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Layal Hneiny

Maryah Damlaj

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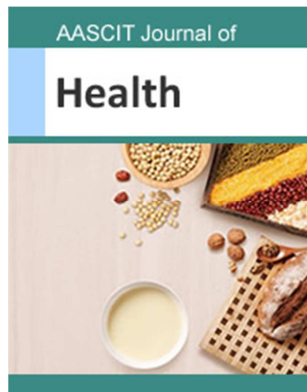


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Redesigning the Door to Doctor (D2D) Process in Emergency Department: The Key to a Successful Patient-Centered Story

Layal Hneiny, Maryah Damlaj

Faculty of Health Sciences, American University of Beirut, Beirut, Lebanon

Email address

lh32@aub.edu.lb (L. Hneiny), mbd05@mail.aub.edu (M. Damlaj)

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Abstract

Lean management, when adopted in health care settings, will influence clinicians to find better ways for providing health care services to patients. In ED's everyday processes, lean focuses on improving the ED process flow through facilitating communication among ED staff and eliminating any unnecessary steps (wastes) along the process. An observational cross-sectional study has been conducted at the Emergency Department (ED) of the American University of Beirut- Medical Center (AUBMC), to assess the extent upon which AUBMC-ED is lean. The time it takes the patient to be examined by an attending doctor, from the moment s/he hits the ED door, denoted as Door-to Doctor (D2D), was measured. A sample size (n) of 135 D2D timings was collected over a period of twenty nine days (October 28th till November 21st, and November 29th till December 2nd, 2013). Average D2D timing was found to be 25 minutes. The current process map of AUBMC-ED was also assessed and analyzed to identify any non-value added steps and obstacles that contributed to such D2D timings. These are increasing the crowding in ED and hindering the ED staff from performing their duties efficiently. These include: ED door being utilized by individuals not directly heading to ED, entrance of more than two relatives per patient in to the different ED units, security guards performing duties not inherent to their jobs such as greeting, and patients and/or relatives being unaware of steps to do after they are done with registration. The paper then proposes multiple feasible recommendations that would redesign the current process map of AUBMC-ED for it to become leaner. These recommendations can serve as a point of reference to promote lean thinking in EDs of other academic hospitals in Lebanon and the region.

1. Introduction

The American University of Beirut- Medical Center (AUBMC), an academic hospital located in the urban areas of Beirut, Hamra established since 1902, is one of the leading hospitals in Lebanon and the region. It is accredited by the Joint Commission International (JCI) on hospital accreditation awarded with the Magnet Recognition Program. This medical center is also a research center that continuously strives to deliver evidence-based quality-driven health care services such as obstetrics care, maternity care, oncology care, surgical care, critical care services, cardiac care, in addition to emergency services.

One of the key goals in AUBMC's Emergency Department (ED) is to meet the patient

needs and increase their satisfaction. Speeding the flow of delivery of care process in ED is a basic way to minimize potential harm that both providers and patients face in case of any delay. One indicator to measure timeliness of care in ED is the Door-to-Doctor (D2D) time. D2D time is the time interval from the moment the patient enters the ED’s door (as walk-in or by ambulance) to the time he/she is seen by an MD/LIP (Medical Doctor/Licensed Independent Practitioner) [1, 2]. Another definition of D2D, coined by Baumlin et al. is “triage time to the time the attending physician signed up for the patient” [3]. D2D is one key process indicator, that when measured on a regular basis can assist in drawing ED’s process map and accordingly explore, identify, and correct possible inefficient steps; thereby, applying lean management principles [4]. This leads to fastening the process flow, promoting patient safety and increasing their satisfaction [5].

The Lean philosophy has been first coined by the Toyota car manufacturing company in the 1950s. Its brilliant principles have then become extensively applied in various managerial, production, and industrial settings [6]. It often revolves around two keystone concepts. Eliminating inefficiencies is one concept that is applied through standardizing operations and involving human resources in performance improvement. The second concept is empowering employees through providing them with the basic tools to improve quality and process flow [7].

When lean management is adopted in health care settings, it will influence clinicians to find better ways for providing health care services to patients. In ED’s everyday processes, lean focuses on improving the ED process flow through facilitating communication among ED staff and

eliminating any unnecessary steps (wastes) along the process. Lean must be supported by the executive team, who should understand that it is a journey which changes how business is done [8]. It will promote efficiency and effectiveness, which with time may evolve into a greater positive impact: cycle of continuous improvement. When all ED staff are involved in such a cycle, the patient’s Length of Stay (LOS) will involuntarily drop, further increasing customers’ satisfaction. Accordingly, ED staff will not rush and minimize interactions with patients to reach an extremely low D2D, rather will be motivated to keep up their progress.

1.1. Aim of This Study

As a continuation of the series of assessment studies done at AUBMC to improve service delivery processes, this observational study aims to address an issue raised by customers in ED: lengthy D2D time.

To set a strategic target situation for AUBMC-ED, the Lean Transformation Services’ approach for implementing improvement projects (Figure 1) was used. It starts with identifying the vision: decreasing the D2D time and enhancing customer satisfaction. This would be achieved through measuring the D2D time and identifying the variables that affect its duration. The current ED process map is then outlined to assess all steps and identify those that are value-added and non-value added (causing avoidable increase in patients’ waiting time) along the process [7, 9]. An improved redesigned map is thus proposed using lean-based management approach to minimize the non- added steps.

