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Analysing Service Philosophies For Hospital Admission Planning By Simulation Process

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ABSTRACT
The 'traditional' service philosophy underlying hospital admission planning has been one of optimising the use of scarce hospital resources without paying much attention to the level of service offered to patients. As patients nowadays do not accept long waiting times for hospital admission, it becomes necessary to consider alternative service philosophies. Waiting lists have also become a political issue, and alternative service philosophies have been advocated, such as giving all patients an appointment for admission. A simulation model was built to examine the impacts of extreme service philosophies in a simplified hospital setting. The alternative philosophies considered are the 'zero waiting time' philosophy (immediate treatment) and the 'booked admissions' philosophy (using an appointment for admission). The results of these service philosophies are compared with the results of the current philosophy, i.e. the 'maximising resource use' philosophy. The implications of the different philosophies in terms of patient service and resource use are discussed and used to feed the debate on more balanced philosophies for admission planning.

Key Terms: *Booked admission, zero waiting time, service philosophies, Admission planning, Modelling approach*

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I. Introduction

Admission planning refers to the operational planning of patients who need to be admitted as inpatients to a hospital (Kusters and Groot, 1996). Patients to be admitted to a hospital can be classified as elective, urgent or emergency. Elective patients do not have to be treated immediately and can therefore be put on a waiting list, to be called when it is their turn. Alternatively, elective patients can be given an appointment for admission. Urgent patients need to be admitted at short notice, which is usually as soon as a bed becomes available. Emergency patients need to be admitted immediately.

The current service philosophy that drives admission planning in hospitals is to utilise the available resources to the maximum, i.e. to treat as many patients as possible within the constraints of available resources.

The waiting lists for elective patients are used as buffers for variations in the level of demand. Elective patients are scheduled by picking them from the waiting list in some priority order. This philosophy of 'maximum resource use' is increasingly viewed as unacceptable. In the current situation priority is given to optimisation of resource use without considering the consequences for the service level. As patients are increasingly aware of what is acceptable as waiting time, it becomes necessary to reconsider the trade-off between service level and resource use.

One of these alternative service philosophies currently in focus for admission planning can be labelled 'booked admissions'. The Pandian hospital promotes this philosophy to reduce waiting lists. Instead of putting patients on a waiting list, an appointment is made for the admission (Frankel *et al*., 1991). In effect, the waiting time for admission may be the same as the waiting time with a waiting list, but the patient now knows the admission date in advance. On the other hand, a chance exists that elective patients will have to be deferred if there is an unexpected inflow of emergency patients. Alternatively, resources might be inefficiently used if not all resources are taken into account when scheduling appointments.

II. Planning problem

To support the alternative service philosophies for admission planning, there is a need to examine the effects of these philosophies in a systematic way and to compare them with the current performance. For each of these extreme philosophies we can foresee the direction of the results, i.e. better performance regarding service versus better performance regarding resource use. This contribution is not, therefore, about providing new insights into the possible effects of the individual philosophies; rather, it aims to offer a platform for comparing the effects of different philosophies currently discussed in health care management forums. By providing information on the effects of these extremes in the debate on waiting list management, it is hoped that the parties involved will develop more feeling for the underlying mechanisms and be able to discuss a more balanced service philosophy for hospital admission planning. For the purpose of illustrating our approach, we use a simplified case derived from a hospital setting. Although the data used are realistic, the results will mainly have an illustrative function.

