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Patient Flow Measurement: Definition, Application and Relevance for Emerging Markets and Developing Countries

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Introduction

Dominated by clinical concerns, healthcare delivery has historically devoted scant attention to issues of management, efficiency or cost containment. The US shift to address these concerns began in the 1990s as medical care costs skyrocketed. Hospitals hired professional mangers and searched for ways to improve performance, leading to efficiency, among other things. Patient flow analysis (PFA) emerged within that context, applying a combination of management techniques, architectural design and technology to improve the delivery of healthcare (Litvak & Long 2000). Aiming at improved efficiency, rational use of resources, improving quality and the patient experience – all objectives under the 2010 Affordable Care Act (ACA) – has accelerated the adoption of patient flow measures and techniques as the ACA targets raising quality and controlling costs. The emerging lessons are instructive for all countries.

In many Low and Middle Income Countries (LMICs) wait times to get appointments or see a physician can be extensive with crowded waiting rooms and further waits for diagnostic tests and returns for results that involve more waiting (Dixon et al 2014; Atnafu et al 2015; Prudtikul and Pathomisiri 2013). Emergency departments (ED) experience similar congestion and chaos, and ED staff has difficulty finding available beds for patients who need to be admitted. At the same time operating theaters can remain idle for much of the day and beds can be empty due to lack of communication across the hospital. Dissatisfied patients complain about wait times, which concern policymakers, but unmotivated staff and underutilized infrastructure compromise overall productivity, raising costs and lowering quality.

PFA is one option for addressing and measuring the chaos that characterizes hospitals and clinics, particularly public ones, across many LMICs. It is one of a spectrum of management tools for medical care services but it has the unique advantage of indirectly introducing management improvements by streamlining hospital operations.

This Note summarizes the concepts, approaches and benefits of patient flow in the US as a backdrop to exploring the use and relevance of patient flow analysis in health care delivery across LMICs. It is meant to provide some basic understanding of PFA, its potential relevance in LMICs and the possible need for alternative metrics for measuring management in those settings.

We have relied upon academic publications, news reports, recent conference and training presentations, webcasts from patient flow summits, reviews of software vendors and informal interviews to provide an up-to-date profile of the technique, its application and impact.

Why Patient Flow Analysis?

PFA is a method of applying qualitative and quantitative tools to analyze the throughput of patients in a hospital, hospital department or clinic. It entails the movement of patients, information or equipment across staff, departments or facility services as part of a patient's care pathway. Its objective is to maximize resource use and minimize patient discomfort and wait times. Annex A lists common PFA indicators.

PFA is a young field, starting fifteen years ago when operations management principles were applied to health care (Litvak & Long 2000). Spurred by the ACA, US hospitals are now incentivized to adopt organizational and technological advances to better use their facilities (Litvak and Bisognano 2011) rather than just upgrading facilities and staff. Reducing patient waiting times and cutting the total time a patient spends in a hospital improves quality, reduces costs and enhances patient experience – specific factors that affect hospital reimbursement levels under Medicare and Medicaid.

Benefits to PFA can be significant and are summarized in Box 1; there are drawbacks as well. Importantly, patient flow methodologies and technologies are evolving and their impacts evaluated in the US because there is demand from the biggest payer, the federal government. Second, without demand from some combination of payers, government or hospital associations PFA is unlikely to be embraced on a national level despite its potential and proven record. Currently PFA is either introduced by technical assistance organizations in LICs, or high end private facilities in Middle Income Countries hire consultants to implement PFA for them. As discussed below, PFA lends itself to application on a smaller scale either at an individual facility, a network of facilities or at a local level where managers or their advisors make strategic decisions about efficiency, and by extension embrace PFA. Finally, PFA requires a cultural shift within medical facilities, a major challenge that is discussed further below. Such impediment can jettison launching any type of reform especially where leadership is weak or physician fiefdoms are strong.

Box 1: The benefits of PFA extend to providers, patients and facility managers

Benefits for Providers:

- decreased average length of stay (ALOS)
- improved utilization of operating theaters, labs and other diagnostic services
- saved nursing and physician time
- streamlined registration of patients

Benefits to Patients:

- enhanced patient safety,
- greater patient satisfaction
- patient education – self management of health care once outside the hospital
- shorter wait times

Benefits to Facility Managers:

- track progress, performance and waste
- promote facility redesign in accommodating the flow of hospital staff and patients
- maximize space utilization

Source: Drazen 2011

As is often the case with adopting new technologies and processes, they invariably clash with current culture and ways of doing business. Focusing on patients and patient throughput is a new concept for providers who have traditionally structured care processes and service flows around their preferences and convenience. This is consistently the case in LMICs. It requires management dedication, leadership, staff engagement and a broader strategy that refits processes to new objectives for PFA to effect change. However, elements of patient flow can be adopted piecemeal and often are, allowing an iterative approach to changes in technology, processes and culture.