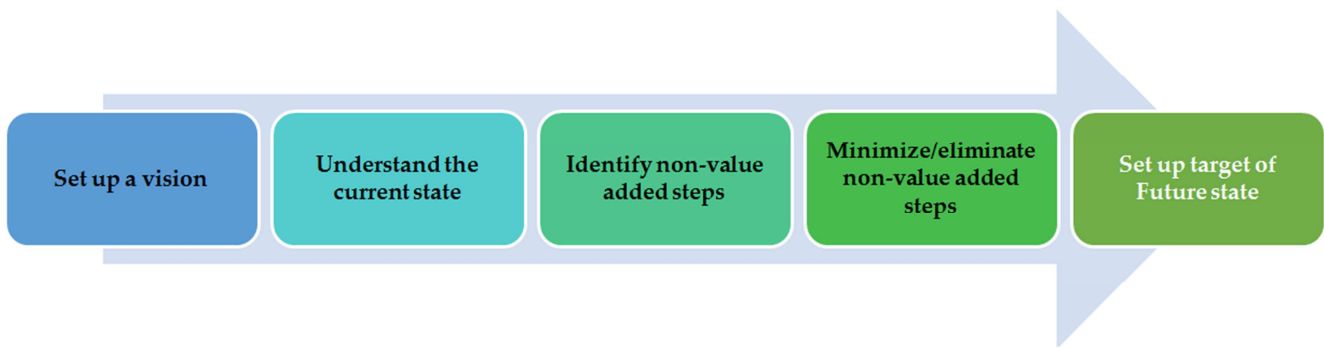


Figure 1. Lean Transformation Services’ approach for implementing improvement projects.

1.2. Significance of This Study

The significance of applying lean management in the D2D process for this study lies at three levels: the patient, the organization, and community. At the level of patients, their satisfaction increases, their LOS decreases and the rate of those “Left Without Being Seen” (LWBS) decreases [7, 10, 11]. At the organizational level, it enhances health outcomes, escalates the volume of emergency-admitted patients with

met expectations, increases its employees’ efficiency and satisfaction [12], and sustains its image among its competitors in the growing healthcare market. All this feeds into the wider community scope, which will promote better health and wellbeing of the population and provide an enhanced proposed model that serves as a benchmark to promote lean thinking in EDs of other academic hospitals in Lebanon and the region.

2. Methods

2.1. Data Collection

An observational cross-sectional study was carried out at the ED of AUBMC to collect the D2D time (measured in minutes) and observe patient's activities during his/her journey. A random sample of patients was taken, meaning that each patient going into AUBMC's ED had an equal chance of being selected in the study. This study was strictly observational, indicating no interaction between the patient and the data collectors to avoid any extra delay in any step of the D2D process.

This study took place over the period of October 28th till November 21st, and November 29th till December 2nd, 2013 from 11 am till 1 am. A total of 135 D2D timings (sample size) were collected, which is considered 95% of the average patients examined per day at AUBMC-ED. The time grid presented in Appendix (A) represents the data collected.

The institutional Review Board (IRB) has reviewed this quality improvement research study. And their response was: As the focus of the study is D2D times and not patients, and involves no interaction with patients or access to private health information, the study is a non-human subject research and does not require IRB approval.

185 D2D timings were collected yet some were excluded to reach a total of 135. The exclusion criteria are as follows:

- cases, who required a consultant physician
- cases where D2D was recorded as door to medical student/ intern/ resident rather than door to attending doctor due to data collector's misjudgment
- cases where the collector's stop watch failed to keep accurate recording.

2.2. Limitations of Data Collection

The limitations while collecting data are mentioned below:

ED staff might have performed their best upon feeling they were monitored by the data collectors, so the timings collected might incur error.

The study was conducted over twenty nine days only, which is not representative of the fluctuation in the patient's volume admitted to AUBMC-ED across the whole year.

3. Results

D2D (the dependent variable) average was 25 minutes with a standard deviation of 15.9. This large standard deviation is assumed to be attributed to shifts [Shift 1, Shift 2], severity index level [ESI: 1-3, ESI: 3-5], and the number of patients per unit per hour that are considered the independent variables affecting the change in the D2D timing. These dependent and independent variables are presented in Table 1.

Table 1. Dependent and Independent variables.

Dependent variable	Independent variable	
D2D	Shift:	Shift 1: 11:00am-5:59pm Shift 2: 6:00pm-12:59am
D2D	Units:	Medicine (ED1) Surgery (ED2) Pediatrics (ED3)
D2D	Volume:	per unit per hour

Two shifts have been assigned upon observation as shown in Table 2: Shift 1 is from 11:00 am till 5:59 pm, while Shift 2 starts from 6:00 pm till 12:59 am. Since independent t-test is utilized to compare means of two not related groups against a numerically continuous variable, it has been used to compare average D2D (dependent variable) across two shifts representing two unrelated groups (independent variables). The results showed that the two shifts do not have a significant effect on the average D2D time ($p>0.05$), that is average D2D in shift 1 is comparable to average D2D in shift 2.

As for the second independent variable (severity), it was divided into three unrelated groups:

- Medicine unit (ED1) admits patients with Emergency Severity Index (ESI): 1-3
- Surgery unit (ED2) admits patients of ESI: 3-5
- Pediatrics unit (ED3) admits patients of ESI: 1-5

ESI=1 given to most severe cases and ESI=5 given to least severe cases. The fact that ESI 3 is repeated in both former units is because the concept of over-triaging is favored over under-triaging in AUBMC-ED.