III. Literature review

The available literature on admission planning and waiting lists is rather extensive; see, for example, Gemmel and Van Dierdonck (1999) for a recent state of the art on admission planning and Mullen (1999) for a review on waiting lists and waiting list management. Many of the studies reported in Gemmel and Van Dierdonck (1999) are concerned with improving the scheduling of admissions and resources. For instance, Smith-Daniels *et al.* (1988) present an extensive literature review on capacity management in hospitals, and they conclude that most admission scheduling systems only consider bed capacity. This may lead to sub-optimal use of other resources such as nursing staff and operating theatre rooms. Fetter and Thompson (1969) introduced a patient classification system, diagnosis related groups (DRGs), that allows different resource requirements for patient groups to be taken into account when scheduling patients for admission. Roth and Van Dierdonck (1995) developed a Hospital Resource Planning system (HRP), based on a master admission schedule (borrowed from the theory on Materials Requirements Planning), that can be 'exploded' into plans for capacity requirements, while making use of the DRG system of patient classification. One other important issue in admission planning is how to deal with urgent and emergency admissions. In the HRP system (Roth and van Dierdonck, 1995) capacity for urgent and emergency patients is reserved, based on a prediction of demand. Groot (1993) uses a planning model for admissions that forecasts resource requirements, taking into account the occurrence of emergency patients. The focus of these studies is to improve the technique of scheduling patients for admission, by taking into account all resources involved, different resource requirements of different patient groups, and ways of dealing with urgent and emergency admissions. All the studies reported regard the level of scheduling of admissions, and do not address the level of the service philosophy behind the scheduling technique, which is the focus of our study.

Mullen (1999) gives a state of the art overview on waiting lists and waiting list management. Many of the studies reported deal with prioritisation, i.e. the order in which patients are selected from the waiting list. This is an important issue in waiting list management, but it is not the topic of this research. Worthington (1991) illustrates in his approach the impact of mechanisms in planning a specialty practice, for instance an extra clinic session, on waiting lists. Bowers and Mould (2002) investigate the effect of concentration and variability of orthopaedic demand on the performance.

In this study we do not aim at a contribution to improve the technique of scheduling admissions, but we aim at a contribution to the service philosophy that governs the technique of planning. The literature reports few studies with a focus on the service philosophy used for scheduling. Some studies investigate policies for a well-defined category of patients such as patients waiting for liver transplantation (Ratcliffe *et al*., 2000), or cardiac surgery (Wright *et al*., 1996) or a hip replacement (Saleh *et al*., 1997).The focus of these disease-specific studies

is often more on the rules of prioritisation and resource allocation, and not so much on the service philosophy driving the admission planning. In this study, we focus on generic and extreme philosophies rather than disease-specific admission policies.

IV. Case study setting

In this case study we consider only one specialty (for instance general surgery) with one type of patients. The five resources considered include:

- Normal beds in wards (denoted by 'N Beds'), expressed in number of beds;
- beds in intensive care units (denoted by 'ICU beds'), expressed in number of beds;
- operating theatre facilities (denoted by 'OTT'), expressed in number of minutes per day;
- nursing capacity (denoted by 'NPT'), expressed in nursing points (a measure of nursing workload) per day;
- specialists (denoted by 'SPT'), expressed in number of minutes per day.

The amount of capacity available for each of the resources is given in Table.1. These amounts are chosen in such a way as to represent a system operating – in a high workload setting – with balanced occupancy levels. As we focus in this study on the impact of philosophies, we want to exclude problems due to there being unbalanced occupancy levels in the baseline situation. Although arbitrary, we have chosen an average occupancy level of 90 per cent for beds and other resources, but for ICU beds an average occupancy level of 65 per cent occupancy. Intensive care units have smaller numbers of beds and more variation in workload, and can, therefore, only operate on a lower occupancy level than other resources (Macfarlane, 1996; Ridge *et al.*, 1998). For a very high workload setting we use 95 per cent for beds. This is quite high for a setting with 50 per cent emergency inflow, but we allow for 20 per cent overflow for borrowing beds and other resources and 70 per cent for ICU beds.

Resource	Unit of resource	Available capacity
Beds	Number of beds	**30**
ICU beds	Number of beds	**5**
OTT	Minutes per day	**360**
NPT	Nursing capacity points	**120**
SPT	Minutes per day	**450**

Table.1 Capacities available Pandian hospital

The number of regular beds available matches roughly with a ward. The number of ICU beds available for the specialty is an approximation of the number of beds available for cardiac patients from the total number of ICU beds of the ICU unit. The number of minutes of OTT available matches an operating theatre session of 6 hours per day. The number of nursing points available per day matches very roughly with a staffing complement of 5 nurses during the day. The number of SPT minutes per day matches very roughly with a situation with 2 surgeons.

