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Full Length Research Paper

Reducing queues in a Nigerian hospital pharmacy

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Queues are characterized structures formed to maintain order and create a hold on time, money and human contribution towards development and efficient performance of any system. The aim of this work was to characterize the queue, describe the queue discipline of the outpatient pharmacy, to institute a cross-sectional intervention by streamlining queue behaviour and to measure the impact of streamlining queue characteristics and queue discipline on waiting time of patients. Results showed that queue characteristics existing at the pharmacy during the situation analysis was a single server-multiple queue model. However, after the intervention was done involving staff re-orientation, the streamlined process reduced waiting time from 167.0 to 55.1 min. Queue discipline was strictly instituted by designed tally cards that were serially numbered. The characterization and discipline that was instituted handled and/or eliminated the challenge of shunting, balking or jockeying and reduced reneging. The workflow chart was sketched and drawn to scale, aiding the collation of baseline data and for proposed structural modifications. Other results obtained include the waiting area to pharmacy space ratio, which gave a good result of 1:9. Effort should therefore be intensified by hospital pharmacists to reduce patient queues and improve efficiency of services, following the results of snapshots from this work.

Key words: Queue characteristics, queue discipline, outpatient pharmacy.

INTRODUCTION

The effect of queuing during hospital visits in relation to the time spent for patients to access treatment in hospitals is increasingly becoming a major source of concern to a modern society that is currently exposed to great strides in technological advancement and speed (Stakutis and Boyle, 2009). Internal operational factors majorly determine outpatient waiting times and include; arrival pattern of prescriptions, sequencing of work, percentage of staff at work, interaction between the pharmacy service providers that is assessor and technician interaction or technician and counselor interaction (Moss, 1987).

A queue is a waiting line, whether of people, signals or things (Ashley, 2000). Queuing time is the amount of time a person, signal or thing spends before being attended to, or before value adding work is performed to or on it (Customer Management IQ, 2011). In many factories, queue time constitutes about 90% of the total lead time (Crabtree, 2008). Queue time can be extended to hospitals pharmacies where patients complain about the amount of time spent before treatment can be received (Bunday, 1996; Zhang et al., 2000). Queues deal with problems which involve waiting for a product or service.

Typical examples might be; hospital/pharmacies/banks/supermarkets waiting for service, computers used in hospital management information system (HMIS) waiting for response, power failure situation that involves waiting for electric power to be restored to enable a piece of machinery used for compounding a prescription medication function. Another example is the public transport system- waiting for a train or a bus to convey a consultant pharmacist to the hospital in the advent of an accident, poisoning or hypertensive emergency. Queuing models have mainly been used to study congestion for interrupted traffic flows at signalized and unsignalized intersections (Woensel and Cruz, 2009). However, it has been shown that they can also be

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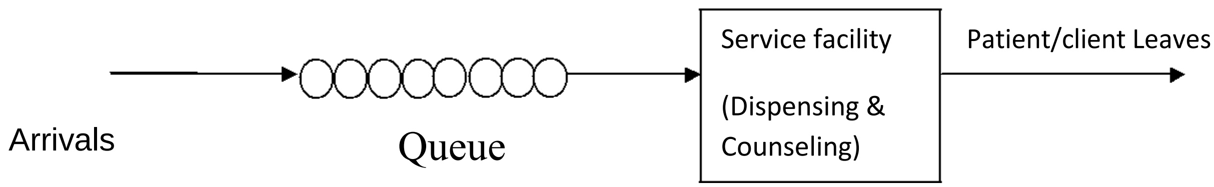


Figure 1. Single server single queue model.

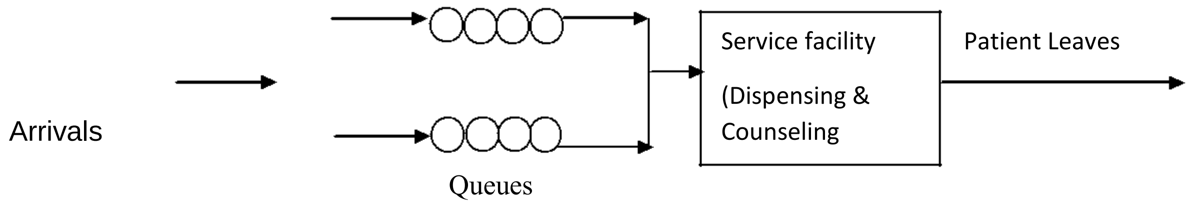
usefully applied to describe and analyze congestion for uninterrupted traffic flows in spite of the absence of the development of a formal queue. Queuing models applied to traffic situations provide an adequate description of the complex dynamic and stochastic environment under study (Woensel and Cruz, 2009).

