A Review on Intelligent Decision Support System for Operation Theater

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Abstract — *The present hospital information systems available in public hospitals, lack a decision support system component that could help achieve better planning solutions. Thus, an intelligent decision support system has been developed, allowing the centralization and standardization of processes planning, the efficiency improvement of the operating theater and well structure the waiting lists for surgical fragile situation. The intelligence of the system formed with the help data mining and optimization techniques, which enhance surgery duration predictions and operating theatre surgery schedules. The experimental results which show significant output, reducing overtime, under time, and better resource utilization. In this topic, intelligent decision support system for operating theater planning and scheduling, and the performance improvement is presented. The two major functions of the system are: (i) To measure the performance of the operating theater (ii) to aid users devising better scheduling alternatives by supporting the task of creating better plans with data mining and optimization technique.*
Keywords— Decision support system (DSS), Operating Theater (OT), Planning.

I. INTRODUCTION

With increase in quality of life, people's life duration has been increase over period of time. Health care organization such as hospitals has to face the significant increase in demands from peoples. The demands could be in form of scheduling of operations, effective management of Hospital resources such as doctors and machinery used in Operation Theater. Today's people are accepting good health care services from hospital, because everyone gives importance to their health and conscious about it. These acceptations of people gave rise for better and satisfactory service that need to be provided by hospital. Hence from hospitals point of view, they need to understand the growing demands of peoples and provide a satisfactory services to peoples. To tackle with this problem health care organization first need to understand their resources such as amount of doctors, quantity and quality of Patients room, no of Operation Theater available etc.

With this background, to maintain good service levels and patient satisfaction, health care organizations have two options. First one is either expand capacity of hospital in form of resources and second one is increase existing resource utilization. The first approach needs investment of huge capital and therefore this option would not be first choice of decision makers of organization. Second option seems to be promising where there is no need for large investment in expansion of capacity. In second option basic idea is to make proper utilization of available resource, so as to minimize need for purchasing extra resources. Here intelligent decision support system comes into the picture. The ultimate goal of this decision support system for Operation Theater is to make proper scheduling and utilization of resource so as to make satisfaction of both organization and peoples in form of patients. This system helps organization in developing course of actions that will easily facilitate scheduling of resources without much investment. The operation theater is considered as the biggest budget consumer and revenue center in a hospital and its performance has a severe impact on peoples in society. One of the issues in scheduling Operation Theater is reducing waiting lists for surgery are a critical issue that affect many lives.

The system was mainly designed for two users, as surgeons and hospital managers. This will provide them a planning framework for tactical and operational problems. The two main functions of the system are: (i) to provide users the means to monitor and to measure the performance of the operating theater and (ii) to aid users devising better scheduling alternatives by supporting the task of creating better plans with data mining and optimization techniques. In later sections we will first see need for developing decision support system and further evolution of decision support system starting with old ones which have least functionality to current ones with advance functionality. We will also see advantages and benefits of each strategy. Next section is all about evolution of decision support system for Operation Theater.

II. NEED FOR DSS

Main need for decision support system is proper scheduling of critical patients. Critical patients need to get scheduled as early as possible, because of risk factor associated with their life. Next need is form business point of view as everyone wants to grow their business and hence through use of DSS organization will provide good services to user thus attracting the customers to towards them. Another need could be to reduce investment in expansion of organization.

<center>III. LITERATURE SURVEY</center>

This section describes the evolution of DSS for Operation Theater. There are two types to scheduling techniques described in this section. First is *Offline Scheduling* which consider static parameters for scheduling i.e. scheduling is based on early identification of parameters required for scheduling. Offline scheduling does not consider scheduling on patients with dynamic or on time entry. Second technique is online scheduling which considers dynamic entry of patient and schedules him/her based on criteria such as age, gender, disease etc. following are papers surveyed which describes both *offline and online* scheduling.

A. In papers [1]-[3], decision making is based on statistical methods to predict the time required to compute a series of surgical task. Here criteria considered for scheduling is only operation room no other parameters such as priority of patient, type of patient i.e. emergency and general conditions. Hence optimal scheduling results are not generated here. And hence during course of time these techniques have become outdated now. There is a need to have a decision support system which will consider all aspects of scheduling and yield maximum throughput along with optimized schedule.