Patient characteristics

We combine urgent and emergency patients as both categories concern non-scheduled patients. We assume an annual inflow of 1,560 patients for a high load setting (or an equivalent of, on average, 6 patients per day), split arbitrarily into 50 per cent elective and 50 per cent emergency.

Elective patients do not need immediate treatment. We suppose that referrals for admission take place only during the working week. Once a decision is taken for admission, the patient is put on a waiting list to be called for admission at a later stage. Each working day patients are scheduled from the waiting list for a period of N working days ahead (notification period). No elective patients are admitted during the weekend.

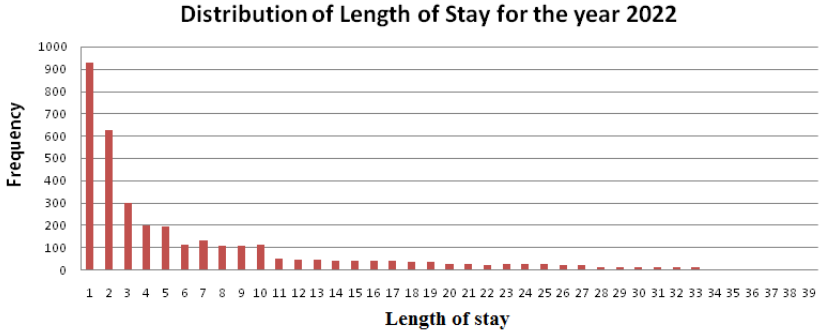

Figure 1 Distribution of length of stay

We consider all inpatient admissions with a length of stay of more than one day. All patients are operated upon on the day of admission. We assume that the length of stay of patients is stochastic (for frequency distribution, see Figure.1) and that this stay can be split into different phases (day of admission/operation, day after operation, other days) that have different resource requirements. We assume an average resource requirement profile during the stay as shown in Table.2.

Resource	Phases in stay of patient		
	Day of admission operation	Day after operation	Other days
Beds	1	1	1
ICU beds	0.30	0	0
OTT (minutes)	60	0	0
NPT (points)	4	4	2
SPT (minutes)	70	10	10

Table 2 Average resource requirement profile during stay of patient

The operation takes 60 minutes of operating theatre time. After the operation 30% of the patients require an ICU bed, but only on the day of operation. The patient requires a regular bed for the whole stay. Even when a patient stays in an ICU bed, the bed at the regular ward will be kept free for the return. The patient requires four nursing points of care during the day of operation and the day after – normally the days with most workload – and two nursing points of care on the remaining days.

Elective patients can be cancelled on the day of admission because there is no capacity available due to emergency arrivals. When the admission is cancelled the patient returns to the top of the waiting list.

Emergency patients need immediate treatment. We suppose that if an emergency patient arrives and no resources are available, the patient will not be admitted and will be moved to another hospital. Emergency patients follow the same resource requirement profile as elective patients. We assume a Poisson distributed arrival process with different arrival rates for the day and night.

Philosophies

In this study we distinguish the following service philosophies for admission planning: maximum resource usage (denoted by 'RUM'), null (zero) waiting time (denoted by 'WTZ'), booked admission without coordination (denoted by 'ABWNC'), and booked admission with coordination (denoted by 'ABWC').Table.3 summarises the characteristics of the different philosophies.

The philosophy RUM tries to maximise the use of resources without considering the impacts for patients. This philosophy resembles the current way of handling patients. First, we determine a certain percentage of the capacity of resources to be reserved for emergency patients. Next, as many elective patients are admitted as possible with the remaining resources, taking into account the expected resource utilisation levels for the next N days ahead. These N days correspond to the notification period used to call elective patients for admission.