Another possible drawback of PFA is its technology-intensive nature, which can be daunting; at the same time LMICs could benefit by leapfrogging to new technologies leaving behind older, less effective management tools, or simply adopting convenient elements of PFA, which is already happening as discussed below.

Patient Flow Analysis Methodology

Patient flow analysis methodology comprises two separate techniques: qualitative *flow mapping*, and *quantitative cycle time measurement* (Backer 2003).

1. *Flow mapping:* the process of determining how patients can best be moved through the facility or department, designing optimal space and husbanding personnel time, ultimately minimizing wait times and patient visits; and,
2. *Cycle-time measurement:* measurement and breakdown of the total number of minutes between patient arrival and departure within the hospital or clinic, measuring the stops, waits and attention received by the patient.

Quantitative measures have spawned a plethora of software to measure ongoing use of resources such as beds, operating theaters or diagnostic services, and tracking of personnel and patients within the hospital. For example, software can track hand washing of personnel, the vacating of a hospital bed or the discharge status of a patient, all through applications of sensors that collect and assemble data on activities (See Annex B). Application of software can respectively improve infection control, maximize bed utilization, and ensure timely discharge (rather than waiting for the attending physician to visit the patient), all of which improve management and patient experience.

Under ideal circumstances these individual methods are carried out in tandem and across the entire facility as patient flow is highly effective as a system-wide approach that provides an overview of how the patient is managed and moved through the hospital (Drazan 2011). In some cases only elements of patient flow technique are utilized – for example, PFA might be undertaken without the quantitative aspects, elsewhere PFA may be applied in just one department like emergency. The value of a facility-wide effort is to integrate the various services of the hospital or clinic to make the whole system work better and to break down the notorious silos of departments that isolate different parts of the hospital from each other and compromise productivity, quality and the patient experience.

The most successful patient flow initiatives are characterized by: a focus on costs, having the right metrics to measure priority changes, an integrated strategic process with adequate resources, involvement of all departments, and well defined processes (Yu 2015).

Spinoffs of PFA offer more limited sets of measures to capture some aspects of efficiency in patient management. First, value stream analysis (VSA) is a simple tool that helps operational managers understand how their patient flows currently operate and how analysis can improve them (Shook 2004). Unlike PFA it takes neither spatial factors nor identical time measurements into account. Services revolve around the timing and needs of the patient to use existing infrastructure and staff more efficiently, and to maximize use of infrastructure like operating theaters (Graban 2011). Initiatives in Canada (Verma & Amar 2015) and the US Veterans Administration (Matt et al 2015) hospitals are the only published reviews of experience, and the results are mixed. However VSA is less technology

intensive and may have promise for LMICs as the hospital itself drives change in devising efficiency for patients and the facility, and implementation is less onerous.

Experience and Potential of Patient Flow Analysis in LMIC Countries

Management challenges and rigidities in LMIC hospital and clinic management structures have led to use of PFA. Table 1 summarizes the salient studies, their approaches and findings. The literature is not vast and highly uneven with a few serious research efforts but a number of descriptions of efforts that apply patient flow concepts for specific purposes. Few of the experiences attempt a comprehensive, facility-wide analysis. Many efforts do not find their way into publications either due to lack of data, or simply a focus on management improvements without a research component.

In India, where private hospitals are projected to be a $125 billion market by 2016, there is little to no review or published study of patient flow though the efficiency of Indian private and nonprofit institutions in eye care and cardiovascular surgery reflect strong focus on minimizing waste, cost containment and quality that underlie patient flow analysis (Martin,2015; Bhattacharya et al 2010). This applies in other countries as well where we see rising efficiency but little evidence on how that has been achieved.