In designing queuing systems we need to aim for a balance in services rendered to clients. In essence, all queuing systems can be broken down into individual sub-systems, consisting of entities queuing for some activity e.g. dispensing and counseling. Queue characteristics determines how, from the set of clients waiting for service, we choose the one to be served next (e.g. FIFO (first-in-first-out); LIFO (last-in-first-out); randomly). This order instituted for waiting is often called the queue discipline (David, 2005). Queue discipline can be examined so as to determine the queue characteristics to implore over a given period in providing pharmaceutical services from the outpatient section or from any other outlet (David, 2005; Noesk and Wilson, 2001). The queue discipline can include balking (clients or patients deciding not to join the queue if it is too long), reneging (clients or patients leave the queue if they have waited too long for service), jockeying (clients or patients switch between queues if they think they will get served faster by so doing).

Moreover, control can be attained using an electronic or manual tally to select a client to be served, a queue of finite capacity or of infinite capacity. Changing the queue discipline can often reduce congestion. The queue discipline often requires we choose the customer with the shortest service time, which will result in the lowest average value of time a client spends queuing. For example, attending to all outpatients with single-drug prescription orders before those with multiple-drug prescription orders will result in lower monetary yield that can influence a functional drug revolving scheme and ultimately the effectiveness of work hours for a pharmacy. It is important to appreciate the fact that the integral to queuing situations is the idea of uncertainty in inter-arrival times and service times (Willig, 1999).

Analysis of queuing situations and questions of interest, are those typically concerned with measures of system performance and include how long a customer expects to wait in the queue before being served or how long it will take to wait before service is complete. There are factors that need to be defined and controlled by health practitioners so that management can evaluate alternatives in an attempt to control/improve queue situations. Some of the problems that can often be investigated in practice include the effort invested in reducing the consultation, counseling or service time employed in practice. In addition, the number of pharmacists, pharmacy technicians, nurses, laboratory scientists or physician servers that should be employed to optimize efficiency or the introduction of priorities for certain types of clients, could serve as indicators. The adequacy of the waiting area for patients is subject to constant review by the hospital management board. The two basic approaches to solve these challenges involve the use of analytic methods or queuing theory for simple queues and simulated (computer based) application for complex queues. Queuing notations are commonly denoted by symbols; λ (lambda) being the mean arrival rate or average number of arrivals per time period, and μ (mu) the mean service rate or average number of clients/patients that are served (dispensing and counseling) per time period. Waiting in lines or “queues” seems to be a patient’s pastime. The frustration associated with those waits whether in line at the stoplight, or in the pharmacy, “waiting our turn” is part of everyday life. According to David (2005) and Zhang et al. (2000), the types of ordered queues, to institute discipline, are represented diagrammatically as shown in Figures 1 to 6).

There are standard notation systems to classify queuing models these are shown in Figures 1 to 6 (Kolobe, 2006). The server in this case is the pharmacist; Figure 1 represents the single server- single queue model (either being served or waiting for service), Figure 2 represents single server – multiple queue model, Figure 3 represents multiple (parallel) servers single queue model, Figure 4 represents the multiple (parallel) servers multiple queues model and Figure 5 represents the Multiple servers in a series to meet specialized needs (e.g. in an HIV/AIDS centre). Figure 6 represents multiple servers in parallel to meet specialized needs and cases (e.g. in a DOTs centre for tuberculosis patients). Based on the earlier queuing characteristics, the hospital pharmacy queuing system can then be classified following the conventional system employed globally (Munro et al., 2007).



Fingure 2. Single server – multiple queue model.

