HSOR NEWS
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Capacity planning for an Acute Stroke Ward

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Why acute stroke ward (ASW)?

Stroke patients admitted directly to organized inpatient care in a dedicated ward have improved health outcomes compared with those in a general ward [1].

It facilitates best practice in one location and rehabilitation planning from the first day, improves patient safety, and enables multi-disciplinary care. TTSH's imperative is to admit patients with acute stroke into an ASW from the Emergency Department (ED), using a protocol of care. The expected length of the short stay is planned for a maximum of 6 days, after which patients are discharged or transferred to the general ward.

Question:

What should be the required size of the ASW for a given daily emergency patient demand that meets the 2 requirements of ASW: *(a) short stay and (b) urgency of admission?*

Requirement 1: Length of stay in ASW

TTSH admitted 1,584 patients (~4.3 patients/day) in 2009 for stroke-related causes whose average length of stay (ALOS) was 8.4 days (sd = 10.7 days).

Figs. 1a and 1b is a schematic representation of the patient flows with and without ASW.

Fig. 2a shows the length of stay (LOS) distribution in the general ward before ASW implementation. The probability distribution of the LOS is approximated as the long tailed negative exponential distribution with equation f(t) and ALOS (L). Fig. 2b shows what the LOS distribution may be in the short stay ward after ASW implementation.

Patients who would have stayed for >6 days will now stay for 6 days in the ASW before transfer.

If the ALOS of patients before ASW is (L), the ALOS of the ASW (L_{ASW}) is given by $L-(L-0.5)e^{-(b-1)/L}$.

For L = 8.4 days and b = 6 days, L_{ASW} = 4 days.

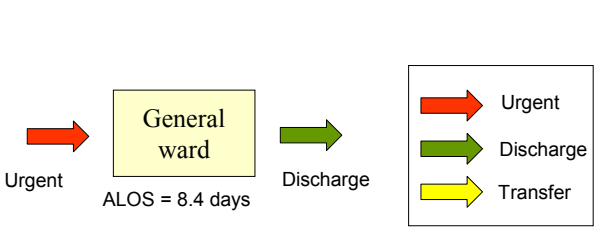

Fig. 1a—Patient flow before ASW implementation

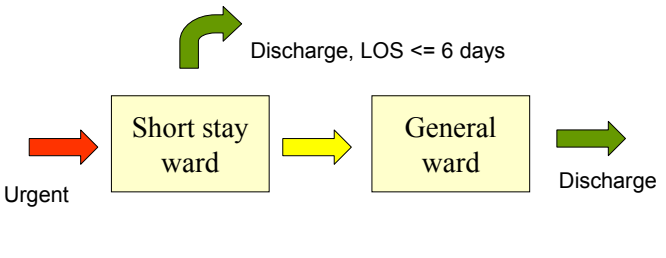

Fig. 1b—Patient flow after ASW implementation

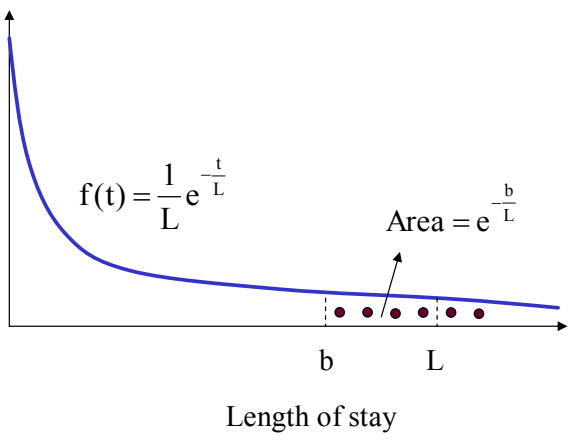

Fig. 2a—LOS distribution in general ward

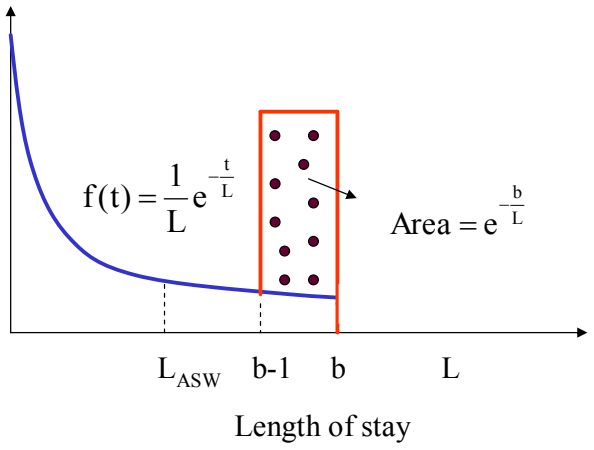

Fig. 2b—LOS distribution in the acute stroke ward

Requirement 2: Urgency of admission

With a daily demand (λ) of 4.3 patients/day, ALOS (L_{ASW}) of 4 days and a bed occupancy rate (BOR) target of 85%, the capacity (c) of the short stay ward is 20 beds (4.3x4/0.85).

But 85% is a target for a general ward which tolerates an admission waiting time of a few hours. For an urgent ward, the BOR has to be lower, as we need additional buffer to admit patients immediately.

Assuming we accept an operational risk (α) that 1% of the time the ASW is full and therefore a new urgent patient may have to overflow to the general ward, we find that the capacity needed is 27 beds using the 'Erlang loss' model equation *(A)* below. This results in a BOR of nearly 65%.

Next, there is a need to segregate the genders into 2 subwards. By splitting the arrival into 2 streams, we will need 32 beds in total resulting in more 'empty beds' on the average. It is a necessary cost when planning for urgent admissions with gender stratification.

$$\text{Prof patients overflow} = \frac{(\lambda L_{ASW})^c / c!}{\sum_{i=0}^{c} (\lambda L_{ASW})^i / i!} \leq \alpha \quad (A)$$

Conclusion

We have estimated the capacity of an ASW for urgent admissions of patients with stroke for short stays after which they are either discharged or transferred out – this comes with a cost of a low BOR and large buffer.

A limitation is that the distribution of the LOS is assumed to be similar before and after the intervention. This may not be the case.

Reference

1. Langhorne et. al. (2001) What are the components of effective stroke unit care? Age and Ageing 31:365-371

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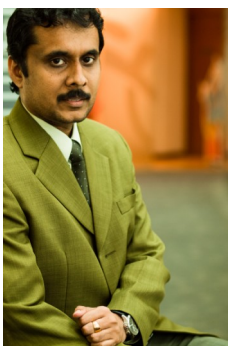

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