Because all severity cases of pediatrics are admitted to ED3 and not streamed like in case of ED1 (ESI=1-3) and ED2 (ESI=3-5) the effect of ED3 patients on D2D was then excluded from comparing severity against D2D. Therefore, the sample size being analyzed decreased from 135 to 102 and is divided between D2D timing in ED1 and D2D timing in ED2. Performing then the independent t-test that serves the purpose of comparing average D2D in ED1 across average D2D in ED2, the results show statistical insignificance. This means that the difference of the mean of D2D does not differ whether the patient is admitted to ED1 or ED2.

The volume of patients per unit per hour was studied across D2D. Since both variables are numerically continuous; a correlation between them can be identified using the simple linear regression. The latter being an approach to find a relationship between a continuous dependent variable and another continuous independent variable. The outcome shows that upon admission of one more patient to a particular ED unit, D2D decreases by 0.011 minutes. The correlation is thus not significant, indicating that the volume of patients in the assigned units does not significantly decrease or increase D2D timing.

Table 2. The outcome of studying the three independent variables across the dependent variable in 2013.

Studying D2D across	Result
- Shift	Insignificant
- Unit	Insignificant
- Volume/ Unit/ hour	Insignificant

Overall, the results revealed that the average D2D timing was neither affected by the shifts (Shift 1/Shift 2), nor by severity level [Medicine unit (ED1)/Surgery unit (ED2)], nor by volume per hour per unit. Because all variables mentioned above showed insignificant effect on D2D timing, other factors in the process map of the patient’s journey in the ED were considered.

The results of this study were compared to that collected during August 20 of which the average D2D was 45 minutes as shown in Table 3.

Table 3. Comparing D2D in Baseline and Current data.

Aug - 2012	Oct 28-Nov 21, Nov 29 - 2013
45 minutes	25 minutes

Neither the two shifts, nor the severity levels had a significant effect on the average D2D time ($p>0.05$). The volume of patients per unit per hour was not studied across D2D, because it was missing, as illustrated in Table 4.

Table 4. The outcome of studying the three independent variables across the dependent variable in 2012 (Baseline).

Studying D2D across	Result
- Shift	Insignificant
- Unit	Insignificant
- Volume/ Unit/ hour	N/A

This significant decrease in 20 minutes in D2D time was attributed to several changes in EDs process flow like:

- a. Introducing bedside registration in ED1 unit (discussed further more in “Current AUBMC-ED situation” section)
- b. Implementing a team assignment system: two teams were assigned to receive and treat patients according to their acuity level.
- c. Adjusting physician-staffing level in which each physician is responsible to treat 2 to 3 patients according to their acuity level.

4. Discussion

4.1. Current AUBMC-ED Situation

Figure 2 presents the current AUBMC-ED layout (not for scale) which allows the reader to track the patient’s journey in AUBMCED according to the different severities of the patient explained in flowchart (Figure 3). It can be noticed from the layout that ED3 holds the smallest surface area compared to ED2 and ED1. Below are the descriptions of the

different routes of patients of varying severities, as illustrated in Figure 3:

- a. If the patient is coming by ambulance, or is suffering from severe chest pain, or other symptoms of stroke/seizure, or is classified to be ESI 1 or 2 according to AUBMC’s ED protocol, s/he will bypass triage, and will directly be admitted to ED1/ED3 by the greeter (orderly) and/or paramedics. The patient then enters a cubicle and examination starts right away. If an MD student/intern/resident and/or attending doctor is not occupied with another patient, s/he examines the patient along with the Registered Nurse (RN); else the patient is examined by an RN, then MD student/intern/resident, then an attending doctor. While patient is in ED1 cubicle, a Patient Access Officer (PAO) does bed-side registration. If the patient is accompanied by relative(s), one of the relatives settles out the bills for the patient at the cashier; otherwise, the clerk or the PAO would be responsible for registering the patients. It is important to note that in case the patient was a pediatric, the clerk/RN would perform PAO tasks in ED3.
- b. For patients coming as walk-in, their first point of contact is the greeter, who guides them to the triage room (average door-to-triage= 1 minute 40 seconds) or triage waiting room in case there were patients in triage room and triage glass room. The triage nurse takes an average of 3 minutes 40 seconds to identify which unit the patient should be admitted to. After triage ends, the triage nurse steps out of triage room and asks the orderly to guide the relative to the registration and patient to the specified unit:
 1. If the patient is classified to be admitted in ED1 (but not with ESI=1), orderlies accompany the patient and relatives to ED1 counter. During the journey, the security guard documents the patient’s name and opens ED1’s door for patient, orderly, and/or relative to enter ED1. If a cubicle is available, the patient is admitted; else, asked to wait in ED1 internal waiting room till a cubicle is ready. The PAO meanwhile does bed-side registration even during the wait, and asks the relative to head to the cashier to settle payments. Meanwhile, the patient gets examined by an RN, followed by an MD student/intern/ resident (average door-to-MD student/intern/resident= 19 minutes and 36 seconds, $n=129$ cases) and then by an attending doctor (average D2D= 25 minutes, $n=135$ cases).
 2. If the patient is classified to be ED2/ED3 (ESI= 3-5) and is accompanied by relative(s), they receive directions to perform registration and financial issues by the orderly (Process A starts). The patient heads to ED2/ED3 unit and waits in the internal waiting area. Before entering the ED2/ED3 unit, the security guard asks the patient for his/her name and opens door for patient to pass. Upon entering ED2/ED3 unit, the patient either wanders in the corridor not knowing what to do, or seats him/herself in the units’ internal waiting room, or asks the clerk or RN what to do. If the unit is