The uses of PFA are illustrative of its bandwidth. For example, in Ghana Dixon et al (2015) quantify hospital infrastructure and staffing using patient flow to help clinical managers improve working arrangements of staff and waiting times of patients, and in Malawi, Agyeman-Duah et al (2014) engaged staff in understanding why chaos persists and how they might improve their and patient circumstances particularly in registration and use of consultation rooms. On the other end of the spectrum, private hospitals and elite public hospitals in Upper Middle Income Countries like Brazil, Qatar and Singapore, apply patient flow in sophisticated ways that mirror those in the US.

The vast majority of patient flow studies address fundamental problems that managers or management advisors are confronting. The mismatch between staffing and patient demand can be difficult to manage particularly in public hospitals that are characterized by a lack of leadership authority and staff accountability. PFA can help engage public sector staff in defining solutions that can be as simple as using appointments to better serve patients (Ethiopia), rearranging workloads of staff (Ghana, Thailand), redesigning how pharmacy stocks are arranged (South Africa). Impacts are equally broad ranging from using color coordinated signs to guide hospital patients (Malawi) to declining lengths of stay (Brazil, Ghana, Qatar) to plunging patient waiting times (Egypt, Ethiopia, South Africa) to dramatic declines in mortality (Malawi). These reflect objectives of PFA.

What is striking about these studies is the innovative ways patient flow concepts and measures are applied. They range from undertaking interviews with staff and/or patients to sophisticated simulation models for predicting potential efficiencies to careful, long term tracking of inpatients. Most adapt some aspects of patient flow for their own needs but effectively make up the measures on the spot. Indeed, few refer to the source of their methodologies. Some, however, adhere to US methods and practices though these tend to be private facilities in richer countries.

Conclusion – Way Forward

Patient flow analysis has not been on the global agenda, but as this review suggests, it represents a potentially valuable tool for hospitals and clinics in developing countries. It could help facilities analyze their processes and effectiveness in delivering services to patients, promote collaboration and team building in developing those processes, and encourage an understanding of data and its relevance to running the hospital or clinic. And that is before the management improvements, financial benefits and enhanced patient experience are captured.

While the summary above provides a sense of the published literature it only offers a glimpse of what is happening across the globe. Indeed, informal discussions with hospital managers in a few countries suggest that experimentation with PFA and PFA-like initiatives is ongoing across the world in multiple settings. The India case above offers a particularly relevant example. Many circumstances could benefit from the approach but have no access to information or guidance on the technique.

The potential for a (set of) metrics is significant and would appeal to countries, hospitals and donors. Benefits in countries or regions with little in the way of hospital management experience would be particularly high. The refrain of "we need more resources" could be replaced with how to use resources better and raise quality through application of PFA processes that eschew a long process of management upgrading. For example metrics and support to: (i) simply benchmark services within a hospital or clinic; (ii) measure waiting times at different points in clinics and hospitals, for example to see physicians, get a lab test, receive an injection; (iii) align supply of medical staff and patient demand across time and space; (iv) improve resource use, for example inpatient beds, dialysis machines, operating theaters; (v) create effective internal communication systems, for example, between emergency rooms and admitting, could leapfrog the process of hospital or clinic management. Appropriately scaled and designed metrics combined with support could assist that kind of process.

Such metrics would allow medical and management teams to focus on solving observed problems, which fosters critical buy-in from staff, and avoids the launching of facility-wide management change that has few of the benefits that targeted PFA initiatives could potentially provide.

Understandable, easy to use metrics would contribute to increasing exposure to management objectives and their link to clinical quality. Developing techniques that embody varying levels of sophistication that allows small clinics or large hospital centers to improve management would be valuable. It would also allow facilities to track their progress, and introduce more complexity and stronger management at each level.

Options and guidance of what and how to apply patient flow concepts would be highly appropriate in LMICs. Current guidance is in English, targeted at technology intensive OECD hospitals, and too involved for most hospitals or clinics to adopt without assistance. Such investments are costly. The potentially simpler methods summarized here, and those of Indian hospitals referred to in newspapers and journals could potentially inform development of such metrics as they have evolved in limited resource settings. Other countries have explored management improvements that revolve around patients.

Working with adaptors and implementers across various settings offers a potentially valuable means of collecting relevant experience to inform priority and ways forward.

Moreover, as mentioned above, low-income countries have the potential to leapfrog into more sophisticated methods that provide information and management tools. For example Sensor Swipe ™ technology tracks hand washing using sensors placed in staff garments to reduce infection; and PowerCADD™, a low cost software for redesigning infrastructure use, using bar coding of drugs and medical consumables for internal distribution to reduce medical error and promote efficiency, and electronic communication across registration, the ER and nurses stations to track available beds are worth considering. Developing appropriate patient flow metrics could raise visibility, provide benchmarks and assist in transferring appropriate and acceptable patient flow techniques to lower income countries.

