represented by single node queueing systems and analysed separately. After gaining insights about the performance of the subsystems, the interaction between these subsystems and the performance of the whole system may be analysed and compared with that of the isolated subsystems. The hospital subsystem considered here is the MRI section of the radiology department. We represent the system as a single node queueing system, where the arrival stream of patients consists of both advance scheduled and same day (i.e., open access) customers. This means that both scheduled and random arrivals have been considered. Multiple classes of patients are considered, the classification being on the basis of type of investigation, source of arrival (i.e., outpatient, inpatient and emergency department) and whether the patients are advance scheduled or same day patients. For illustration, we consider a real life MRI section of the Radiology department of a multi-speciality hospital situated in easternIndia. To parameterize the queueing models, data on arrival patterns and service times have been collected from the hospital information system and log books at the department of radiology. Some managerial implications and future research directions are also discussed.

Key Words: Patient flow, Stochastic modeling, Queueing theory

Health Implications of Drought and Feasible Preparedness and Mitigation Measures

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Over 68% of India is prone to drought of varying severity. 'Drought' is a hydro-meteorological disaster which indicates scarcity of water and moisture-stress caused by below normal rainfall, resulting in low agriculture and livestock productivity affecting livelihoods and human health badly. Drought is a complex and least understood disaster, the impacts of which often depend upon the nature of socio-environmental background in the region, and affects more people spatially than any other disaster. India receives 73% of rainfall during monsoon (June to September) and due to its failure, the rain-fed agriculture is impacted badly recording low food grain yields. Drought and malnutrition are intricately related as evident from past famines caused by drought. In later part of 19th century, about 25 famines killed 30-40 million people, which is an indicator of drought causing malnutrition leading to morbidity and mortality. Unsuitability of water resources in terms of feasibility or water quality, water losses due to evaporation, overexploitation and wastage, contamination by over use of water for non-agricultural purposes are some of the attributes aggravating multiple socio-economic problems and health hazards. Drought has multiple adverse health effects ranging from malnutrition, water borne diseases, air-borne diseases, vector borne diseases and even mental illness provoking suicides. There is no doubt that drought has multiple adverse indirect health outcomes too. The severity of impact varies according to underlying vulnerability of the population from death at one extreme to minimal or no effect where the population/individuals have financial and other resources to buffer themselves from any potential effects of impending health hazards. Essentials to drought preparedness and mitigation in reducing the effects of drought on human health, are early warnings and drought monitoring systems to timely warn people of potential threats to health, to create a historical record to assess changing conditions and disease profile, risk identification of vulnerable population groups, regions, and sectors most at risk during drought. Scientists believe that adaptation strategies need to strengthen health sector preparedness for drought, including heat-health action plans, emergency medical services, improved climate-sensitive disease surveillance, improved health service delivery, provide safe drinking water with improved sanitation and good hygiene conditions to check epidemic outbreaks.

The paper seeks to identify major health hazards posed by food insecurity caused by drought and outline possible preparedness and mitigation measures to reduce debilitating impacts of drought conditions on human health.

Key Words: Drought, Hydro-meteorological Disaster, Normal Rainfall, Health hazards Malnutrition, Preparedness and Mitigation

Real Time Non-Invasive Cardiac Health Monitoring System

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The project aims at making a portable device to measure pulse rate, Blood pressure, Cardiac output, respiration rate, oxygen saturation and heart rate variability in a single device , non-invasively from Photoplethysmography (PPG) signal and Electrocardiogram (ECG) signal. According to government of India figures, 70% of patients in the country are village-based whereas, 75% of Doctors are placed in urban areas. The doctor-patient ratio was a sparse 1:1722 in 2005. That figure is fairly small to handle a country with progressive cardiac patients estimated to 4.58 million by 2015. Study reveals that by 2020 60% of cardiac patients are in India. Moreover existing devices present in the market make use of cuff pressure and tonometer methods for measurement of BP; these cannot be used for continuous/real time monitoring. Devices employed in hospitals for measuring Cardiac Output are invasive, bulky, nonportable monitors and use expensive disposable flow sensors for each patient and do not come in a single integrated unit . A device to measure pulse rate, Blood pressure, Cardiac output, respiration rate, oxygen saturation and heart rate variability non-invasively is not available at present in miniaturized forms. This has inspired us to come up with this type of system where, both ECG and PPG signals are obtained using analog processing circuits. Data Acquisition Systems are used to