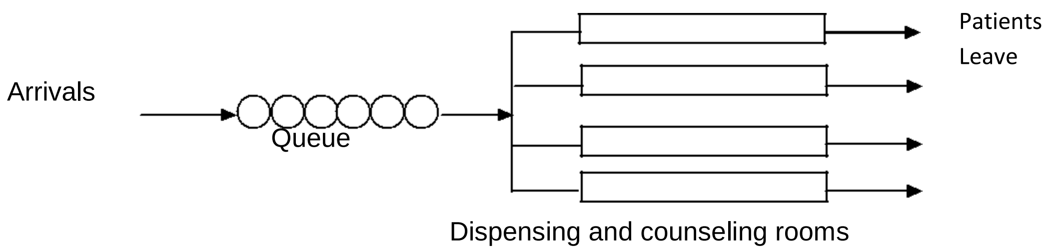


Figure 3. Multiple (parallel) servers single queue model

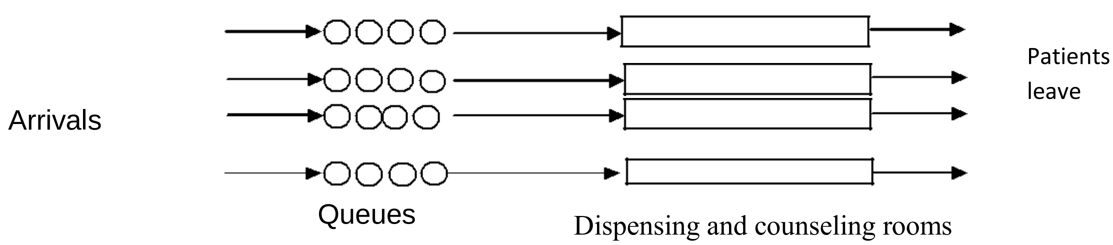


Figure 4. Multiple (parallel) servers multiple queues model.

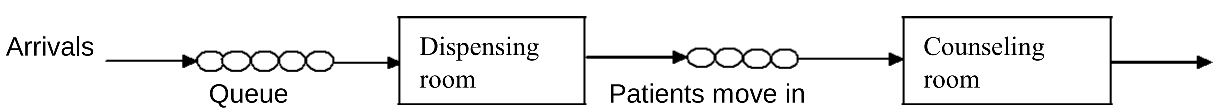


Figure 5. Multiple servers in a series to meet specialized needs (e.g. in an HIV/AIDS centre).

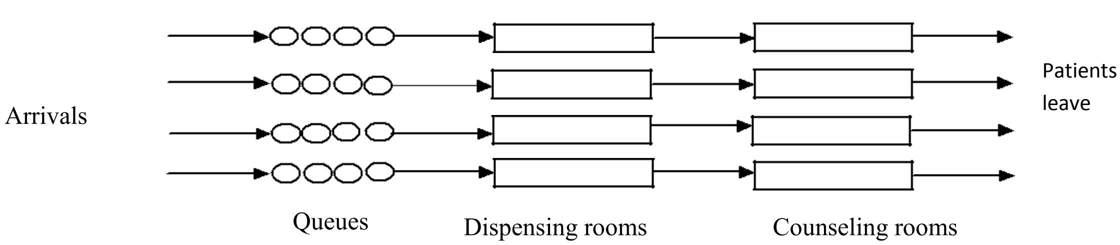


Figure 6. Multiple servers in parallel to meet specialized needs and cases (e.g. in a DOTs centre for tuberculosis patients).

Queuing theory and its application has gotten very little attention from pharmacy operations management. However, pharmacy practice could benefit by understanding and applying some of the theory's concept. Donehew et al. (1978), used queuing theory to address prescription queues and work measurement assessment of prescription fill times (WHO/EDM, 1999). Vemuri (1984) used computer simulation with a queuing model to assess patient waiting time in the outpatient pharmacy at the medical college of Virginia. This study concluded that the most significant factor contributing to patient waiting times was the interaction between pharmacy service providers, specifically the pharmacist and the technician. In a study by Moss (1987), queuing theory was used to assess the relationships among the number of pharmacy staff members, prescription dispensing processes and outpatient waiting times. He used a mathematical queuing model to estimate the probability of waiting time exceeding a given value when prescription arrival, service rates and number of servers are known. The study revealed that the major factors determining outpatient waiting time were the arrival pattern of prescriptions at the pharmacy, sequencing of work and percentage of staff at work.

Noesk and Wilson (2001) briefly discussed queuing theory using advanced mathematical models from queuing theory and customer wait-time on operations management for pharmacists. However, the only suggestion offered by the authors for managing perceived waiting time was to distract the client by providing entertainment, refreshments or comfortable conditions, such as television and coffee in the waiting area (WHO/EDM, 1993).

