field a length of the cellulose acetate paper, wherein the generated electric field induces migration and separation of hemoglobin variants in a blood sample introduced to the cellulose acetate paper that extends through a portion of the microchannel into one or more bands on the cellulose acetate paper;

an imaging system structured to detect the one or more bands of the hemoglobin variants of the blood sample on the cellulose acetate paper caused by the generated electric field and to generate band detection data based on the one or more bands of the hemoglobin variants of the cellulose acetate paper, wherein the imaging system is used for visualizing and quantifying hemoglobin variant migration along the cellulose acetate; and

an imaging processor programmed to receive the band detection data to determine one or more band characteristics corresponding to the one or more bands of the hemoglobin variants of the blood sample and identify hemoglobin variants in the blood sample, wherein the image processor includes a software application that recognizes and quantifies the hemoglobin band types to make a screening decision or diagnosis.

2. The electrophoresis system of claim 1, wherein the imaging system is portable and computer interfaceable.

3. The electrophoresis system of claim 2, wherein the portable, computer interfaceable imaging system includes a camera that images hemoglobin variant migration.

4. The electrophoresis system of claim 3, the housing including an optically clear area for visualizing the cellulose acetate paper and hemoglobin variant migration.