crowded, the ED staff may not even have time to communicate to the patient and inform him/her that s/he needs to wait in the unit's waiting room or corridors for cubicles to be vacant (Process A is on hold/Process B starts). Meantime, the relative performs the registration (takes an average of 8 minutes 31 seconds from reaching ED door, n=33 cases). When this is done waits for the security guard to let him/her enters the unit (takes 73 seconds on average of 7 cases [n]). The relative then heads to the counter to give the clerk the admission paper (which needs signature) to initiate patient's admission to cubicle. In cases of crowding, the relative may not be instructed on what to do, so s/he might keep the admission paper with him/her and sit with the patient in the internal waiting room. Then the relative heads back to registration area to finish

payment issues, and finally returns to ED2/3 to be next to the patient (Process B ends/Process A presumed). When a cubicle is free, and the relative of the patient has finalized registration and payment, the patient is then admitted to the latter in order to be examined first by the RN, followed by MD student/intern/resident (average door-to-MD student/intern/resident= 19 minutes 36 seconds, n=129 cases) and discusses the case with the attending (usually at the isle or in corridors) before the latter sees the patient (Process A ends).

3. If patient is classified to be admitted to ED2 and is not accompanied with a relative, or ED3 with only one relative accompanying him/her, then the patient has to pass through both process A and process B.