Similarly, Boyce and colleagues sought to determine the impact of a computerized waiting time program on order-turnaround time in a hospital pharmacy (WHO/EDM, 2002). Perhaps the most common and useful application of queuing theory in pharmacy operations is to reduce patient waiting time and maximize staff effectiveness. Lin et al. (1999) used workflow analysis and time study to identify factors leading to excessive waiting times in an ambulatory pharmacy at the University Hospital Inc., Cincinnati, Ohio. In another study by Lin, work measurement and computer simula-tion were used to assess the re-engineering of community pharmacies to facilitate patient counselling. Though queuing theory was never mentioned in these articles, the authors used many concepts similar to queuing theory's and their results could be instrumental in designing queuing applications for reducing patient waiting time and improving staff utilization. Analytic queuing network models often assume infinite capacity queues due to the difficulty of grasping the between-queue correlation. This correlation can help to explain the formation and spread of congestion. Osorio and Bierlaire (2009) presented an analytic queuing network model for finite capacity of queues and used structural parameters to comprehend the between-queue correlation. This novel model maintained the network topology and the queue capacities exogenous.

In addition, congestion was directly modeled via a novel formulation of the state space of the queues which explicitly captured the blocking phase, revealing the sources and effects of congestion. Automated queuing technology (AQT) is primarily utilized in the federal sector and includes numerous pharmacies like the Department of Veterans Affairs (VA), and the Department of Defence (DoD) of Navy hospital pharmacies in the United states. However, several prominent foreign pharmacy organizations utilize AQT, including the University of North Carolina, Medical College of Virginia, Jewish Hospital in Cincinnati and Parkland Hospital in Dallas (David, 2005). Both the DoD and the VA operate very busy outpatient pharmacy departments, some filling in excess of 2,500 outpatient prescriptions and servicing over 1,000 patients daily (David, 2005).

Automated queuing systems are typically PC based systems that can track a multitude of useful information that was previously very difficult to quantify for pharmacy managers. Pharmacies utilizing AQT can easily track variables such as customer arrival and departure time, patterns of arrival, prescription-fill time, waiting time and individual staff member productivity. In addition, AQT can track numerous points of service and different service categories (that is, certain patients may get priority service or can be used to track patient counselling) if desired. AQT can also provide clients with information that can directly improve their queuing experience, such as having a ticket with a unique number and the estimated wait time. This makes for a less confusing, more relaxed, and much more positive waiting environment for the patient.

At the time of this study, QMatic Corporation was identified as an example of a corporate body that distributes automated queuing technology systems (David, 2005). Many pharmacies do not experience problems with queues; however, there are many that experience difficulties with queue formation. For example, pharmacies that experience high-volume prescription workload frequently have difficulty in managing workflow and waiting times. This could also be true in pharmacies that offer their clients multiple points of service (that is, bank teller design type). Pharmacies such as those in large managed care organizations and university health systems typically fit this description. It is safe to say that the traditional methods employed by pharmacies to distract clients (e.g. comfortable waiting area, coffee and television) would be of limited benefit in pharmacies that fill in excess of 1,000 prescriptions per day and have patient waiting times that commonly exceed one to two hours. Automated queuing technology has been successfully developed and applied in areas of pharmacy practice that specifically address customer waiting times. Prior to this innovation, the most advanced queuing applications to manage customer waiting times in pharmacies was a consecutive number ticketing system commonly found in shops and stores.

The aim of this work includes characterizing the queue, to describe the queue discipline of the outpatient pharmacy, to institute a cross-sectional intervention by streamlining queue behaviour and pattern as well as to measure the impact of streamlining queue characteristics and queue discipline on waiting time of patients.

METHOD

Queuing discipline was strictly instituted by designing tally cards that were serially numbered. Workflow analysis that aids characterization of queues in the outpatient pharmacy involves the sketching of a schematic flowchart as shown in Appendix 1, representing the system of activities in the pharmacy that served the patients. The workflow highlighted on the sequence of activities involved in the dispensing procedure and dealt with what could be done, how fast it could be done, and how well it fitted into our present needs in the queue forms. The SPO (structure, process and outcome) model was applied to analyze the current situation of workflow present in the outpatient pharmacy (Marc, 2004).