	RUM	**WTZ**	**ABWNC**	**ABWC**
Reservation for emergency	Yes	No	Yes	Yes
Waiting list for electives	Yes	No	Appointment	Appointment
Notification period	Fixed	No	Variable	Variable
Cancellation of electives	Similar for all philosophies			
Rejection of emergencies	Similar for all philosophies			
Planning of resources	All resources	No	OTT and SPT	All resources

Table.3 Summary of characteristics of service philosophies

The philosophy WTZ strives to admit all patients immediately, without any delay or waiting time. WTZ treats all patients like emergency patients, so no spare capacity is required for emergency patients. However, differences between 'real' emergency and 'pseudo' emergency remain, i.e. emergency patients have priority over elective patients. If the hospital is fully occupied, the elective patient will be put on a special waiting list to return next day.

ABWNC is a philosophy that gives a patient an appointment for admission without considering the availability of all resources that are required for the admission. Only the availability of operating theatre time and specialist time are considered. We suppose that this philosophy comes nearest to the practice of booked admissions where appointments are given in an outpatient setting where the specialist can consult only his or her own diary and the scheduling of operations in operating theatre sessions, and not the availability of beds, ICU

beds and nursing staff. For each arriving elective patient, we determine the earliest date of admission by taking into account only operating theatre capacity and specialist capacity. However, when not enough capacity is available on the day of admission/operation, the patient' admission is cancelled and they are given a new date for arrival.

ABWC is similar to ABWNC, but this philosophy considers all resources when the date for admission is determined. This philosophy resembles a practice in which the specialist can consult a computer support system with information on the availability of resources when making an appointment for the admission. For every patient the earliest admission date is determined, using information on the residual length of stay of patients who have already been admitted and information on the expected length of stay for all patients scheduled for admission prior to the patient considered.

V. MODEL - Simulation model

The simulation model is built to compare the impacts of different philosophies for a simplified hospital setting. For this model we have made several assumptions and we will give justifications for these assumptions. The general assumptions used for all philosophies include:

- The number of patients arriving each day is Poisson distributed with an average of 6 patients per day (representing a setting with a high load) and 6.5 patients per day (representing a very high load level). Based on 50 per cent elective and 50 per cent emergency, the arrival intensity for each type of patients can be derived. The length of the day part and evening/night part was used to distinguish between the arrival rates for emergencies during the day and during the evening/night, respectively.
- The model interprets the capacity available for a specialty not in a very strict sense. We suppose for all resources except ICU beds that 20 per cent extra capacity is available before the decision is taken to cancel or reject patients. Compared with the target capacities in Table.1, this corresponds with an extra capacity of, say, eight beds (that can be borrowed from another ward), an extra capacity of two hours OT capacity (in case the operating theatre session overruns), and equivalent amounts of extra NP and SP capacity (representing the flexibility of these personnel resources for dealing with extra work). The ICU beds are interpreted in a strict sense, as one extra bed added to the two beds normally available would make the model insensitive for the different philosophies. Emergency patients leave the system when they are cancelled, while elective patients return to the waiting list when the admission is cancelled. Even with this less strict interpretation of available capacity, cancellation and rejection may occur in the model more often than in reality. The results should, therefore, be seen as illustrative.
- All patients have a fixed duration of operation of 60 minutes. In reality, the duration of the operation is stochastic, but in this study we are not interested in this feature of hospital operations. In reality, sessions may overrun if operations take longer than scheduled.
- At the time of scheduling an admission, it is known whether the patient will require an ICU bed after the operation.
- Emergency patients arrive during the day and the night, while elective patients can be admitted only during the day.
- We assume that during the night operating theatre and specialist capacity is always available, and that in the beginning of the night all ICU beds are available. Elective patients can be operated on only during the day, with restrictions on the number of operating theatre resources available as noted in Table 1.

The procedure for simulating events uses the following order for each day of the simulation: discharge of leaving patients; emergency admissions during daytime; admission of elective patients; determination of admission date for patients on the waiting list who do not have a date yet; and, finally, emergency admissions during night-time. The procedure for planning electives takes into account the patients in the hospital, the patients already scheduled within the notification period and the capacity reservation for emergency patients.