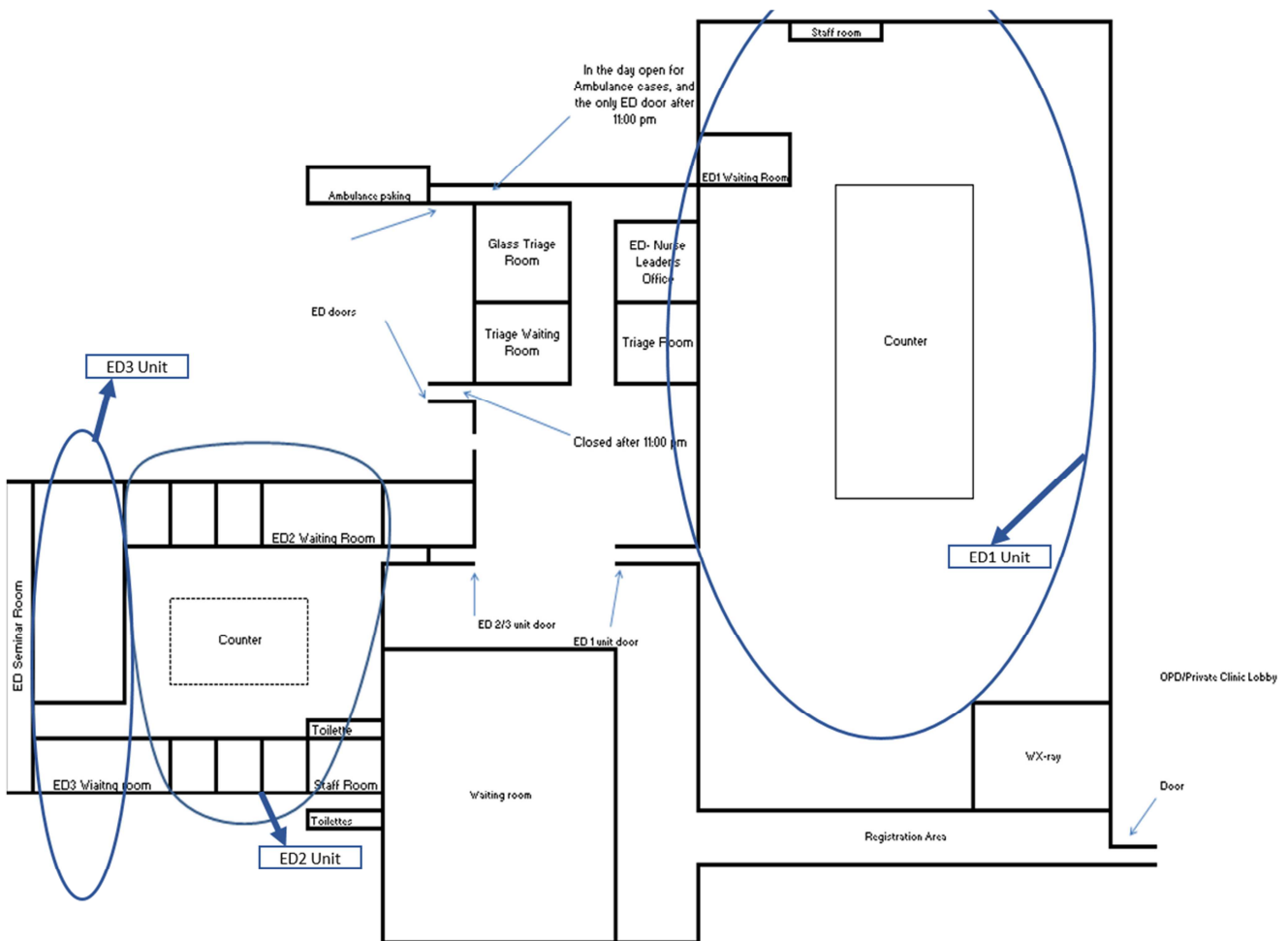
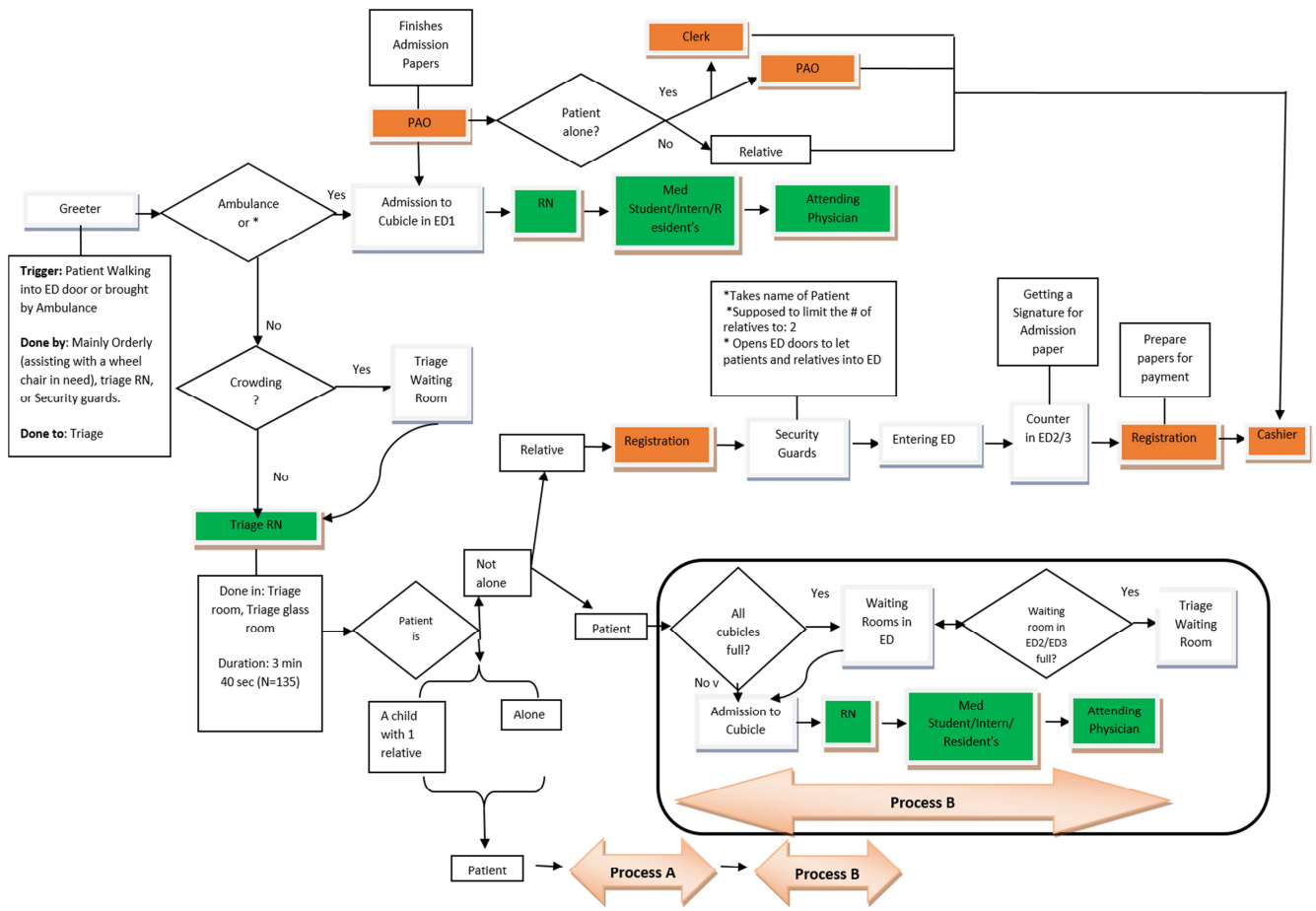


Figure 2. AUBMC-ED's layout.



Key:

- Red boxes indicate steps by which patients interact with Administrative staff in ED
- Green boxes indicate steps by which patients interact with healthcare providers in ED

*Patients suffering from severe chest pain or other symptoms of stroke/seizure, or other cases that are classified to be to be ESI 1 or 2 according to AUBMC-ED's Protocol

Figure 3. AUBMC-ED Process Map.

4.2. Calling for Lean

ED staff can work radically together to lessen the number of steps involved in D2D process. For example, Sumner Regional Medical Center in Gallatin implemented a change to lessen the number of D2D steps from initially forty four to four [13]. This approach has been similarly practiced in Three Rivers (MI) Health, a small rural community hospital with sixty beds when it launched the new design of ED process in October 2010. The ED staff worked to eliminate forty one steps in D2D process and cut the number of handoffs from five to one which served to decrease the D2D by 87% [14]. This redesigned process flow adopted a leaner culture that is more able to continuously meet customers' demands.

As presented earlier in Figure 3, AUBMC-ED has different routes that patients of different severities follow to receive their treatment. Each route incurs several non-value added activities and obstacles that hinder the D2D process from becoming more efficient. Table 5 presents these activities and obstacles and proposes different

recommendations for the process to become leaner.