RESULTS

Queue characteristics and queue discipline practiced in the outpatient pharmacy

The queue characteristics existing at the pharmacy during the situational analysis was single server-multiple queue model. However, after staff re-orientation and interaction, the intervention to streamline process and reduce waiting time was done and the queue character-ristics adopted by consensus and practiced was that of multiple servers, single queue model as adopted and modified (David, 2005; Zhang et al., 2000).

Queuing discipline was strictly instituted by designed tally cards that were serially numbered. The characteriza-tion and discipline that was instituted handled and/or eliminated the challenge of shunting, balking or jockeying and reduced reneging. The patient waiting time was reduced from 167.0 to 55.1 min which indicated a 67% reduction in time.

Other observed results

Other results obtained and identified include the waiting area to pharmacy space ratio that gave an approximate result of a 1:9 (21.72:195.16 (m^2)). The workflow chart was sketched and drawn to scale with suggested inputs as seen in Appendix 1.

DISCUSSION

Process control techniques was used to identify extremes in waiting time; root-cause analysis was employed to identify specific delay causes and minimize the contribu-tion of the root causes which led to an improvement in queue formations and overall system performance. During data collection, decrease in the occurrence of excessive clinic delays caused a large and sustained decrease in queues and in patient waiting times which was consistent with results of the work done (Groome and Mayeaux, 2010). Simple and compound waiting times are implicated in an attempt to access treatment through queues from the perspective of the patient (David, 2005).

In a study carried out, patients experienced difficulty in accessing treatment at healthcare facilities because of inconvenient opening hours and provider absenteeism as reported (Munro et al., 2007). About 60% of the respon-dents reported spending four hours and above at the clinic with some cases where participants spent the whole day on queues after coming two hours earlier than opening time.

However, various methods have been adopted to reduce queues to the barest minimum and this has led to several techniques employed by health care facilities to queuing and its characteristics on queuing systems, service or server efficiency, service space and service point(s) provided (Kolobe, 2006). The queue characteristics existing at the pharmacy during the situational analysis was that of a single server multiple queue model as characterized (Zhang et al., 2000). However, after staff re-orientation in strategy, technical and operational factors, and after proper intra-professional interaction, an intervention to streamline the queue patterns and reduce waiting time was implemented. The queue characteristics adopted, guided by a Delphi-technique consensus involving staff, was that of multiple severs single queue model. Considering the insufficient pharmacy staff strength in the health facility, the adoption was immediately implemented.

Analyzing the results of a previous work done by Green et al. (2006), timely access to a provider was observed as a critical dimension for quality performance in emergency department of hospitals. In an understaffed environment, analyses of arrival patterns and the use of queuing models was useful in identifying the most effective alloca-tion of staff. Queuing discipline was strictly instituted, using a time monitoring card in a first come-first serve (FCFS) order. The queue characterization and discipline instituted, controlled and/or eliminated the challenge of shunting, balking and jockeying. Having determined the waiting area to waiting space ratio to be 1:9 (21.72:195.16 (m^2)), the recommended queuing characteristics best for the outpatient pharmacy would have been multiple (parallel) servers multiple queues model. The streamlined processes reduced overall patient waiting time by 67%; from 167.0 to 55.1 min. The workflow chart was drawn to scale with suggested structural modifications recommended to improve on the existing outpatient pharmacy design to improve on workflow as seen in Appendix 1. A similar study conducted in a large VA hospital reported that pharmacy redesign improved patient satisfaction because of a 50% decrease in patient waiting time (Noesk and Wilson, 2001). Finally, another article described the relationship between waiting time and satisfaction in the context of social justice or injustice, as the case may be (Higby, 2002).

Conclusion

Queue characterization of a hospital's outpatient pharmacy is now possible for its queue characteristics and discipline. A cross-sectional intervention that involved streamlining queue behaviour and pattern was implemented. The queue characterization was that of multiple severs single queue model. Queuing discipline was strictly instituted, using a time monitoring card in a first come-first serve (FCFS) order.

The impact of streamlining workflow pattern on queue characteristics and discipline was measured and found to reduce waiting time by up to 67% from baseline data. Problems manifesting, specifically at the health facility under study included long waiting times, queues, lack of privacy, inconvenient appointment times and the poor upkeep of clinic appointments by patients.