Performance criteria

The performance criteria considered are the utilisation of resources (beds, ICU beds, operating theatres, specialists, and nursing staff), the average waiting time for patients, the percentage of cancelled patients at the moment of admission, the percentage of emergency patients that are rejected, as well as the percentage of days the target capacity use is exceeded. The waiting time calculated by the model is the time that is not spent in the hospital between the initial arrival of the patient in the outpatient or emergency department and their inpatient admission. If the admission of the patient is not cancelled, this is simply the time elapsed from the arrival to the scheduled admission date. For elective patients who are cancelled, the waiting time is the sum of all waiting times until the patient is eventually operated upon.

VI. RESULTS

In Tables.4 and 5 we summarise the main results of this study for different load levels, and for two levels of reservation for emergencies and two periods of notification for the RUM philosophy. All service philosophies are simulated with the same patient flow. We assume no waiting list at the beginning of the simulation. The simulation is carried out over 06 batches of 25,000 days, which was long enough to produce reliable results (average results with standard errors less than 1 per cent for all results except waiting time, which may have a larger error of about 5 per cent; the first batch was used as the warm-up period and was disregarded in the calculation of results).

Philosophies	RUM with N=1		RUM with N=7		WTZ	ABWNC		ABWC	
Emergency reservation	R=0	R=1	R=0	R=1		R=0	R=1	R=0	R=1
Utilisation of resources (%)									
Beds	85	85	85	85	85	85	85	85	85
ICU beds	63	65	63	65	63	63	63	63	63
OT	84	84	84	84	84	84	84	84	84
NP	83	83	83	83	83	83	83	83	83
SPT	81	81	82	81	81	81	81	81	81
Average waiting time (in days)	1.5	3.0	8.1	9.2	0.5	1.5	1.7	1.5	3.0
Cancellation percentage electives (%)	8.3	3.3	8.3	3.3	0	11.5	7.2	8.3	3.3
Rejection percentage emergencies (%)									
Daytime	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
Night-time	1.7	1.5	1.5	1.4	1.7	1.6	1.5	1.7	1.5
Percentage days target capacity use is exceeded (%)									
Beds	17	16	17	16	17	17	17	17	16
OT	38	26	38	25	38	36	25	38	26
NP	16	15	15	14	16	16	15	16	15
SPT	21	17	21	16	21	21	17	21	17

Note: RUM = maximum resource use; WTZ = zero waiting time; ABWNC = booked admission without coordination; ABWC = booked admission with coordination; ICU = intensive care; OT = operating theatre; NP = nursing capacity; SPT = specialists; N=notification period, R= number of reservations for emergency patients

Table.4 Summary of results for a high load level (ICU=65%, other resources 90%)

First, results are given for the utilisation of the different resources realised in the simulation. The realised utilisations can deviate a little from the target utilisation level. This is due to the setting of parameters for arrival intensity and due to the possibility of cancellation and rejection. Next, results are given for the average waiting time, the percentage of elective patients that are cancelled, the rejection of emergency patients during the day and during the night, and the percentage of days the target capacity use is exceeded. The average waiting times produced by the model are shorter than the waiting time common in practice. One explanation is a difference in the interpretation of waiting time. In practice, waiting time often also includes the visit to the pre-operative screening. In addition, we consider only cardiac specialty with a proportion of 50 per cent emergencies. In many other specialties (for instance general medicine, neurology, pulmonology), the percentage of emergency patients can be as high as 70–90 per cent).This will also result in longer waiting times.

At this level of resource occupancy, the philosophies RUM with N=1 and ABWC produce the same results. Maximising the resource utilisation of all resources involved, and booking admissions while considering all resources involved, does not make a difference. ABWNC produces similar or even shorter waiting times (in the case of a reservation policy for emergencies) but with a higher level of cancellation of elective patients. The cancellation of elective patients can be reduced greatly for all philosophies by making a reservation for emergency patients. This increases the waiting time slightly. For the RUM philosophy, using longer notification period results in a corresponding increase in the length of the average waiting time. When a patient is cancelled, under a RUM philosophy the patient needs to wait again at least as long as the notification period. WTZ has, of course, the shortest waiting time, and no cancellations. The ABWNC philosophy produces the most cancellation of elective patients, compared with RUM or ABWC. This is due to the fact that the ABWNC philosophy uses all capacity left (after reserving capacity for emergency patients) for elective patients. If it becomes very busy due to peaks in the arrival of emergencies, this will result in cancellation of elective patients. Rejection of patients during the day and the night is at a similar level for all philosophies. Apparently, the philosophies do not have much impact on the rejection of emergencies. The degree to which target capacity use is exceeded also

does not differ much between philosophies. In the case of a reservation policy for emergencies, the chance of exceeding target capacity use is lower than in the case of the no reservation policy.