4.3. Future AUBMC-ED Situation

After thoroughly understanding the work flow of D2D process in ED and discovering non-value added steps in the process, there is a driving force for the hospital administrators to implement changes to minimize them; thereby, enhancing efficiency, and promoting leaner thinking. The below changes to the ED process mapping activities mainly focus on minimizing crowding, recruiting additional Health Human Resources (HHRs), implementing new ED policies, infrastructural changes and Health Information Systems (HIS). They are also found in Table 5, matched to the gaps currently present at AUBMC-ED process flow. AUBMC-ED management department using the appropriate performance improvement tool can evaluate the effectiveness of the interventions.

- The literature supports increasing the number of health care providers [15]:
 1. An academic hospital entitled VU University

Medical Center, addressed a sample of patients who visited the ED on their own initiative (self-referrals), on one condition that their medical problem could be adequately treated by a General Practitioner (GP). The study indicated that staffing a GP in the ED is a cost-effective product compared to that provided by an emergency physician. However, it remains unclear in terms of its association with waiting time [16].

2. Other studies analyzed the effect of Nurse Practitioners (NPs) on cost, quality of care, satisfaction and wait times in ED. A systematic review concluded that adding one NP to treat minor injuries is more cost-effective than recruiting a board-certified doctor. In other words, the NP staffing option has proven to be practical in reducing waiting times and effective upon having a limited number of physicians [10].
 3. Staffing a greeter and a leading nurse were two interventions among others in Three Rivers (MI) Health that have been attributed to the decrease of D2D time by 87% [14]. Similarly, AUBMC-ED already recruited a greeter and assigned a schedule for some ED RNs to be *in charge* to control and oversee patients flow into ED1/ED2/ED3.
- b. Other staffing recommendations:
1. At AUBMC-ED, recruiting another orderly/courtesy officer is one viable option, because it was observed that security guards are performing responsibilities that are not inherent to their jobs, such as greeting and guiding patients. This may hinder the security guard from performing his duties fully. Recruiting a courtesy officer to guide and greet patients at the reception office, may allow the security guard to perform his assigned duties fully.
 2. Recruiting a PAO in ED2/ED3 to do bed-side registration like the case in ED1.
 3. The ED2 self-admitters (patients coming alone) as mentioned in "Current AUBMC-ED Situation" section, exert the most effort before being seen by an attending doctor. ED2/ED3 patients and their relatives feel left out and lost because they are not being accompanied by an HHR to know the steps in order to admit themselves or their relatives. And during the data collection process registration was observed to be a non-value added step that increased the dissatisfaction of patients and/or their relatives. Furthermore, the back and forth movement from registration unit to ED2/ED3 and vice versa increases psychological stress on the ED staff indirectly. That is why, replicating the processes of ED1 [ESI (3-5)] is the utmost feasible and affordable solution for the time being. The recommendation is to have additional PAO that performs the bed-side registration in ED2/ED3 units similar to the existing registration process in ED1.
- c. Implementing a *policy* to: limit the number of relatives to only one family member, to avoid ED crowding. AUBMC can do so by writing the policy and enforcing it by having signs all over the ED area and assisting the security guards to implement it as soon as possible.
- d. Implementing *infrastructural change* to minimize crowding through:
1. increasing corridor spaces inside ED units, the counter's spaces can be decreased by:
 2. increasing number of beds in ED3; thus, extending the area to take some of the external waiting room space to meet high volume of patients during peak hours.
 3. installing security barriers at registration to keep the customers (patients/relatives) from invading the space of another customer being served.
 4. closing the entrance between the registration unit and the outpatient clinics lobby to decrease the number of non-ED patients, such as AUBMC non-ED staff and outpatients, entering through ED door.
- e. Introducing a new *HIS*:
1. *Doctor and nursing documentation*: used to simplify ED charting. When implemented in Good Samaritan Hospital (GSH) in Kearney, a community partner hospital, it reduced duplication of work and increased efficiency in GSH's ED [17].
 2. *Mobile computer workstation*: Aligning with improving timeliness of D2D, JFK Medical Center had its patients undergoing both triage and registration at the bedside by a primary nurse and a registration staff using a *mobile computer workstation*. By that, one nurse meeting and one handoff are reduced which decreases the probability of error. The primary nurse is given a better chance to understand more thoroughly the patient's condition. Also, very importantly, bottlenecks that might occur at triage get eliminated. This showed an estimated decrease in D2D time of 12 minutes, in door-to-triage time from 25 to 17 minutes, and door-to-discharge from 3 hours to 1 hour 45 minutes [4]. And so, AUBMC-ED quality and management division can consider implementing a *mobile computer workstation* to replace paper-work and automating the current registration process (which directly finishes insurance procedures and sends an e-approval). Because ED2/ED3 patients and relatives might not know who to hand the registration paper for, which should be correctly placed in the "New Patient tray", decreasing the probability of the registration paper being unnoticed, dropped at the floor and accidentally stepped at or torn. Thus, this substitutes the extra recruitment of PAO to perform the bed-side registration in all ED units, hence decreasing crowding in ED units.
 3. A tracking display of patients' conditions inside ED can be implemented by installing LCD screens in the waiting areas as Three Rivers (MI) Health has already put into operation. Noting that the tracking display shows the patient's [case] number and not name in order not to breach privacy and confidentiality [14]. This would reduce any contact between the healthcare provider and the relatives

during the process of care, which may result in increasing the D2D time.