send the data to a microprocessor where the waveforms are analyzed. Using signal processing techniques, the mentioned parameters are calculated and displayed. The pulse rate is calculated by using peak detection algorithm by using the PPG Signal. The average time interval between successive peaks gives the pulse rate. PPG signal has AC and DC components of which the latter is analyzed to calculate Respiration Rate using VFCDM technique. BP has inverse relationship to Pulse Transit Time (PTT). PTT is calculated as the time difference between the R-peak of ECG signal and the peak of the PPG signal. Blood Pressure is measured by correlation with PTT. SpO2 is calculated by computing the AC and DC components of both the red and infrared LEDs corresponding PPG signals. The PPG signal is analyzed to obtain an index called inflection and harmonic area ratio (IHAR), which has a correlation with Cardiac output. The device would be easy to setup and determining these parameters would be instantaneous (5- 10 seconds), which is of great help in case medical emergencies and ambulatory services.

Key Words: Photoplethysmography (PPG), Electrocardiograghy (ECG), Pulse Transit Time(PTT), Variable Frequency Complex Demodulation (VFCDM), Cardiac Output(CO)

Family Friendly Hospital Initiative: A Stepping Stone Towards Continuous Quality Improvement

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The paper presents a unique 'Family Friendly Hospital Initiative' (FFHI) that works towards provision of comprehensive patient care in a safe environment in public health institutions, by focusing on resource inputs, process inputs and monitoring outcomes. This was initiated under the aegis of Government of Bihar (GoB) through a DFID funded project, in collaboration with Bihar Technical and Assistance Support Team (BTAST), wherein IPE global is one of the implementation consortium partners. The Family Friendly Hospital is envisaged to create an enabling environment in public health facilities, where service providers offer quality care and ensure patient safety by adhering to evidence based protocols. The hospital environment is made conducive for the facility's beneficiaries to enjoy comfortable institutional stay, particularly for women and new borne. Thus, an FFHI focuses on five strategic areas- Patient Care, Patient Safety, Patient Stay, Patient Feedback and Service Providers' Capacity. FFHI is a quality assurance initiative, which ensures provision of a minimum quality essential hospital services package through a series of participatory processes, where the entire hospital staff shares responsibility for improving the service provision in the facility, and progressively moves ahead in improving quality through a system of internal and external audits, certifications and accreditation. It is implemented in three phases: Commencing with Preparatory Phase which entails assessment of the facility, a visioning exercise and participatory preparation of a problem bank, followed by Intervention Phase wherein intensive action is undertaken towards the agreed solution paths considering seven FFHI mandated standards, under the overall guidance of a nominated lead. This is followed by Certification Phase that aims at accrediting the facility to be 'family friendly' based on an internal assessment using a checklist. Beyond these the hospitals move into the phase of Continuous Quality Improvement (CQI). The FFHI certification is a pre-step to prepare the facility for higher levels of national and international certification and accreditation like NABH. The FFHI is supported by district and state level quality assurance to provide supportive supervision, developed by BTAST within the directorate of Health GoB. Early results of implementation of FFHI in 82 facilities in Bihar have shown significant improvement in quality of health services, in turn, generating greater demand in these FFHI facilities and certification of 28 facilities will be achieved by August 2013. Each hospital has a FFHI consultant to provide handholding and supportive supervision support to monitor quality of service delivered. Four FFHI centres have achieved ISO 9001:2008 certification and two are moving ahead for NABH accreditation. In one such hospital in Banka district, the number of inpatients went up by 152% and number of patients availing ambulance services went up by 144%. The FFHI initiative with its people centric perspective in bringing about changes from within the system is commendable and has proved to be a stepping stone in establishing quality health management system. The State is now encouraged for further scaling up the programme in 178 facilities.

Gram Varta: A Valuable Tool for Community Mobilisation

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The paper presents an innovative demand side intervention of Gram Varta (GV) or 'village dialogue', which is a social auditing system, rolled out with dual objective of: Enhanced Community Ownership, and Community Mobilization to increase uptake of quality services in public delivery system and lead to better health outcomes for the community. With the objective to ensure equity and increase accessibility, affordability and quality of services in areas of health, nutrition, water and sanitation, DFID has funded a 'Sector Wide Approach to Strengthening Health' (SWASTH) supported by a consortium partnership, wherein IPE Global as a partner provides Bihar Technical Assistance and Support Team(BTAST). The SWASTH program is an integrated program involving all three departments of Health, Social Welfare, and Public Health and Engineering under Government of Bihar(GoB), thereby addressing both demand and supply interventions to impact health specific and sensitive issues. One such demand side low cost, sustainable and integrated intervention is Community based GRAM VARTA initiative of BTAST under the aegis of GoB, which involves various Self Help