At a very high level of resource occupancy the results are most interesting. Now not all arriving patients can be treated and shortages of resources occur more often, not only for ICU beds but also for regular beds. For all philosophies except ABWNC, waiting times substantially increase in the case of reservation for emergency patients. The explanation is that ABWNC does not consider all resources and, therefore, reservation policies do not have much impact. At this level of occupancy, reservation for emergency also leads to a slightly better occupancy of ICU beds. Cancellations of elective patients and rejections of emergency patients occur more often. Again, the WTZ philosophy is best in waiting time but less good in relation to the rejection of emergency patients during night-time. The cancelling of elective patients occurs most often with the ABWNC philosophy. This illustrates the somewhat naive planning in the ABWNC philosophy that considers only OT and SPT. For all philosophies, the chance of exceeding target capacity use is much higher than at a lower level of resource occupancy.

As we have chosen our parameter settings in such a way as to operate under comparable resource constraints, it is possible to tell something about the efficiency of resource use of the different philosophies. By supposing a setting with comparable service performance of the different philosophies, we can draw a conclusion on resource use. When, for instance, for a very high level of resource occupancy and a reservation for one emergency patient, we suppose a cancellation percentage for all philosophies to be 5–7 per cent, the ABWNC philosophy requires more resources than the RUM philosophy and the ABWC philosophy. The WTZ philosophy requires more resources to produce a similar level of rejection of emergency patients to the other philosophies.

Philosophies	RUM with N=1		RUM with N=7		WTZ	ABWNC		ABWC	
Emergency reservation	R=0	R=1	R=0	R=1		R=0	R=1	R=0	R=1
Utilisation of resources (%)									
Beds	93	93	93	93	93	93	93	93	93
ICU beds	68	71	68	71	68	68	68	68	71
OT	92	92	92	92	92	92	92	92	92
NP	91	91	91	91	91	91	91	91	91
SPT	90	89	90	90	90	90	89	90	89
Average waiting time (in days)	1.8	14.3	8.5	20.6	0,8	1.9	2.4	1.8	14.3
Cancellation percentage electives (%)	11.0	4.9	10.9	5.0	0	14.9	9.4	11.0	6.6
Rejection percentage emergencies (%)									
Daytime	0.1	0.1	0.1	0.1	0.1	0.1	0.2	0.1	0.1
Night-time	4.4	3.9	4.0	3.8	4.6	4.3	3.9	4.4	3.9
Percentage days target capacity use is exceeded (%)									
Beds	36	35	36	35	36	36	35	36	35
OT	50	36	49	35	50	47	34	50	34
NP	34	33	33	32	34	33	33	34	33
SPT	40	34	39	34	40	39	34	40	34

Note: RUM = maximum resource use; WTZ = zero waiting time; ABWNC = booked admission without coordination; ABWC = booked admission with coordination; ICU = intensive care; OT = operating theatre; NP = nursing capacity; SPT = specialists; N=notification period, R= number of reservations for emergency patients

Table.5 Summary of results for a very high load level (ICU=70%, other resources 95%)

VII. Findings and Conclusion

The conclusions of this study regarding the results of the different service philosophies for admission planning on performance measures such as resource use and waiting times can only be formulated tentatively, as it is not yet proved that the model developed is robust to the simplifications made. At this stage of development it is only possible to formulate a number of possible conclusions provided that the model has passed the test of robustness. Therefore conclusions are presented as an illustration of the type of conclusions that can be drawn:

- Simulation can help in the study of the effects of different service philosophies for admission planning of hospitals by visualising consequences in a comparative way.
- The simplification of the case study hospital (one specialty and one patient category) does not necessarily harm the generalisable nature of the findings, as long as essential characteristics are included (e.g. emergency flow, stochastic length of stay). The simplicity of the case allows for a better focus on the

analysis of performance of different philosophies. Some of the simplifications make the model differ from reality but still make it possible to draw conclusions in a comparative way.