A feasible strategy going forward would entail the following kinds of steps:

- Identifying ways that PFA has been adopted in LMICs that have promise more broadly, extracting useful approaches and effective metrics from these experiences, and assessing whether PFA ever leads to broader managerial shifts or clinical improvements such as increased reliance on clinical protocols.
- Developing a core set of metrics that could be applicable in different settings, providing guidance on adoption and categorizing them for easy access – and translating these into languages other than English;
- Assessing demand or willingness to engage on management upgrades, process improvements or simply ways to raise control of patients and services in clinics and/or hospitals. This can be at a government, sub-national, network of facilities or individual facility level
- Identifying collaborators who have an interest, willingness and ability to implement PFA
- Investing in demonstration projects in at least two settings that test metrics, processes and approaches to PFA implementation.

Given the meager evidence base most of these activities would entail site visits in a set of countries with broad consultation with managers and providers. All or part of this agenda can help to move PFA forward in developing country settings.

Table 1: Summary of Studies of Patient Flow in Low and Middle Income Countries

Country	Hospital/ Clinic/ Institute	Ownership	Summary of intervention	Results	Reference
Brazil	Albert Einstein Israelite Hospital, Sao Paulo	Non-profit	Intervention aimed at decreasing ALOS	Reduced ALOS over 6 years led to virtual bed capacity increase of 66 beds	Neto, personal communication, 2015
Brazil	Brazilian National Cancer Institute, Rio De Janeiro	Public	Discrete event computer simulation for mammography clinic	Model indicated optimal capacity configurations	Coelli et al., 2007
Egypt	National Heart Institute, Cairo	Public	Study evaluated the impact of a new scheduling system on patient waiting time and overcrowdedness for cardiac cauterization	Patient crowding decreased, waiting time from arrival to cauterization fell 13%	Wong et al., 2012
Ethiopia	14 country-wide hospitals	Public	Mentors placed with hospital management team for 1 year plus course work	Improvement in 60% of key management indicators	Bradley et al., 2008
Ethiopia	Gondar University Public Teaching Hospital, Gondar	Public	Study at ART clinic set up centralized patient appointment system, daily patient limit, and educating patients on adhering to appointments	Reduced overall patient waiting time by 40%	Atnafu et al., 2015
Ghana	Kintampo Municipal Hospital, Kintampo	Public	Highlighted unclear arrival procedures, limited seating capacity, no initial triage, inefficient supply storage, inadequate hospital staff given demand, staff communication lapses	Designated registration areas, efficient history taking, increased consultation rooms, staff expansion	Dixon et al., 2015
Ghana	District Hospital, Kintampo	Public	Study applied Discrete Event Simulation to results of a previous time and motion study to build models for improving patient flow	ALOS would fall by 96 minutes coordinating shifts to patient arrivals, & 152 minutes combining registration & history taking	Best et al., 2014
Ghana	Nkawie Government Hospita, Nkawie; Aniwaa Medical Center, Kumasi	Public, Private	Comparative study of a public and private hospital sought inefficiencies in supervision	Study found greater inefficiencies in supervision at the government hospital compared to the private facility	Mensah, Asamoah & Tawiah, 2014