Studies carried out elsewhere, were consistent with results from this work, the major issue that came strongly from the participants was the amount of time they spent waiting for service (Madaki, 2000). Therefore, effort should be geared towards developing appropriate techniques by which hospital pharmacists can reduce patient queues and improve efficiency of services rendered.

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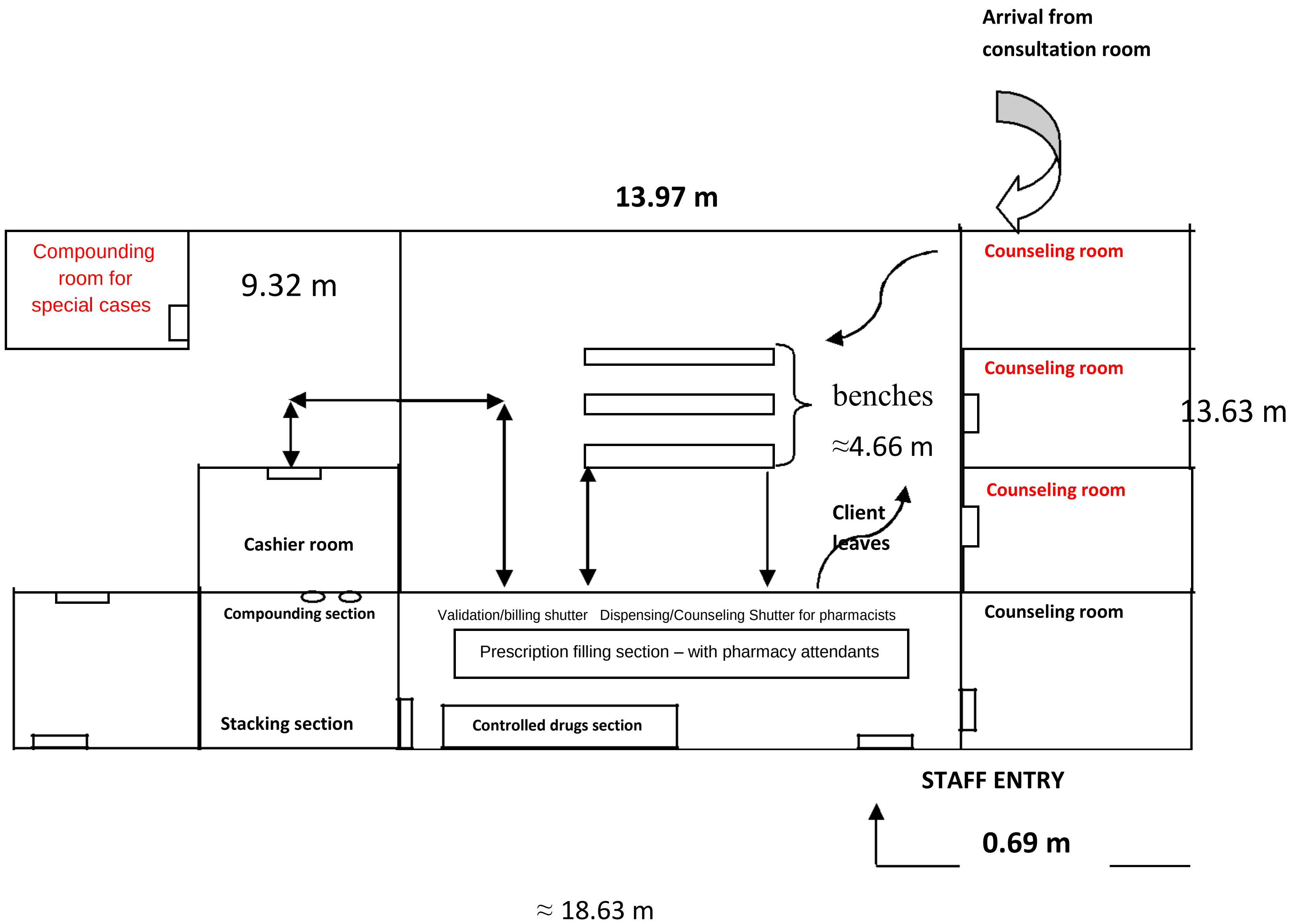
Appendix 1. Workflow pattern depicting patient flow in and out of the outpatient pharmacy for LUTH.



Black writings: existing structure; red writings: proposed (suggested) structural inputs; arrows: direction of patient queue formation pattern in and out of the pharmacy.