- The results of the simulation show that the philosophies have a different impact on the performance. The scenario with very high occupancy levels produces longer waiting times, higher cancellation percentages and more frequent excess of target capacity levels – as can be expected. The cancellation of electives can be reduced by reservation of capacity for emergency patients. Reservation for emergency patients proves to be very effective, although at a very high level of occupancy it increases the waiting time substantially. This effect is more prominent with the RUM and ABWC philosophies than with the ABWNC philosophy.
- It is important for policy makers to see that RUM as a current philosophy does not perform badly at all. The waiting times under RUM are not longer than the ones under the philosophies ABWNC or ABWC, and cancellations of elective patients and rejections of emergency patients do not occur more often. The advantage of the ABWNC and ABWC philosophies is that patients know in advance the date of admission. However, for the ABWNC philosophy this seems to be more a marketing point than reality as many appointments need to be cancelled due to the variability in the number of emergency patients per day. The ABWC philosophy performs better in this respect, and illustrates the advantage of coordination. The WTZ philosophy is best in waiting time but less good in rejections of emergency patients during night time. This does make the WTZ philosophy less acceptable as a philosophy. The RUM or ABWC philosophies show the best performance for a hospital operating on a high level of resource occupancy.

The results and approaches of this study can be helpful for policy makers who are discussing alternative service philosophies for hospital admission planning and attempting to find an appropriate balance between resource utilisation and service levels. The ‘maximum resource use’ philosophy is where we come from, and its performance in a hospital with a high load on resources is not bad at all, as shown earlier. The major drawback of this philosophy is that the patient does not know the exact admission date in advance. In addition, waiting times in a real world situation might be longer. The ‘zero waiting time’ philosophy sounds attractive but shows serious drawbacks in the handling of emergencies. Because of the stochastic nature of the emergency patient flow, the workload will show huge variations in time. These can be handled only by deferring patients in the case of a fully occupied hospital or by creating over-capacity. The popularity of booked admissions philosophies is due to its patient friendliness, but coordination of resources should not be neglected. The ‘booked admissions without coordination’ philosophy has as a major drawback the many cancellations of elective patients, which is not patient friendly at all. The ‘booked admission with coordination’ philosophy can overcome this drawback. The right handling of the emergency patient flow, for instance by making a sufficient reservation of capacity, is the key to a successful philosophy. The best philosophy is probably a mix between the extreme philosophies that booked admissions for certain well-defined categories of patients, for instance day-surgery patients, a reservation of capacity for emergency patients and a waiting list system for other categories of elective patients with a sufficiently long notification period to allow the patient to prepare for the admission.

The approach is illustrated for a specific case setting. The approach can also be used for other specialties with different characteristics, or for a whole hospital. Depending on these characteristics the outcome may differ for each setting. For instance, a specialty with hardly any emergency patients could benefit from choosing a booked admissions policy, as cancellation of patients due to inflow of emergencies will not happen. To use the approach for a whole hospital with a range of specialties would make it possible to compare the outcomes for the different specialties and to show that the best philosophy might be different for each specific setting.

As other recommendations for further study, more service philosophies for admission planning could be included in the study. An alternative philosophy, for instance, would be to have a number of patients on call for ‘last minute’ admissions when other patients have been cancelled. Furthermore, we could also evaluate the philosophies on their effectiveness in clearing long waiting lists. It remains also to be investigated whether the philosophies that perform best under the purely stochastic scenario of this study, would remain best under circumstances with periods of time when demand exceeds capacity, perhaps due to seasonal effects, ward closures, sickness of personnel, etc. Another extension might be to include more resource areas in the ABWC analysis, for example rehabilitation services for hip replacements. Delays in access could extend patient stay.

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