Table 1: Summary of Studies of Patient Flow in Low and Middle Income Countries

Country	Hospital/ Clinic/ Institute	Ownership	Summary of intervention	Results	Reference
India	Aravind Eye Hospitals, country-wide	Non-profit	Hospitals in India train high school graduates to be patient flow managers		Bhattacharya et al., 2010
India	Narayana Health Group, country-wide	Private	Greenfield hospitals with high volume of surgeries - doctors perform 2-3 surgeries/day; 60-70 hours a week	Flagship hospital charges $2000 for bypass surgery	Martin, 2015; Anand, 2009
Madagascar	Salfa Eye Clinic, Fianarantsoa	Indeterminate	Fully integrated Electronic Medical Records system installed	Clinic manager can manage patient flow	Pons, 2012
Malaysia	Obstetrics and Gynecology Department, unnamed hospital	n/a	Study developed a simulation model to improve flow	Two proposed solutions project decreased waiting times for patients by 56% and by 90%	Najmuddin, Ibrahim & Ismail, 2010
Malawi	Kamuzu Central Hospital, Lilongwe	Public	Medical department conducted a situational analysis	Staff misalignment with patient rush hours; patient flow was assisted by color coordinated signs	Agyeman-Duah et al., 2014
Malawi	Queen Elizabeth Central Hospital, Blantyre	Public	Pediatric outpatient and emergency unit tested triage at entry, quick referral to specialties, redesign to move patients in one direction, colored numbers and signs on doors	Inpatient mortality fell from 10-18% to 6-8%	Molyneux, Ahmad & Robertson, 2006
Qatar	Unidentified hospital	Indeterminate	Computer simulation modeling to suggest improvements to patient flow in cardiac surgery department	Simulation models predict a 23% decrease in LOS for admitted patients	Khayal et al., 2013
Singapore	National University Hospital, Singapore	Public	Empirical study on inpatient flow management	Patients admitted before noon had a shorter ALOS	Shi et al., 2014
South Africa	Groote Schuur, Khayelitsha, GF Jooste, Eersteriver and Worcester hospitals province-wide	Public	The provincial Government of the Western Cape announced the development of a plan to improve patient flow in five participating hospitals (Note: this is a description of something planned rather than a completed project)	Unknown	Rossouw, 2013

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Country	Hospital/ Clinic/ Institute	Ownership	Summary of intervention	Results	Reference
Tanzania	Kilminjaro Christian Medical Center, Kilminjaro	Non-profit (Trust)	Baseline assessment identified patient inconvenience, inefficient use of personnel, inefficient procedures, monitoring, and stores and purchasing as problem areas	Outreach counselors took vital signs and consent forms in the field; nurses had more time	Pons, 2012
Thailand	Unnamed hospital	Public	Discrete event simulation model to improve patient flow	Physician working schedule changes proposed	Prudtikul & Pathomsiri, 2013
West Africa	General		Triage guidelines for workers in general hospital settings in West African countries affected by the Ebola virus	Unknown	US Centers for Disease Control, 2015
Uganda	Mulago HIV Clinic, Mbarara Municipal Council Clinic, Reachout Mbuya	Public	Time and motion study to evaluate patient flow at 3 clinics	More effective triage and longer visit intervals recommended to improve patient flow	Wanyenze et al., 2010

Annex A - Patient Flow Metrics

Metric	Unit
Patient Movement Through a Hospital	
Emergency Department Metrics (Door to Doctor)	Time
Average Patient Length of Stay (Inpatient)	Time
Patient Wait Times	Time
Average Patient Throughput (ED)	Time
Typical Cycle Time Breakdown - Patient Movement	
Arrival to Room	Time
Triage time	Time
Triage to registration	Time
Triage to Room	Time
Arrival to Provider	Time
Consultant called to present	Time
MD visit to first lab order	Time
MD visit to first X ray order	Time
In room to first MD visit	Time
Arrival to Admit	Time
Disposition to discharge	Time
Disposition to admit	Time
Arrival to Discharge	Time
Room to Departure	Time
Disposition to Departure	Time
Left Without Being Seen (LWBS)	Qty.
Other Metrics	
Bed Turns (Hours bed empty)	Time
Number of ED ambulance diversions (ED full)	Qty.
Hours to ambulance diversion (ED full)	Time
Increased admissions	Qty.
Bed Utilization Rates	Qty.
Discharges Before a Set Time	Qty.

Annex B - Examples of Technological Solutions

Technology Type	Manufacturer/Vendor	Solution
Real Time Location Services	Versus	Badges pinpoint locations and activities of patients and staff, enabling room allocation, reducing manual data entry, notifying personnel of patient need, monitoring staff hygiene, coordinating lab work, and eliminating paperwork
Event driven data	Medhost	Software accumulates information about staff variance, service line saturation, real time push notifications, and analytics about patient days by unit and hospital utilization
Software vendors		
Allscripts, Awarepoint, CareLogistics, Central Logic, Cerner, Hill-Rom, McKesson, Medhost, NovaSim, PatientTrak, Patient Care Technology Systems, Patient Focus Systems, Versus, WellSoft		

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Aceso is a pioneering collaborative consisting of researchers, practitioners, policy makers and investors active in improving performance of hospitals and health care systems in emerging markets. The founder and CEO of Aceso Global, Maureen Lewis, Ph.D., is a respected thought leader in global health and health economics. At the World Bank, she was Chief Economist for Human Development, and both managed and worked globally.

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