B. Offline scheduling [4]-[10]

As discussed above offline scheduling is static scheduling technique which needs all decision making parameters in advance such as age, gender, severity of disease etc. Main aim of online scheduling technique is to minimize overtime and maximize throughput [4]. Overtime will act as a crucial factor if patient is too serious; also if patient is not treated within time then further treatment would be of no use. Throughput can be in form of number of patients surveyed in given duration of time. Offline scheduling techniques try to make schedule in such a way that will maximize the throughput of organization. Reference [5] considers patient constraint as an input parameter in making decisions. Constraint considered is deadline to perform a given surgery in given time.

This is because if surgery is not performed within given time then this will have negative effect of patient's health. In worst case patient may loss his life. Hence deadline to perform surgery in given time is crucial parameter in decision making. Reference [8] considers minimizing hospitalization cost, overtime and patient waiting time as input parameter. Service is acceptable if it is affordable. This is considered here, which focuses on reducing hospitalization cost. Also if waiting time for patients is more, then patients will not prefer our health organization to visit again. Keeping this in mind DSS in [8], makes decision governing to above mentioned factors. Reference [9] considers quality of care measure and reduces waiting for children during morning. This is because quality of care is an important aspect which will attract much of patients and also help them to recover as early as possible. Technique used in [10] reduces under time and overtime in scheduling.

B. Online scheduling

Online scheduling is dynamic scheduling technique. The emergency patients who cannot be planned in advance are considered in this technique. Emergency patients have high priority in scheduling and should be given first preference in treatment [11]-[14]. Online scheduling considers this constraint and makes decision in such a way that surgery should start as early as possible In online scheduling factor such as duration of surgery is also considered [15]. This is because of use of shared resources such as operation theater room, doctors etc. If duration of surgery is known, scheduling of subsequent surgeries can be done in effective manner.

Other factors such as anesthesia type, risk associated with surgery, patient age and gender [16] is also taken in account while performing decisions. This will factor will enhance decision making capabilities of system by increasing effectiveness of results. The nature of time period required in surgery is not fixed hence we need to consider upper and lower bound on surgical process. This will give maximum as well as minimum time limit to perform operation [17]. We need to also consider if mistake happens then what will be decisions that should be followed this is described in [18]. To reduce harmful and expensive medical mistakes and help clinical staff to perform their jobs better decisions are produced.
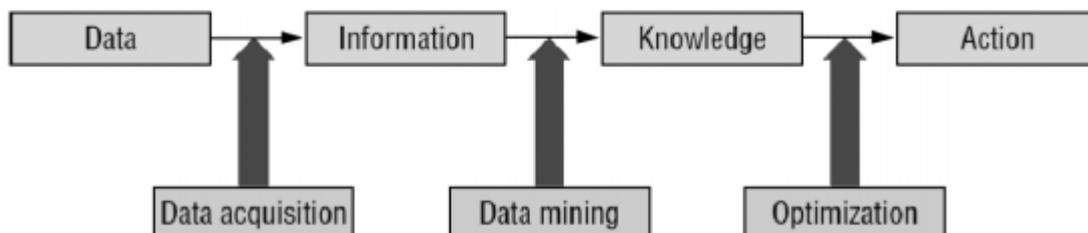

<center>Fig:1 Intelligent decision support system process flow.</center>

IV. WORKING OF DSS

Fig: 1 shows general flow of activities in decision making. First we have set of raw data, upon which activity called as data acquisition is performed which includes data cleaning, data pre-processing, and data transformation activities. These activities will convert raw data into information. Next data mining is performed on generated information which will yield knowledge. Knowledge is hidden information which we need to extract. Lastly by use of knowledge we can make decisions which will lead to actions. In context of DSS for operation theater data could be no of patients, doctors working in organization, available physical resources etc. By process of data acquisition we will gather this data and refine it to produce information. Next using technique known as data mining we will analyze our input parameters to produce knowledge. Knowledge is actual decisions produced by system. Next through process of optimization we will enhance the effect of decision produced by DSS.

A. Characteristics of DSS
- Event and change detection.
- Error Detection and recovery.
- Identify information out of date.
- Predictive capabilities.

V. CONCLUSION

In summary, this paper reports the development of a decision support system intended to endorse the process of operating theater scheduling. The solution presented is mainly directed to the efficient management of the operating theater, where data mining and optimization components are added to allow for more effective scheduling. With best knowledge this work is the first to combine the said techniques to reduce surgery uncertainty and to achieve a better utilization of the present resources through scheduling optimization in decision support systems. The outcome, regarding both scheduling and estimation of duration of surgery, are better than the current reality and also Provide the end-user a way when planning, compared to the methods used in the past. Extensions of the optimization model to include other upstream and downstream resources shall be considered in the future, as well as the development of a simulation component to better evaluate generated solutions.