f. *Minimizing ED crowding* through:

1. Installing a *telephonic triage service*, this is used to decrease the number of patients not needing to utilize emergency services. An RN operating on a triage telephone line during all hours of the day and all days of the week can help the patients calling from home to decide whether to utilize the ED for care for their present medical condition or other healthcare delivery options. When implemented at Midland Memorial Hospital (Texas), it triggered a reduction in the D2D time by almost half and decreased the number of non-urgent ED patient volume, thereby avoiding bottle necks. Total LOS in ED was reduced from 180–200 minutes to 140–150 minutes, better Press-Ganey patient satisfaction scores were produced and 13% of the LWBS rates were cut [4].
2. Applying *Queuing theory*: a lean management principle that assists in the process flow. It is a quantitative study

that provides models to forecast system’s behavior when providing services for random arrivals. Key components of it include: patient arrival rate (number of patients per hour), service rate (rate of services offered per one arrival), and the variability around these rates. Queuing system also controls service delivery through prioritizing patients with the highest severity index (acute patients). It regulates the service responsiveness according to server usage (infrastructure and resources) to reduce patient’s waiting time [18]. At AUBMC-ED, applying queuing model will increase the preparedness of ED staff, because it gives an estimated volume and severity level of patients coming into ED.

3. Encouraging the department’s leadership team to sustain teamwork.
4. ED staff should be more attentive to guide patients coming back from X-ray to another cubicle so that they do not enter the cubicle that they were admitted to before heading to X-ray, which could have been occupied with another patient.

Table 5. Non-value added activities and obstacles in AUBMC-ED process flow and their corresponding recommendations to promote leaner thinking.

Non-value added activities and obstacles	Recommendations for a leaner D2D process
<p>ED door is utilized by individuals who are not directly heading to ED like AUBMC non-ED staff and outpatients heading to private clinics/outpatient department. This increases chaos in the ED and overwhelms ED staff.</p> <p>Triage nurse does not close door of triage glass room before performing triage, which may risk privacy of patients inside of it to be breached.</p> <p>Security guards were observed to have performed responsibilities that are not inherent to their jobs, such as greeting and guiding patients. This may hinder security guards from performing their duties fully.</p> <p>Customers standing in line at the registration area get in close proximity to the customer already being served, which may lead to frustration among customers.</p> <p>Relatives in the ED unit might exceed two per patient. This may lead to crowding and increased stress among ED staff and other patients.</p> <p>Patient/ relative is not guided by an ED staff to the specified ED unit after finishing registration and paying the bill.</p> <p>If patient 1 is asked to do an X-ray, they might come to head to the cubicle they were initially admitted to find that it is occupied with another patient (patient 2). This way, patient 1 has breached the privacy of patient 2 unwillingly. Patient 1 then felt neglected for having to wait in the waiting area till another cubicle gets empty.</p> <p>Pediatrics unit (ED3) is small in size and is not able to accommodate many patients at same time.</p> <p>The ED2/3’s small surface area is leading to collisions between ED staff and dropping off urine and blood samples on the ED floor.</p>	<p>Closing the entrance leading to private clinics/outpatient department.</p> <p>Implementing a policy that would emphasize closing triage glass room when patient is inside of it.</p> <p>Recruiting a courtesy officer to guide and greet patients at the reception office.</p> <p>Setting up security barriers that restrict other customers from invading the area of the customer being served.</p> <p>Implementing a policy in the ED to limit the number of visitors to two only.</p> <p>Recruiting a courtesy officer, who is attentive and always in place at the ED reception to guide and mentor the patient.</p> <p>Staff should be more attentive to guide patients coming back from X-ray to another cubicle so that they do not enter the cubicle they initially were admitted to.</p> <p>Performing infrastructural change to widen ED3 and incorporate more beds accordingly.</p> <p>Decreasing the counter’s surface area would increase the ED’s surface area.</p> <p>Telephonic triage service: can be utilized to decrease the number of patients not needing to utilize emergency services. An RN operating on a triage telephone line during all hours of the day and all days of the week can help the patients calling from home to decide whether to utilize the ED for care for their present medical condition or other healthcare delivery options.</p> <p>Applying Queuing theory, which is a lean management principle that assists in organizing the process flow.</p> <p>- Conducting feasibility studies to consider recruiting additional number of health care providers [15], possibly a: general practitioner (GP) nurse practitioner greeter and/or a leading nurse</p> <p>- ED quality and management division can consider implementing a: Mobile computer workstation to replace paper-work and eliminate the registration process (non-value added step). This also substitutes the extra recruitment of PAO to perform the bed-side registration. Doctor and nursing documentation to simplify ED charting, reduce duplication of work, and increased efficiency in ED</p>
<p>Crowding in ED units may lead to chaos and difficulty in identifying patients who need to be served before others.</p>	
<p>ED staff feel overwhelmed upon arrival of huge volume of patients per unit per hour.</p>	

4.4. Limitations upon Adopting the Future AUBMC-ED Situation

The major limitations for adopting the new proposed model are as follows:

- a. *Financial constraints*: ED management division needs to allocate a specific budget particularly to change the infrastructure of the ED by increasing ED3's surface area to accommodate the volume of patients it holds. Furthermore, the management needs to allocate a salary for a PAO and a courtesy officer. This will cost both time and money for both recruitment and training processes. The recruitment requires time from the ED management division to interview the short-listed candidates, which has a high opportunity cost. During the training process, the mentor will be training the newly-employed staff rather than performing his/her duties, increasing by that the opportunity cost which at a certain point in time might cost an increase in D2D time. Moreover, the cost of LCD screens which constitutes not only direct costs, but also running costs due to continuous maintenance. The cost of implementing the mobile computer workstation in terms of hardware and recruiting both internally and externally IT staff to customize and continuously maintain and update the software database of the computer network into the Dashboard of AUBMC-ED.
- b. *At bedside*: Conflicts over financial matters might probably occur between the patients/relatives and PAO next to bedside which is inappropriate scenario in a critical situation like the ED. This problem will persist even if the mobile computer workstation is implemented upon not receiving an e-approval from the insurance company.
- c. *Policy implementation*: for restricting the number of relatives to two family members per patient, this requires first promoting for change by educating and making relatives aware of the public health benefit out of it; which is decreasing the stress induced from the crowding in ED on both ED staff and relatives, which would affect the quality of care provided. Second intervention to implement this change will be done using enforcement by the courtesy officer.
- d. *Resistance to change*: inevitable condition of any change implementation to the current situations, especially upon introducing technology/HIS. Since the cornerstone factors for lean management to properly function are: management support, employee involvement (physicians, nurses, and other ED staff) and preparedness for change [10, 12]. Successful application of the lean methodology would require the managers to take the "subordinate role" and empower their delegates. That way, the employees would not feel forced to execute tasks delegated through the top-down approach, but rather feel more innovative in developing process improvement ideas [6]. This all requires

willingness and ability to change.

Other EDs of local Academic Hospitals

As an attempt to compare AUBMC-ED's process map flow to other academic hospitals in Lebanon seeking for continuous improvement, an observation at "Saint Georges" located in Ashrafieh-Beirut and "Makassed" Hospital located in Makassed Area-Beirut was done. Saint Georges has no triage whereby the patient or relative directly starts from registration and payment. The units are divided within the same surface area, and the attending is not present rounding about the cubicles, like in the case of AUBMC-ED. Instead, the attending stays in a closed room and patients leave the ED without being seen by him/her.

As for Makassed hospital, it resembles Saint Georges; yet, the patient is not asked to settle their bills until s/he is treated by an attending doctor who works along other ED staff. Note that Makassed has a triage room, which is currently used as a cubicle.

The below recommendations deduced from the literature, propose already implemented procedures in the current situation at AUBMC-ED, yet important implementations for academic hospitals like Saint Georges and Makassed hospitals to consider:

- a. *Fast-track*: is the most conventional lean management streaming process that is already being performed at AUBMC. It refers to the stream that handles less serious injuries and symptom patients. Streaming is a concept that is heavily tackled in the literature indicating its feasibility and importance. It designates the process of dividing patients going through triage into different streams/ processes. Its end product shows significant enhancement in operational outcomes (patient satisfaction). This is because it gives patients additional contact time with the nurse translating into shorter LOS, improved communication between patients and nurses (the voice of the customer became heard more effectively), and elevated patient satisfaction [9, 19, 20].
- b. *Scheduling the shifts of ED staff according to peak times*: Currently at AUBMC-ED, two triage nurses are assigned at duty during peak hours of the day. One takes vitals and the other fills the triage assessment form. Similarly, according to literature, the Sumner Regional Medical Center in Gallatin adjusted its staffing to meet the needs of patients, by changing the shifts of ED staff according to peak times. These have led to boosting the patient approval and enhancing the quality of care [13].

5. Conclusion

Lean focuses on improving the ED process flow through facilitating communication among ED staff and eliminating any unnecessary steps (wastes) along the process. D2D process map is one lean strategy that is useful for assessing the current ED situation. In this study, the average D2D time, one process indicator that reflects on patients' satisfaction,

was found to be 25 minutes. It was found that none of the severity levels, shifts or number of patients admitted to ED unit affect the D2D timing significantly. When analyzing the process map, it was found that low severity cases, who get admitted to ED2/ED3 follow more steps than the patients admitted to ED1/ED3 of high severity cases. It was found also that there are other non-value added activities and obstacles that are suggested to making the process less efficient. These include: ED door being utilized by individuals not directly heading to ED, entrance of more than two relatives per patient in to the different ED units, security guards performing duties not inherent to their jobs such as greeting, and patients and/or relatives being unaware of steps to do after they are done with registration. The paper then proposes multiple feasible recommendations that would redesign the current process map of AUBMC-ED for it to become leaner. These include recruitment of a PAO in ED2/ED3 to facilitate the procedure on the patients and their relatives. Furthermore, a courtesy officer has been proposed to be recruited to perform greeting instead of the security guard for s/he is the one responsible for controlling the number of relatives entering with the patient, which helps in controlling crowding. Introducing HIS by installing a doctor and nursing documentation, mobile computer workstation and tracking display were other recommendations that might lessen the number of steps followed by the patients and/or their relatives to more easily finish registration. For minimizing the crowding inside the ED units, telephonic triage service was recommended in addition to applying the queuing theory to forecast how the system should operate upon random arrivals. These recommendations, if implemented, will serve in the continuous quality improvement of AUBMC-ED process flow and thus enhance the indicator: patients' satisfaction. This paper also serves as a point of reference to promote lean thinking in EDs of academic hospitals in Lebanon and the region.

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