VI. REFERENCES

[1] F. Dexter, R. D. Traub, and F. Qian, "Comparison of statistical methods to predict the time to complete a series of Surgical cases," J. Clinical Monitoring and Computing, vol. 15, pp. 45–51, 1999.

[2] B. Cardoen, E. Demeulemeester, and J. Beliën, "Operating room planning and scheduling: A literature review," EurJ.Oper. Res,ol. 201, no. 3, pp. 921–932, 2010.

[3] F. Guerriero and R. Guido, "Operational research in the management of the operating theatre: A survey," Health Care Manage. Sci., vol. 14, pp. 89–114, 2011.

[4] B. T. Denton, A. J. Miller, H. J. Balasubramanian, and T. R. Huschka, "Optimal allocation of surgery blocks to Operating rooms under uncertainty," Oper. Res., vol. 58, pp. 802–816, Jul. 2010.

[5] M. Lamiri, J. Dreo, and X. Xie, "Operating room planning with random surgery times," in IEEE Int. Conf. Autom Sci. Eng. (CASE'07), 2007, pp. 521–526.

[6] H. Fei, C. Chu, N. Meskens, andA.Artiba, "Solving surgical cases assignment problem by a branch-and-price Approach," Int. J. Prod. Econ., vol. 112, no. 1, pp. 96–108, Mar. 2008.

[7] E. Hans, G.Wullink, M. van Houdenhoven, and G. Kazemier, "Robust surgery loading," Eur. J. Oper. Res., vol. 185, no. 3, pp. 1038–1050, 2008.

[8] A. Guinet and S. Chaabane, "Operating theatre planning," Int. J. Prod. Econ., vol. 85, no. 1, pp. 69–81, 2003. [9] A.Riise and E. Burke, "Local search for the surgery admission planning problem," J. Heuristics, vol. 17, pp. 389–414, 2011.

[10] A. Jebali, A. B. H. Alouane, and P. Ladet, "Operating rooms scheduling," Int. J. Prod. Econ., vol. 99, no. 1–2, pp. 52–62, 2006.

[11] M. Lamiri, X. Xie, A. Dolgui, and F. Grimaud, "A stochastic model for operating room planning with elective and Emergency demand for surgery," Eur. J. Oper. Res., vol. 185, no. 3, pp. 1026–1037, Mar. 2008.

[12] D.-N. Pham and A.Klinkert, "Surgical case scheduling as a generalized job shop scheduling problem," Eur. J. Oper.Res., vol. 185 no. 3, pp. 1011–1025, Mar. 2008.

[13] D. Min and Y. Yih, "Scheduling elective surgery under uncertainty and downstream capacity constraints," Eur. J. Oper. Res., vol. 206, no. 3, pp. 642–652, 2010.

[14] M. Persson and J. Persson, "Analysing management policies for operating room planning using simulation," Health Care Manage. Sci., vol. 13, pp. 182–191, 2010.

[15] Y.Li, S. Zhang, R. F.Baugh, and J. Z. Huang, "Predicting surgical case durations using ill-conditioned CPT code Matrix," IIE Trans., vol. 42, no. 2, pp. 121–135, 2009.

[16] D. P. Strum, J. H. May, and L. G. Vargas, "Modelling the uncertainty of surgical procedure times: Comparison of log-normal and normal models," Anaesthesiology vol. 92, no. 4, pp. 1160–1167, 2000 [Online]. Available: http://www.ncbi.nlm.nih.gov/pubmed/19762753

[17] P. S. Stepaniak, C. Heij, G. H. H. Mannaerts, M. De Quelerij, and G. De Vries, "Modelling procedure and surgical times for current procedural terminology-anaesthesia-surgeon combinations and evaluation in terms of case-Duration prediction and operating room efficiency: A multicentre study," Anaesthesia Analgesia, vol. 109, no. 4, pp. 232–1245, 2009. SPERANDIO et al.: AN INTELLIGENT DECISION SUPPORT SYSTEM FOR THE OPERATING THEATER: A CASE STUDY 273

[18] C. Jao and D. Hier, "Clinical decision support systems: An effective pathway to reduce medical errors and improve Patient safety," Decision Support Syst., pp. 121–138, 2010.